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62nd ISI WORLD STATISTICS CONGRESS 2019

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Preface

The 62nd International Statistical Institute World Statistics Congress (ISI WSC 2019) has a long tradition since 1887, held for the first time in Kuala Lumpur, Malaysia on 18 to 23 August 2019. ISI WSC 2019 is a global gathering of statistical practitioners, professionals and experts from industries, academia and official authorities to share insights in the development of statistical sciences.

The congress attracted an overwhelming number of participants across the regions. The scientific sessions were delivered over five days with parallel sessions and e-poster sessions running all day long. The scientific program reaches across the breadth of our discipline that comprised of Invited Paper Sessions (IPS), Special Topic Sessions (STS) and Contributed Paper Sessions (CPS). Papers presented exhibit the vitality of statistics and data science in all its manifestations.

I am very honoured to present the proceedings of ISI WSC 2019 to the authors and delegates of the congress. The proceedings contain papers presented in IPS, STS and CPS which were published in fourteen (14) volumes. Scientific papers were received from August 2018 and were carefully reviewed over few months by an external reviewer headed by Scientific Programme Committee (SPC) and Local Programme Committee (LPC). I am pleased that the papers received cover variety of topics and disciplines from across the world, representing both developed and developing nations.

My utmost gratitude and appreciation with the expertise and dedication of all the reviewers, SPC and LPC members for their contributions that helped to make the scientific programme as outstanding as it has been.

Finally, I wish to acknowledge and extend my sincere thanks to the member of National Organising Committee of ISI WSC 2019 from Department of Statistics Malaysia, Bank Negara Malaysia, Malaysia Institute of Statistics and International Statistical Institute for endless support, commitment and passion in making the ISI WSC 2019 a great success and congress to be remembered.

I hope the proceedings will furnish the statistical science community around the world with an outstanding reference guide.

Thank you.

Dr. Mohd Uzir Mahidin
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Relation between Economic Cost of Having Child and the Socio-Economic Demographic Determinants: Case Study

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Abstract
Statistical and economic studies in the field of population are rare, at the national level in Egypt and also at the global level are not enough Therefore, this study is concerned with calculating the cost of a child (before and after birth),the aim of the study was to know the relationship between socio-economic and demographic factors and the cost of having a child it was use multiple regression and study was found that many factors were significant affected on the cost of having a child like (Age at first marriage, Husband educational status, Mother age at first child, Total expenditure, Total income, Duration of married life) and it was positive relation our Recommendations: For researchers interested in financial and economist have to do more study about the Economic Cost of Having Child

Keywords
Economic Cost of Having Child; Significant affected; positive relation; multiple regression.

1. Introduction

Like most developing countries, Egypt suffers from the population problem which is one of the most important impediments to the overall development to the overall development. Egypt became aware of the existence of a population problem represented in its first dimension in rapid increase in population growth rate as an inevitable result of highness of fertility rate remarkable sharp decline in mortality rate since the forties of the last century. Since the sixties of the last century Egypt has adopted many of population policies and programs that work to lower fertility rate, despite the decrease in the total fertility rate kept in pace with such increase.

The most of the world countries suffer from the population problem on one way or another, Egypt suffers in particular and developing countries in general from the existence of steady population increase this problem is that such increase hinders the development efforts on one hand and the imbalance between the resources of the country and the increase in the other hand. Thus, two problem arise one of them is the provision of basic needs of the steady increasing population, and the other problem is to reduce the gap between them and developed countries. However, there are countries their population problem is represented in the low population growth. The problem of population decline in these countries (some developed countries characterized by the phenomenon of seniority) is represented in being made remarkable progress in all areas, and in order to maintain their achievements they must have manpower needs to maintain this progress and continue with it, but there is another side to that problem at the individual and family levels lying in the desire of many people to enjoy the luxury and this would reduce the desire for childbearing, and therefore fertility decline in these communities. If this the case with developed countries despite of the high development condition in general and economic conditions in particular the matter that may lead to reduce fertility .Therefore, this will be the first priority of developing countries in general and in Egypt in particular to look after fertility from an economic standpoint.

It was many studies like study of Expenditures on Children by Families 2015, (M) Lino, (K) Kuczynski,(N) Rodriguez, (T) Rebecce (2015 (Summarized that Since 1960, the U.S. Department of Agriculture (USDA) has provided estimates of annual expenditures on children from birth through age 17. This technical report presents the 2015 estimates for married-couple and single-parent families. Results shown the Expenditures are provided by age of children, household income level, major budgetary component (housing, food, etc.), and region (for married-couple families).

Study of The Career Costs of Children (J) Adda, (Ch) Dustmann, ((K) Steven (2015) This paper studies fertility and labor supply of women to quantify the life-cycle career costs associated with children. We estimate a dynamic life-cycle model, extending existing work by incorporating occupational choices, allowing for skill atrophy that is occupation specific and can vary over the career cycle, and by introducing risk aversion and savings. This allows us to better understand the interplay between job characteristics, such as skill atrophy or differential wage growth, and the planning of fertility, as well as the sorting that takes place both into the labor market and across occupations, and to capture the trade-off between occupational choice and desired fertility. We use this model to determine the costs of children, how they decompose into loss of skills during interruptions, lost earnings opportunities, lower accumulation of experience, and selection into more child-friendly occupations, and analyze what are the longer run effects of policies that encourage fertility.

Study On Measuring Child Costs: With Applications to Poor Countries (A) Seaton, (J) Muellbauer (1986) was showed The theoretical basis for measuring child costs is discussed, and de- tailed consideration is given to two straightforward procedures for calculation, Engel's food share method and

Rothbarth's adult good method. Each of these methods embodies different definitions of child costs so that the same empirical evidence can generate quite different estimates depending on the method used. It is shown that true costs are generally overstated by Engel's method and under- stated by Rothbarth's procedure, although the latter, unlike the former, can provide a sensible starting point for cost measurement. Our estimates from Sri Lankan and Indonesian data suggest that children cost their parents about 30-40 percent of what they spend on themselves.

Study of Estimates of the Cost of a Child in Ireland (E) Garvey, (E) Murphy, (P) Osikoya(2011) showed that The cost of a child is estimated using information from the household budget surveys from 1987 to 2004. We use an Engel method, where the share of household expenditure on food and a broader basket of necessities both act as proxies for the material standard of living. The cost of a child is also disaggregated according to age, gender and the income status of the family. We find that older children are more costly than younger children and that children cost proportionately more in lower income households. The gap between the cost of children for lower and higher income households has increased over time. Our findings on the cost of children according to age are consistent with international findings and previous results for Ireland. Our results on the cost of children according to the income status of their families are consistent with the results of international studies using comparable methods.

Study of The Rising Cost of Child Care in the United States (M) Chris (2015) showed that Anecdotal evidence suggests that the cost of child care in the U.S. has increased substantially over the past few decades. This paper marshals data from a variety of sources to rigorously assess the issue. It begins by using nationally representative survey data to trace the evolution in families' child care expenditures. I find that the typical family currently spends 14 percent more on child care than it did in 1990. This is less than half the increase documented in previous work. Interestingly, low-income families spend the same amount or less on child care, while their high-income counterparts spend considerably more. Despite this divergence, families at all income levels allocate the same share of income to child care as they did several decades ago. The next section of the paper draws on establishment- and individual-level data to examine trends in the market price of child care. The evidence suggests that after persistent, albeit modest, growth throughout the 199•s, market prices have been essentially flat for at least a decade. In the paper's final section, I analyze several features of the child care market that may have implications for prices, including the demand for child care, the skill-level of the child care workforce, and state regulations. A few findings are noteworthy. First, I show that child care demand stagnated around the same time that market prices leveled-off. Second, although the skill-level of the child care workforce increased in absolute terms, highly-educated women increasingly find child care employment less attractive than other occupations. Finally, child care regulations have not systematically increased in stringency, and they appear to have small and inconsistent effects on market prices. Together, these results indicate that the production of child care has not become more costly, which may explain the recent stagnation in market prices.

2. Problem of the study

The study problem has characterized in the following point:

- Not knowing what the cost of having a baby?
- Not knowing what is the relation between the cost of having a baby and the Socio-Economic and Demographic Determinants?

3. Study objectives

This study aims to

- Find out the cost of having a child
- Determine the relation between the Socio-Economic and Demographic Determinants and Economic Cost of Having Child

4. Study Methodology

Use of multiple regression analysis method to discover the effect of social, economic and demographic factors at the cost of having a baby.

5. Source of data: Field study Data Sources

The field study was conducted using the following steps: The questionnaire form was designed in light of previous studies and results of focus group (15) and (15) in-depth interviews. The focus group and in-depth interviews were conducted, The questionnaire (660) case Approval of the finalized questionnaire form was obtained from the Central Agency for Public Mobilization and Statistics (CAPMAS), The mother of children approved verbally to conduct the survey, most of them accepted to complete the survey, Duration of the interview between 20-30 minutes.

6. Determination of the study population

The study population is determined as (Mothers whose ages are 15-45 years, and have one baby at least this study applied on 6th October governorate.

7. Results

The study has calculated the cost of have child which mean (cost of pregnancy and childbirth care, Delayed pregnancy, follow- up pregnancy, birth process, health of the baby, the cost of raising a child (school, clothes and shoes, books and tutorials, transportation, food, medicine, personal expenses, remedial teaching, other expenses).

Efficacy of Classification of the model of social, economic, demographic on the cost of having child (cost before bring a baby and cost after having a baby). The Model is acceptable because the (F test) showed was significant and the result showed the quality of model was 73%

The result of the model was showed That many factors affect in total cost of Child - like Age at first marriage, Husband educational status, Mother age at first child, Total expenditure, Total income, Duration of married life) all the relation is positive relation so its mean when any factor increase its mean the Economic Cost of Having Child and when any factor decrease its mean Economic Cost of Having Child decrease it showed in table (1).

8. Recommendations

For researchers interested in financial and economist have to do more study about the Economic Cost of Having Child

Annexes

Table 1: Socio-Economic and Demographic Determinants Affecting on total Economic Cost of Having Child

	B	S.E	T-TEST	S.
Constant	5158.29	3193.43	1.615	0.107
Residence	-604.00	454.84	1.328	0.185
Age at first marriage	650.50	117.92	5.516	0.000
Mother educational status	269.24	481.04	0.560	0.576
Husband age	-26.73	49.48	0.540	0.589
kinship between the husband and wife	164.02	421.58	0.389	0.697
Husband educational status	1523.75	548.22	2.779	0.006
Husband work out country	-265.99	554.76	0.479	0.632
Mother age at first child	-594.56	93.99	6.326	0.000
Total expenditure	2022	0.47	4.688	0.000
Total income	-1.65	0.48	3.401	0.001
Husband work status	-1096.16	756.56	1.449	0.148
Mother work status	1324.07	1730.30	0.765	0.444
Duration of married life	673.10	6.90	1.874	0.000
$R^2 = 0.731$ $F = 55.008$ Sig = 0.000				

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A new discrete analog of the continuous Lindley distribution, with reliability applications

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Abstract
Apart from discretization techniques, we propose and study a new natural discrete analog of the Lindley distribution as a mixture of geometric and negative binomial distributions. The proposed model extends some recent discrete Lindley distributions like the discrete Lindley of Bakouch et al. (2014), the two-parameter discrete Lindley of Hussain et al. (2016). The new distribution has many interesting properties which make it superior to many other discrete distributions, particularly in analyzing overdispersed count data.

Keywords
Discrete Lindley analog; Maximum likelihood; Mean residual life; Negative binomial distribution; Reliability

1. Introduction

In spite of all the available discrete models. There is still a great need to create more flexible discrete lifetime distributions to serve many areas like economics. social sciences. biometrics and reliability studies to suit various types of count data.

As a consequence. various models that are less restrictive than those presented in the statistical literature. (see. e.g., Nakagawa and Osaki (1975). Famoye (1993). among others). are needed.

In order to create a natural discrete analog of Lindley's distribution (Lindley. 1958). we relied on the well-known fact that the geometric and the negative binomial distributions are the natural discrete analogs of the exponential and the gamma distributions. respectively (see. e.g. Nakagawa and Osaki (1975) and Roy (2004). among others). This fact has motivated us to construct a natural discrete analog to the continuous Lindley distribution by mixing the discrete counterparts of the exponential and gamma distributions. apart from, discretizing continuous distributions. More specifically. a new two-parameter natural discrete Lindley (TNDL) distribution can be constructed as a mixture of geometric and negative binomial distributions] with common success probability θ and mixing proportions $\frac{\theta}{\theta+\beta}$ and $\frac{\beta}{\theta+\beta}$.

This new distribution can be considered as an alternative to the negative binomial. Poisson-inverse Gaussian. hyper-Poisson and generalized Poisson distributions.

Definition 1

Let X be a non-negative discrete random variable obtained as a finite mixture of geometric (θ) and negative binomial $(2,\theta)$ with mixing probabilities $\frac{\theta}{\theta+\beta}$ and $\frac{\beta}{\theta+\beta}$ respectively. The new TNDL distribution is specified by the pmf

$$p(x;\theta,\beta)=\frac{\theta^2}{\theta+\beta}(1-\theta)^x[1+\beta(1+x)],\quad x=0,1,2,\dots,\beta \; and \; \theta\in(0,1).$$

We note that the TNDL distribution includes the following discrete distributions as particular cases:

(i) The geometric distribution when $\beta = 0$.
(ii) The two-parameter discrete Lindley distribution of Hussain et al. (2016), when $\theta = 1 - p$ and $\beta = 0.5$.
(iii) The two-parameter discrete Lindley distribution of Bakouch et al. (2014), when $\theta = 1 - p$.

The corresponding survival function (sf) and the hazard rate function (hrf), denoted by $r(x;\theta,\beta)$, of the TNDL are given for $x = 0,1,2,\dots,\beta > 0$ and $\theta \in (0,1)$ by

$$S(x;\ \theta,\beta)=P(X\geq x)=\frac{\theta(1+\beta)+\beta(1-\theta+\theta x)}{\theta+\beta}(\theta)^x$$

and

$$r(x;\ \theta,\beta)=\frac{\theta^2[1+\beta(1+x)]}{\theta(1+\beta)+\beta(1-\theta+\theta x)}.$$

Without any loss of generality, our derivations shall focus on of the single parameter natural discrete Lindley (NDL) distribution, i.e., TNDL when $\beta = 1$. We note that the NDL distribution is the counterpart of the single parameter continuous Lindley distribution.

2. The NDL distribution

Definition 2

Let X be a non-negative random variable obtained as a finite mixture of geometric (θ) and negative binomial $(2,\theta)$ with mixing probabilities $\frac{\theta}{\theta+1}$ and $\frac{1}{\theta+1}$,respectively. The new distributions specified by the pmf

$$p(x;\theta)=\frac{\theta^2}{1+\theta}(2+x)(1-\theta)^x,\qquad x=0,1,2,\dots\theta\in(0,1). \tag{1}$$

The corresponding sf of the NDL distribution is given by

$$S(x;\theta)=P(X\geq x)=\frac{1+\theta+\theta x}{1+\theta}(1-\theta)^{x}, x=0,1,2,\dots\ \theta\in(0,1).$$

Its hrf reduces to

$$r(x;\theta)=\frac{p(x)}{P(X\geq x)}=\frac{\theta^{2}(2+x)}{1+\theta+\theta x},\quad x=0,1,2,\dots\ \theta\in(0,1).$$

It is easy to see that $\lim_{x\to\infty} r(x;\theta)=\theta$. Hence, the parameter θ can be interpreted as a strict upper bound on the failure rate function, an important characteristic for lifetime models, corresponding to Equation (1).

Figure 1 shows some possible shapes for the pmf of the NDL distribution. One can note that the NDL distribution is always unimodal for any value of θ (see also Theorem 1). Figure 2 indicates that the hrf of the NDL distribution is always increasing in θ (see also Theorem 1).

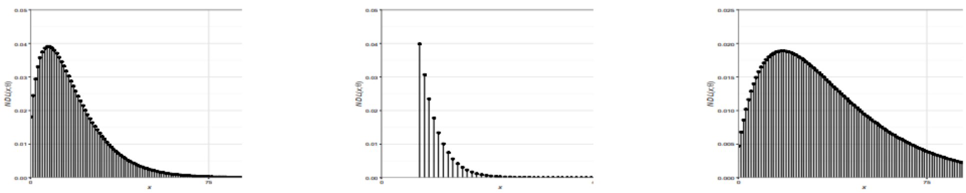

Figure 1: pmf plots of the NDL distribution: $\theta=0.1$ (left panel), $\theta=0.3$ (middle panel) and $\theta=0.05$ (right panel).

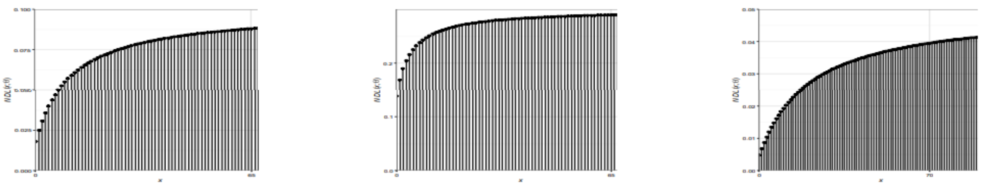

Figure 2: hrf plots of the NDL distribution: $\theta=0.1$ (left panel), $\theta=0.3$ (middle panel) and $\theta=0.05$ (right panel).

3. Reliability properties of NDL distribution

3.1 Log-concavity

Definition 3: A discrete random variable X with pmf $p(x)$ is said to be increasing failure rate (IFR) if $p(x)$ is log-concave, i.e., if $p(x)p(x+2)\leq p(x+1)^{2}, x=0,1,2,\dots$ (see, e.g., Keilson and Gerber, 1971).

Theorem 1: The pmf of the NDL distribution in (1) is log-concavefor all choices of $\theta\in(0,1)$.

Proof. The condition in Definition (3) is easily verified from (1). Generally, it is well-known that a log-concave pmf is strongly unimodal (see, e.g., Nekoukhou et al., 2012) and accordingly have a discrete IFR. It follows from Theorem 1 that the NDL distribution is unimodal and has a discrete IFR (see Figures 1 and 2). Thus, we have the following corollary.

Corollary 1: If the random variable $X \sim NDL(\theta)$ then the mode of X is located at w, where w is a positive integer satisfies $\frac{1-3\theta}{\theta} \leq w \leq \frac{1-2\theta}{\theta}$. This implies that $p(x+1) \geq p(x)\ \forall x \leq w$ *and* $p(x+2) \leq p(x+1)\ \forall x \geq w$.

Definition 4: A discrete life distribution $\wp = \{p_k = P(X = k)\}, k \in \mathcal{N}$, where $\mathcal{N}$ is the set of all non-negative integers. With $A_k = P(X \leq k)$, we define the discrete reversed failure rate (DRFR) as follows

$$r_k^* = \frac{p_k}{A_k}, k \in \mathcal{N}.$$

Definition 5: (Al-Zahrani and Al-Sobhi, 2015): A discrete life distribution $\wp = \{p_k = P(X = k)\}, k \in \mathcal{N}$, where $\mathcal{N}$ is the set of all non-negative integers is said to be discrete increasing (decreasing) reversed failure rate DIRFR (DDRFR) if $r_k^*, k \in \mathcal{N}$ is increasing (decreasing).

Proposition 1: Let p_k the sequence defined by the NDL distribution, then NDL distribution has the DIRFR property.

Proof. It is easy to prove that r_k^* is increasing in k. The reversed hrf of X is

$$r^*(x;\theta) = \frac{p(x;\theta)}{1 - S(x;\theta)} = \frac{(1+\theta+\theta x)(1-\theta)^x}{[(1+\theta) - (1+\theta+\theta x)(1-\theta)^x]}.$$

Remark 1: The following is a simple recursion formula for $p(x+1)$ in terms of $p(x)$ of the NDL for $x = 0,1,2,\ldots$, where

$$p(x+1) = \frac{3+x}{2+x}(1-\theta)p(x), where\ p(0) = 2\theta^2/(1+\theta).$$

Remark 2:

(i) $r(0) = p(0)$.

(ii) $r(x)$ is an increasing function in x and θ.

(iii) $r(x) \geq r(0)\ \forall\ x \in \mathcal{N} and$ hence the NDL distribution has the new better than used in failure rate (NBUFR) property (see, Abouammoh and Ahmed (1988)).

3.2 Stochastic interpretations of the parameter theta

Stochastic orders are important measures to judge comparative behaviors of random variables. Shaked and Shanthikumar (2007) showed that many stochastic orders exist and have various applications.

The following chains of implication (see, e.g., Shaked and Shantihkumar, 2007) hold.

$$X \leq_{lr} Y \Longrightarrow \begin{array}{c} X \leq_{hr} Y \\ \Downarrow \\ X \leq_{st} Y \end{array} \Longrightarrow X \leq_{mrl} Y \text{ and } X \leq_{lr} Y \Rightarrow X \leq_{hr} Y$$

Theorem 2: Let $\sim NDL(\theta_1)$ and $Y\sim NDL(\theta_2)$. Then, $X \leq_{lr} Y$ for all $\theta_1 > \theta_2$.

Proof.
We have

$$L(x) = \frac{p_X(x)}{p_Y(x)} = \frac{\theta_1^2(1+\theta_2)(1-\theta_1)^x}{\theta_2^2(1+\theta_1)(1-\theta_2)^x}.$$

Clearly, one can see that $L(x + 1) \leq L(x)\ \forall\ \theta_1 > \theta_2$.
Theorem 2 shows that the NDL distribution is ordered according to the strongest stochastic order (v).

Corollary 2: Based on the chain of stochastic orders in the definition (4), $X \leq_{hr} Y, X \leq_{rh} Y, X \leq_{mrl} Y\ and\ X \leq_{st} Y$.

Definition 6: The discrete random variable X is said to be smaller than Y in weak likelihood ratio ordering (denoted by $X \leq_{wlr} Y$) if $\frac{p_X(x+1)}{p_Y(x+1)} \leq \frac{p_X(0)}{p_Y(0)}\ \forall\ x \geq 0$ (see, Khider et al., 2002).

Theorem 3: Let $\sim NDL(\theta_1)$ and $Y\sim NDL(\theta_2)$. Then, X is said to be smaller than Y in weak likelihood ratio ordering, denoted by $X \leq_{wlr} Y$, for all $\theta_1 > \theta_2$.

Proof.
According to Definition 2.5 of Khider et al. (2002), we can prove that

$$\frac{p_X(x+1)}{p_Y(x+1)} \leq \frac{p_X(0)}{p_Y(0)}.$$

Then, we obtain

$$\frac{\theta_1^2(1+\theta_2)[(1-\theta_1)^{x+1} - (1-\theta_2)^{x+1}]}{\theta_2^2(1+\theta_1)(1-\theta_2)^{x+1}} \leq 0, \forall\ \theta_1 < \theta_2.\text{ Hence } X \leq_{wlr} Y.$$

The mean residual life (MRL) function of the NDL distribution is defined by

$$m(x) = E(X = x|X \geq x) = \frac{1-\theta}{\theta^2}r(x) + \frac{(1-\theta)(2-\theta)}{\theta(1+\theta+\theta x)},$$

where $r(x)$is the hrf of the NDL distribution.

4. Moments

The first four raw moments of the NDL distribution are, respectively, given by

$$\mu_1' = E(X) = \frac{(1-\theta)(2+\theta)}{\theta(1+\theta)}, \quad \mu_2' = \frac{\theta^3+\theta^2-8\theta+6}{\theta^2(1+\theta)},$$

$$\mu_3' = \frac{(1-\theta)(\theta^3+2\theta^2-24\theta+24)}{\theta^3(1+\theta)}$$

and

$$\mu_4' = \frac{(1-\theta)(-\theta^4 - 2\theta^3 + 78\theta^2 - 192\theta + 120)}{\theta^4(1+\theta)}, where\ \bar{\theta} = (1-\theta).$$

The corresponding variance and index of dispersion (ID) are

$$\text{Variance(X)} = \frac{(1-\theta)(4\theta+2)}{\theta^2(1+\theta)^2} \text{ and ID(X)} = \frac{\text{Variance(X)}}{\text{E(X)}} = \frac{2(2\theta+1)}{\theta(1+\theta)(2+\theta)}.$$

The moment generating function is

$$M_X(t) = E(e^{tX}) = \frac{\theta^2(2-\bar{\theta}e^t)}{(1+\theta)(1-\bar{\theta}e^t)^2}, t < \log(1-\theta) \text{ and } \theta \in (0,1).$$

The kth descending factorial moment of X is given (for $k = 0,1,2,\dots$) by

$$\mu_{[k]}' = \frac{[k(1-\theta)^2 + 1 + \theta - 2\theta^2]k!}{(1+\theta)\theta^k},$$

where$\mu_{[k]}' = E[X(X+1) \ldots (X+k-1)]$. Clearly, for $k = 0$, we obtain $\mu_{[0]}' = (1+\theta-2\theta^2)/(1+\theta)$ and the mean of X follows as $\mu_{[1]}' = E(X)$.

5. Estimation

In this section, we estimate the parameter θ of the NDL distribution by the maximum likelihood method and the method of moments. Both maximum likelihood estimator (MLE) and moment estimator (ME) are the same and are available in closed forms. $1 + \theta$

Let $x_1, \dots, x_n$ be a random sample of size n from the NDL distribution, then the log-likelihood function is given by

$$\ell(\theta|\mathbf{X}) \propto 2n\, log(\theta) - n\, log(1+\theta) + n\bar{x}\, log(1-\theta).$$

The maximum likelihood estimator of θ follows by solving $\frac{d}{d\theta}\ \ell(\theta|\mathbf{x}) = 0$, then we have

$$\hat{\theta} = \frac{1}{2}\sqrt{1 + 8/(1+\bar{x})} - \frac{1}{2}.$$

Remark 4: It can be shown that the method of moments yields the same estimator derived using the MLE method.

6. Two applications

In this section, we use two real datasets to illustrate the importance and superiority of the NDL distribution over the existing models namely discrete Lindley (DL) (Bakouch et al., 2014), discrete Burr (DB) and discrete Pareto (DP) (Krishna and Pundir, 2009) distributions.

Table 1: Fitted estimates for datasets I and II

Data	Model	Estimates		AIC	BIC	KS	P-value
DATA SET I		0.0893(0.0135)		**159.687**	**160.683**	**0.1175**	**0.9450**
		0.0954(0.0151)		159.759	160.755	0.1254	0.9112
		28.627(48.865)	0.9869(0.0220)	189.259	191.250	0.3409	0.0191
		0.6957(0.0564)		192.895	193.891	0.3562	0.0124
DATA SET II		0.2500(0.0140)		**682.039**	**684.851**	**0.1370**	**0.0197**
		0.3001(0.0194)		683.605	686.417	0.1515	0.0070
		2.5026(0.4870)	0.7611(0.0427)	750.786	756.410	0.1924	0.0002
		0.5462(0.0298)		781.270	784.082	0.2495	0.0000

The first dataset consists of remission times in weeks for 20 leukemia patients randomly assigned to a certain treatment (Lawless, 2003). The second dataset consists of 123 observations and refers to numbers of fires, only fires in forest districts are considered, in Greece for the period from 1 July 1998 to 31 August of the same year (Karlis and Xekalaki, 2001). It is shown, from Table 2, that the new NDL distribution provides better fits for both data sets than the DL, DB and DP models. Probability–probability (PP) plots for both datasets are shown in Figures 6 and 7, respectively.

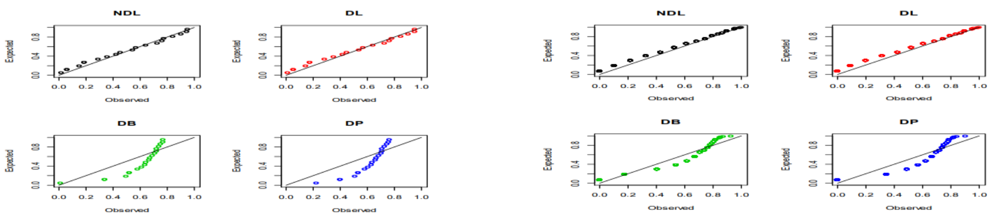

Figure 6: PP plots for dataset I (left panel) and for dataset II (right panel).

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Right censored observations in a parametric mixture cure fraction Models: application to ovarian cancer

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Abstract
The modeling and analysis of lifetime for terminal diseases such as cancer is a significant aspect of statistical work in a wide variety of scientific and technological fields. This study focus on the parametric cure model that can handle survival data such as G-Family link function. Some structural properties of these models are studied and the method of maximum likelihood was used to model parameters of the models. The significance of the models in diagnosis of ovarian cancer is uncovered and a simulation study was done for assessing the efficiency and capability of the model. Our results show that the parametric cure fraction model estimates is found to be quite robust.

Keywords
G- Family link function; ovarian cancer; parametric cure model; structural properties

1. Introduction

The evaluation of cure fractions in oncology research under the well known cure rate model has attracted considerable attention in the literature (Hsu et. al., 2016). The benefits of cure rate models over the traditional methods of survival analysis, including the well-known Cox regression model. However, in certain types of cancers such as breast cancer, leukemia, a significant fraction of patients may now be cured through therapy called cured proportion or immunes or long-term survivors, The population of interest is thus divided into two groups viz., cured and non-cured and Cure rate models provide satisfactory models in such cases (Elangovan and Jayakumar, 2016). A patient who has survived for five years after a cancer diagnosis is not necessarily medically cured but is considered statistically cured because the five−year relative survival analysis is considered a good indication that the cancer is responding to treatment and that the treatment is successfully extending the life of the cancer patient. The survival figures so obtained are utilized in choosing treatment types and regimes, doses, in discriminating between the side effects profiles and cost effectiveness. Cure models are survival models basically developed to estimate the proportion of patients cured in a clinical trial. These models estimate the cured proportion and also the probability of survival.

Mixture cure model: This one can evaluate the percentage of patients cured and the survival function of the uncured patients Boag (1949) & Berkson and Gage (1952)].

Non-Mixture Cure Model: This can also be called the Bounded Cumulative Hazard Model (BCH), [Yakovlev et al (1993)].

The following highlighted points are the essential importance of statistical cure.

- Patient survival is one of the most important questions in cancer research.
- Cure models give more information about patient survival.
- Cure models predict the proportion of patients cured from cancer.
- They predicts time until cured.
- Estimate survival time of patients not cured.

Seppa *et.al.* (2009) applied a mixture cure fraction model with random effects to cause-specifc survival data of female breast cancer patients collected by the population-based Finnish Cancer Registry. Two sets of random effects were used to capture the regional variation in the cure fraction and in the survival of the non-cured patients, respectively. The random effects allowed the fitting of the cure fraction model to the sparse regional data and the estimation of the regional variation in 10-year cause-specific breast cancer survival with a parsimonious number of parameters which led to the capital of Finland to clearly stood out from the rest, but since then all the 21 hospital districts have achieved approximately the same level of survival.

Verdecchia *et.al.* (1998) also asserted that traditional parametric survival models that assume that all patients are susceptible to eventually die from the disease itself are often inadequate in describing the survival experience of cancer patients. It is conceivable that many patients are in fact cured in the sense that their lifetime is not shortened by the cancer but their mortality rates remain the same as if they had avoided the cancer. At an individual level it is practically impossible to determine for sure whether a patient is cured or not. However, for many cancers it appears to be possible in principle to identify the cure fraction, i.e. the proportion of patients, whose mortality will not be elevated as compared with the mortality rates in a similar cancer-free population. Francisci (2008) concluded that Cure fraction models have become increasingly popular in population based studies on cancer survival performed for individual countries, but also in international comparisons, and their usefulness is motivated. The proportion cured and the mean survival time for the non-cured patients can be useful summary parameters for detailed assessment of the differences in survival.

De Angelis *et.al.* (1999) and Lambert *et.al.* (2007) reported that Cure fraction models can also be extended for analyses of relative survival.
The main aim of this research is to apply a new mixture cure model that is capable of handling and accommodating non-normality in survival data and which will give a better information of the proportion of Ovarian cancer patients that have benefitted from medical intervention.

2. Methodology

2.1 The Model (Mixture Cure Model)

This model which was first developed by (Boag, 1949) and was modified by (Berkson \& Gage, 1952) can be defined as:

$$S(t) = c + (1-c)S_u(t) \tag{1}$$

Where:
$S(t)$ = The survival functions of the entire population
$S_u\,(t) =$ The survival functions of the uncured patients
$c =$ The proportion of cure patients that is the cure fraction rate.

2.2 Estimations of Cure Fraction Model (Mixture Cure Model)

The estimation employed shall be parametric in nature. Given the cure model in equation (1), the estimate of parameter c is given as:

$$c = \frac{S(t) - S_u(t)}{1 - S_u(t)} \tag{2}$$

The likelihood estimation of cure fraction model is:

$$L = [f(t_i)]d_i[f(t_i)]\ 1 - d_i$$

2.3 Distributions of Cure Models

Some existing univariate distributions were examined for the mixture cure model to estimate the corresponding c (proportion of cure patients), their median time to cure and variances. The following are some of the reviewed parametric cure fraction models.

2.3.1 Generalised Gamma

$$f(t) = \frac{\beta}{\theta\Gamma(\alpha)}\left(\frac{t}{\theta}\right)^{\alpha\beta-1} e^{-\left(\frac{t}{\theta}\right)^{\beta}} \qquad t > 0, \alpha > 0, \beta, > 0, \theta\ > 0$$

Where $\theta\ >\ 0$ is a scale parameter, $\beta\ >\ 0$ and $\alpha\ >\ 0$ are shape parameters and $\Gamma(x)$ is the gamma function of x.

2.3.2 Log-normal

$$f(t;\mu,\sigma) = \frac{1}{t\sigma\sqrt{2\pi}} e^{\frac{1}{2}\left(\frac{log\, t-\mu}{\sigma}\right)^2} \qquad t, \mu, \sigma\ >\ 0$$

2.3.3 Weibull Distribution

A random variable t is said to follow a Weibull distribution if it satisfies the density function:

$$f(t) = \frac{\alpha}{\beta^{\alpha}} t^{\alpha-1} e^{-\left(\frac{t}{\beta}\right)^{\alpha}} \qquad t, \alpha, \beta > 0$$

2.3.4 Log-Logistic Model

A random variable $f(t)$ is said to be distributed log-logisticsl if its pdf. is given as:

$$f(t; \alpha, \beta) = \frac{\frac{\alpha}{\beta}\left(\frac{t}{\beta}\right)^{\alpha-1}}{\left[1 + \left(\frac{\alpha}{\beta}\right)^{\alpha}\right]^{2}} \qquad t, \alpha, \beta > 0$$

2.4 Proposed Model: Gamma-generalised gamma mixture cure model

We need a new $f(x)$, so we assume the existing to be $G(x)$, $g(x)$. Thus, link function of the Gamma - Generated Gamma is given in equation (2.7) below.

$$f(x) = \frac{1}{\Gamma(a)} \left[-log[1 - G(x)]\right]^{a-1} g(x) \tag{3}$$

where, a = Shape parameter, G(x) = cdf of baseline distribution, g(x)= pdf of baseline distribution

If the shape parameter, $a = 1$, then

$$f(x) = \frac{1}{\Gamma(1)} \times [-\log[1 - G(x)]]^{1-1} \quad g(x) = [-\log[1 - G(x)]]^{0} \;\; g(x)$$

$$\therefore \; f(x) = g(x)$$

Gamma-Generalised Gamma Mixture Cure Model

The study employ a new distribution called Gamma-generalised gamma mixture cure model using both the pdf and cdf defined below

Assume t follow a generalised Gamma pdf given as

$$f(t) = \frac{\beta}{\theta\Gamma\alpha} \left(\frac{t}{\theta}\right)^{\alpha\beta-1} \quad e^{-\left(\frac{t}{\beta}\right)^{\beta}} \tag{4}$$

and its cdf as;

$$F(t) = \frac{\gamma\left[\alpha, \left(\frac{t}{\theta}\right)^{\beta}\right]}{\gamma(\alpha)} \tag{5}$$

But in scale location form, eqn. (4 & 5) becomes

$$f(t) = \frac{1}{\sigma\Gamma\alpha} \; e^{-\alpha\left(\frac{log\, t - \mu}{\sigma}\right)} - e^{\frac{log\, t - \mu}{\sigma}} \tag{6}$$

and

$$F(t) = \frac{\gamma\left[\alpha, \; e^{\frac{log\, t - \mu}{\sigma}}\right]}{\Gamma(\alpha)} \tag{7}$$

If we put the pdf and cdf in equation (6 & 7) into (3), we have

$$g(t) = \frac{1}{\Gamma\beta}\left[-\log\left[\frac{\gamma\left[\alpha,\ e^{\frac{\log t-\mu}{\sigma}}\right]}{\Gamma(\alpha)}\right]\right]^{\beta-1} \frac{1}{\sigma\Gamma\alpha}\, e^{-\alpha\left(\frac{\log t-\mu}{\sigma}\right)} - e^{\frac{\log t-\mu}{\sigma}} \qquad (8)$$

where $\beta = a$ in equation (3) the cdf of gamma generalised link function is

$$G(t) = \frac{\gamma\big(-\log\big(F(t)\big),\beta\big)}{\Gamma_{\beta}} \qquad (9)$$

Putting eqn. (7) in scale location form into eqn. (9), we obtain the cdf of Gamma generalised Gamma as

$$G(t) = \frac{\gamma\left[-\log\left[\frac{\gamma\left[\alpha,\ e^{\frac{\log t-\mu}{\sigma}}\right]}{\Gamma(\alpha)}\right], \beta\right]}{\Gamma_{\beta}} \qquad (10)$$

3 Result

3.1 Data Description

The data used to show the capability of the proposed GGGMCM over the existing one was ovarian cancer data from 37 patients that received treatment (surgery and chemotherapy) at Department of Obstetrics and Gyneacology, University College Hospital, Ibadan, Nigeria between January 2004 and December 2015.

Exploratory Data Analysis (EDA)

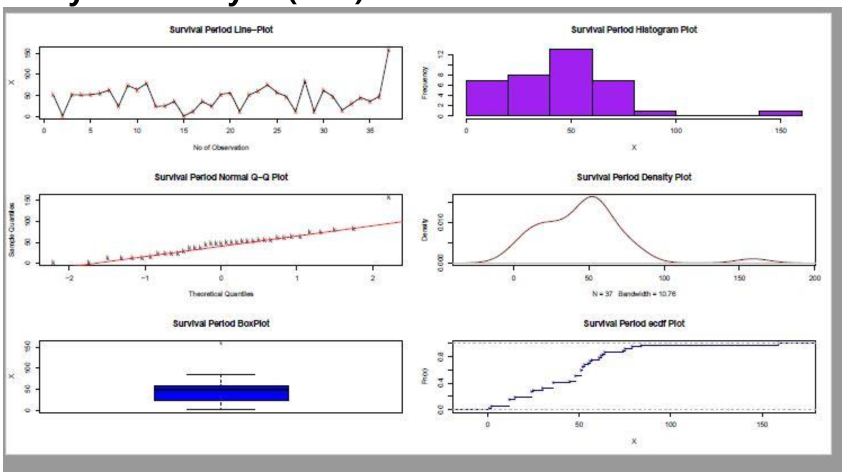


Figure 1: Exploratory Data Analysis (Ovarian Cancer)

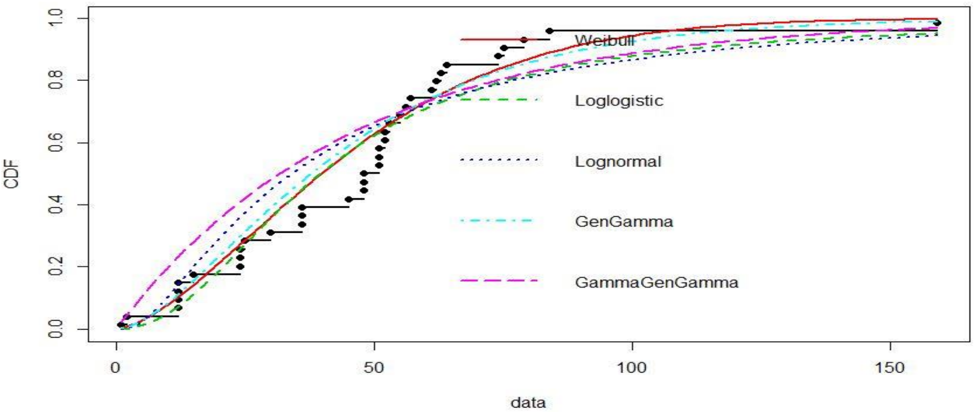
Table 1: Descriptive Statistics of the Survival Time of Ovarian Cancer

Min	Q_1	Median	Mean	Q_3	Max	Skewness	Kurtosis
1	24	48	45.05	57	159	1.395	7.339

Table 2: Model evaluation for the ovarian Cancer

Model	AIC	-2loglike	$\tilde{\mu}$	σ	$e^{\tilde{\mu}}$	c	Var(c)
Weibull	216.8845	210.8846	2.4400	68.200	60.0706	0.2890	0.096810
Lognorm	205.9782	199.9782	4.0400	0.3280	57.9748	0.3712	0.004261
Llogis	203.2744	197.2744	5.9701	56.207	56.8649	0.1810	0.287870
GenGamma	206.2014	198.2014	3.9635	0.3017	20.90111	0.1084	0.005230
GGG	199.2353	194.4712	7.5240	15.2460	11.8201	0.8207	0.000125

Weibull: Weibull Mixture Cure Model **Lognorm**: Log-Normal Mixture Cure Model
Llogis: LogLogistics Mixture Cure Model **GenGamma:** Generalised Gamma Mixture Cure Model
GGG: Gamma Generalised Gamma Mixture Cure Model $\tilde{\mu}$: Median, $e^{\tilde{\mu}}$: median time to cure



Simulated Data

The simulation study utilized data based on continuous uniform distribution with $b = 100$ and $a = 1$ using sample of sizes (n) of 10, 20, and 50 each in 50, 100, and 500 replicates (r). In other to compare the models, we consider MSE, RMSE and Absolute BIAS as the criteria to check for the flexible best across the replications considers. The lower the value of these criteria, the more efficient is the model.

Table 3: Model Evaluation of Simulation Result

Sample Size	rep										
		llogis	Weibu	lognom	GG	GGG	llogis	Weibu	lognom	GG	GGG
N = 10	50	791.30	772.11	707.23	691.03	701.10	28.13	27.79	26.48	26.29	26.48
	100	801.90	777.03	700.52	700.10	710.40	28.32	27.89	26.47	26.45	27.65
	500	856.20	819.45	810.01	711.32	750.61	29.26	28.63	28.46	26.67	26.40
N=20	50	695.20	611.59	655.71	601.33	609.31	26.37	24.73	25.61	24.52	24.64
	100	720.50	774.63	671.91	623.50	620.90	26.84	27.83	25.92	24.97	24.92
	500	751.30	712.98	704.13	671.45	663.53	27.41	26.70	26.53	25.91	25.76
N = 50	50	719.64	700.18	699.52	689.15	601.59	26.83	26.46	26.45	26.25	24.53
	100	703.90	707.48	700.85	610.79	598.40	26.53	26.60	26.47	24.71	24.46
	500	644.59	623.90	619.61	602.10	501.37	25.39	24.98	24.89	24.54	22.39

Table 3: Model Evaluation of Simulation Result (Continued…)

Sample	rep					
		llogis	Weibu	lognom	GG	GGG
N = 10	50	27.89	26.10	26.70	25.33	25.81
	100	27.10	26.23	25.90	25.89	25.97
	500	27.15	26.55	27.20	25.91	26.38
N=20	50	26.00	23.59	25.31	23.57	23.89
	100	26.23	26.19	25.50	23.27	23.13
	500	26.71	25.55	25.89	24.89	23.80
N = 50	50	25.50	25.77	25.83	25.59	23.15
	100	25.90	25.98	25.80	24.08	23.03
	500	24.89	23.95	24.01	24.00	22.11

Key

llogis: LogLogistics Mixture Cure Model
lognom: Log-Normal Mixture Cure Model
Weibul:} Weibull Mixture Cure Model
GG Generalised Gamma Mixture Cure Model
GGG Gamma Generalised Gamma Mixture Cure Model

4 Discussion and Conclusion

From the simulated data result, the results described the model evaluation using MSE, RSME and absolute BIAS, it was discovered that the proposed model performed same with the Generalised Gamma Mixture Cure Model when the sample size is 10 and replicated 50 times. But when the replications increased to 100 and 500 respectively, the proposed outperformed it. Also, it was depicted that Gamma Generalised Gamma Mixture Cure Model (GGGMCM) has the least across the criteria considered when sample size increased to 20 and 50 as well as each level of replications. Similarly, from the real life data result of Ovarian Cancer, the results described the model evaluation using log likelihood, AIC and Variance of c. The lower the value of these criteria, the more efficient is the model. The proposed gives the least value in terms of the criteria used, it gives the minimum variance of c.

From the summary of the results for both the simulated data and real life data set, we can conclude that Gamma Generalised Gamma is the Flexible best model that explained the ovarian cancer used for the study in term of AIC, value of c and Median time to cure. The GGGMCM can be used effectively to model a good sizeable of data set. The results showed that the new GGGMCM was an improved model for statistical modeling and inference for survival data that exhibits skewness.

From the results above, both from the simulated data and the real life data set, the GGGMCM performs better than the existing mixture cure models considered.

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Using Brain Storming in training enumerators for Egyptian Census 2017 to develop their communications skills with households

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Abstract

The mission of census or the statistical surveys is to provide as complete and accurate statistical data as possible for decisions makers and statistical users in general to Make Decisions and researches depended in it, to achieve this target the NSO in all over countries makes courses for Interviewers about How they can deal with households in professional ways , because the failure in collecting data with correct way mean The expense, resources, efforts for the census and surveys become futile totally. On the other hand, the most of NSO uses traditional methods in training programs for the Interviewers such as (theoretical lecture –Discussions-writing instructions for interview) and these methods of education didn't give them the communications skills that they needed it, the critical thinking skills that help them to deal with the refuse situations in the field. In this context the national statistical office in Egypt started this year in preparing for the field operations for Egyptian census 2017 by using new techniques in training the enumerators depended on using Brain storming as a training approach can use it to improve teamwork, understanding and generate creative and out-of-the-box solutions during training. so this paper will discuss the modern tools in Egyptian census 2017 (using tablet in collecting data), the basic rules in brainstorming in training enumerators, recommendations for enumerators about how to deal with respondents during census, type of communication skills that enumerators need to it, how to read body language for respondents, and the results of measuring satisfaction of enumerators about the training program by using Likert scale.

Keywords

Interviewing techniques; critical thinking; teaching method; measuring satisfaction

1. Introduction

The Population and Housing Census is the backbone of the national statistical system for any country. It is the only operation that provides complete population counts at both national and local levels. These can be used for drawing administrative boundaries, apportioning political representation, and allocating fiscal resources. It provides demographic data for decision-making and policy planning in a great number of areas and is the basis for the sampling frames of all large-scale surveys. Egypt is one of the first countries which conducted census, its first population census in modern concepts goes back to 1882 and the total population was 6.7 million, the census 2006 the total population reached 72.8 million and the 2017 Census is the fourteenth in the series which considered first E- census in Egypt, (the total population reached 94.7 million).

The objectives of this census is develop an integrated comprehensive technological system that respond to the strategic goals of the census, while at the same time Provide the Country with accurate, trust worthy and timely fundamental data for development planning at various administrative levels.

In this context the NSO in Egypt used Brain storming session as training approach for trainer of trainee (TOT) in the 2017 census to make staff from instructors have modern concepts about training enumerators, this paper discusses how the NSO in Egypt used brain storming in preparing instructors for 2017 census and measuring satisfaction of (TOT) about this tool in training for census.

2. The Modern Techniques that will use in the Egyptian Census 2017

1. Using Digital Maps

   National statistical office in Egypt (CAPMAS) spent about 3 years started from 2013 and ended at the beginning of 2016 for the preparation of the Census 2016 maps with different scales suitable for each supervising stage to ensure perfect coverage and avoid any overlap at first stage in Rural and Urban areas., Maps are being prepared for around 31 thousands enumeration areas, 2500 inspector, 400 area supervisor and 27 governorates.
2. Collecting census data through using Tablet and the Web with all possible validation rules, consistency checks and edits:
   - Inventory of buildings and units (for housing or work);
   - Population census counting individuals and their characteristics;
   - Establishment census.
3. Allow self-enumeration for those households expressing interest to fill form of census by using website of census.

Brain storming as educational approach in training enumerators for census

Brainstorming with a group of people is a powerful technique. Brainstorming creates new ideas, solves problems, motivates and develops teams. Brainstorming motivates because it involves members of a team in bigger management issues, and it gets a team working together. However, brainstorming is not simply a random activity. Brainstorming needs to be structured and it follows brainstorming rules. The brainstorming process is described below, for which you will need a flip-chart or alternative. This is crucial as Brainstorming needs to involve the team, which means that everyone must be able to see what's happening. Brainstorming places a significant burden on the facilitator to manage the process, people's involvement and sensitivities, and then to manage the follow up actions. Use Brainstorming well and you will see excellent results in improving the organization, performance, and developing the team.

Brainstorming process that used in training enumerators for census 2017

1. Define and agree the objective.
2. Brainstorm ideas and suggestions having agreed a time limit.
3. Categorize/condense/combine/refine.
4. Assess/analyse effects or results.
5. Prioritize options/rank list as appropriate.
6. Agree action and timescale.
7. Control and monitor follow-up.

Ideas about how the enumerators deal with households during census according to Brain storming session

The training program for instructors of enumerators applied the pervious brainstorming process, the instructors divided to groups (5 individuals in each group) to discuss situations that faces enumerators when they deal with households during census.

1. **The results of brain storming sessions:**

   The Trainer of Trainee (TOT) for Egyptian census presented some situations that face enumerators, and how the enumerators overcome it and this table summarize some results of brain storming session:

Responding of Household	How the enumerators deal?
"I'm not feeling very well."	In these cases, you have caught the person at a bad time, but the situation is temporary. The respondent is likely to agree to be interviewed at another time. Say that you will come back later.
"My house is too messy for you to come in."	Offer understanding by saying something like the following: "That's no problem. We can do the screening right here. Or we can schedule another time for me to come back.
Lack of trust/invasion of privacy or confidentiality.	Assure the respondent of confidentiality. Show him or her the Statement of Confidentiality. Remind the respondent that the information he or she provides is Combined with information from other interviews and is reported in summary form.

"How did you get my address?"	Explain that census get information from all residential Addresses across the country using a scientific procedure.
"I don't care about that issue."	Explain importance of census in some fields such as education, housing, employment etc

On the other hand, the enumerators, should begin by trying to gain rapport with the respondent. With a friendly and respectful manner, the enumerators should introduce themselves by name, and as a representative of the organization, presenting his or her identification card (which should be worn at all times during the interview). The survey should then be introduced, with an explanation of its purposes and how the information will be used.

The enumerator should be prepared to answer questions such as:

- Where did you get my name?
- Why was I chosen for this interview?
- What kinds of questions are you going to ask?
- I'm old I'm not disabled. Why are you including me in the census?
- Why does the government spend money on census instead of providing better services to those who need them?
- What services are offered in my area?

Once the introduction and some explanation about the survey/census have been made, the interview can begin. The interviewer's goal is to collect accurate information by using the questionnaire according to proven interview techniques. Since data users need to combine information collected from all interviews, the questions must be presented in a uniform manner.

2. Reading body language for respondents (Household)

Body Language is a significant aspect of modern communications and relationships, is therefore very relevant to management and leadership, and to all aspects of work and business where communications can be seen and physically observed among people. The enumerators can benefit from reading body language to get data with high quality, for example: Lying: Of all the non-verbal body language that we may observe, being able to tell whether a person is lying or not will stand you in good stead. There are some of the typical signs and signals that a person is lying include:

- Eyes maintain little or no eye contact, or there may be rapid eye movements, with pupils constricted.
- Hand or fingers are in front of his or her mouth when speaking.

- His or her body is physically turned away from you, or there are unusual/unnatural body gestures.
- His or her breathing rate increases.
- Voice changes such as change in pitch, stammering, throat clearing.

On the other hand, the brain storming sessions constrain on effective body language during interview which summarized in the following points:

- Eyes look away and return to engage contact only when answering.
- Finger stroking on chin.
- Hand to cheek.
- Head tilted with eyes looking up.
- So, whether you are on the receiving end of someone pondering, or you are doing the pondering, there are certain gestures that give it away.

But the enumerator should know, as with all non-verbal language, it's important to remember here that everyone's personal body language is slightly different. If you notice some of the typical non-verbal signs of lying, you shouldn't necessarily jump to conclusions, as many of these signals can be confused with the appearance of nervous-ness. What you should do, however, is use these signals as a prompt to probe Add to My Personal Learning Plan further (as enumerators), ask more questions and explore the area in more detail to determine whether they are being truthful or not.

Methodology of Measuring the satisfaction of TOT brain storming session for Egyptian census.

- The community of this study consists of (50) participants who enrolled in the brain storming session under name (Ice ball).
- Tool of the study: Questionnaire for measuring satisfaction of paticipants in TOT brain storming session. This questionnaire has been divided into three Sections as follows:
  - First Sections (the objectives of TOT brain storming sessions): Discusses the satisfaction of participants about the objectives of training program (TOT brain storming sessions) in raising the Capabilities of the participants such as dealing with household – understand the modern tools that will use in Egyptian census 2017–steps of interview during census– soft skills for enumerators.
  - Second Section: (the implementation interview with household) Discusses the satisfaction of participants about how (TOT brain storming sessions) helped participants understanding steps of

implementation interview with household during census - dealing with Refusals - reading body language for respondents

- Section third: (advantages of TOT brain storming sessions) Discusses the satisfaction of participants in TOT brain storming sessions in raising communications skills with households for enumerators to get responses during Egyptian census 2017 with professional way.

3. Result

Sample, consists of 50 participants (30 male/20 female) who will responsible about training programs of enumerators for Egyptian census 2017 were distributed according to sector of work (15.5 % sector of economic statistics - 17.5% population statistics - 57% Regional Branches Sector - 10% of the information technology sector.

Calculated the satisfaction using Likert scale have been reached following results:

- ✓ Results Showed that participants have positive trend towards (the objectives of TOT brain storming sessions (95% from participants were satisfied), although it was noted that there are (5%) neutral, this return from researcher opinion to some participants have experience in field work in statistical survey according to traditions way and they believe that field work depended on experiences.
- ✓ Results Showed that trend of participants in brain storming sessions is positive about this section II (the implementation of interview with household during census) ,(85% from participants were satisfied) with the exception of a degree neutral(15% from participants) in terms of dealing with Refusals because Most participants were expressed about that they needs design real situation for enumerators according to type of respondents using multimedia or role play for enumerators.
- ✓ Results Showed that trend of participants in brain storming sessions is positive about this section III (advantages of TOT brain storming sessions) the trainees showed a positive trend is also about the third section But noted that there is neutrality (25% from trainee) on the part of some trainees to express their opinion on the point "I can apply what I were trained in the census training programs " because from the viewpoint of the researcher that there are some trainees need more role play about reading body language for respondents in real situations.

4. Discussion and Conclusion

During brain storming sessions (TOT for Egyptian census 2017), there are a few simple rules should be followed by enumerators, could summarized it at following points:

- Keeping the information confidential. The information that interviewer gather it is strictly confidential. So, do not discuss any information obtained in your survey work with anyone but your supervisor or other authorized personnel.
- Should be asked exactly as worded on the questionnaire.
- Questions must be asked in the order they appear on the questionnaire.
- Every question in the questionnaire must be asked.
- The interviewer should wait for the respondent to finish talking before starting to record their response. Failure to listen carefully can offend the respondent and result in errors.
- The interviewer should not interrupt the respondent, even if he or she hesitates or is quiet for a while. Sometimes people initially answer, "I don't really know" when in fact they are thinking about their answer.
- After completing the interview, the interviewer should always check if all the questions are asked and if the answers are consistent.
- At the end of each interview, the respondent should be thanked for their time and cooperation.

In brief , The enumerators has get many benefits from using brain storming as training approach for census 2017 such as knowing how to deal with differences and diversity of personalities and behaviors of respondents to answer questions posed in the census form, to reduce the errors of response and that arise from giving the respondent data is inaccurate or did not express the data to be obtained ,so brain storming session is a good educational approach to make senior to know how to deal with the problems of field work and how the enumerators should deals with it.

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Stochastic modeling of the impact of climate change on the variability of daily rainfall in Benin

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Abstract

In spite of uncertainties about their width and their variability, the impacts of the climatic modifications observed as well at the global level as local are already pointed out in the countries of the sahelo-Saharan zone of Africa like Benin. The dryness which results from a deficit of the level of precipitations as well as the distribution of precipitations in time and space constitute the climatic attributes which make this phenomenon's degree significant. Our objective is to model and analyze the level of daily precipitations on the basis of stochastic model. The proposed model is non homogeneous hidden Markov model with a special structure that captures the semi-property of hidden semi-markov model, thus the model allows arbitrary dwell-time distributions in the states of the Markov chain. Despite the Markov chain is non homogeneous, we showed that it is semi-regenerative process and ergodic and identifiable in mild conditions. This model can reflect a stochastic seasonality of dailys precipitations, and then is able to modelize additional seasonal variability due to climate evolution. This model delimits both the end and beginning of rainy seasons, but also through these parameters, the quantity of precipitation and the regularity of the rainy season from one region to another. Apply the model to data of Kandi, Parakou, Natitingou, Savé, Cotonou and Bohicon (six towns of Benin which have synoptic stations) we prouved the impact of climate change in daily precipitation. And with the likelihood ratio test, we dected the rupture on the daily precipitation data of each town.

Keywords

Markov chain; Hidden Markov model; EM-Algorith; Identifiability; Mixture; breaking; likelihood ratio.

1. Introduction

About its latitude position (between 6 30 and 12 30 of North latitude), Benin is among countries in which the climate is hot and wet in the intertropicale zone. The drought that has affected many African countries south of the Sahara has not spared Benin, especially since the 1970s. The consequences of this phenomenon are dramatic for the populations: reduction of water ressources and forest ressources, reduction of livestock, dam filling up, decrease of agricultural productivity, and brutal reduction of rainy season and precipitations in the time and space. To Le Barbé and al.[5] we got a reduction from 15 to 20 per cent of Benin yearly precipitations from the seventies. Those kind of modifications can be very well analysed with stochastic method, taking into account random and dynamic aspects of rainy events occurrence.

2. Main Objectives

The objective of our work is to study a model stochastic able to describe and analyze the variability of daily rainfall and the climatic impact on the precipitation at Benin. For that we will break down the study in several stages:

1. Build a stochastic model, we realize the implementation of a Markov hidden model with a periodicity on the Markov chain (which is non-homogeneous) and a mixture as a law of emission, the study of the ergodicity of the Markov chain, and finally the identifiability of the model.
2. Implementation of an EM algorithm for the adjustment of the data to model by the maximum likelihood method in using the Baum-Welch procedure and the Viterbi algorithm.
3. Estimation of a break in the model corresponding to a climatic evolution by likelihood ratio.
4. Application to the series of daily levels of precipitation in Benin.

Materials and Methods

Station	start	end	days
Cotonou	1952	2007	20440
Bohicon	1940	2007	24820
Savè	1921	2007	31755
Parakou	1921	2007	31755
Kandi	1921	2007	31755
Natitingou	1921	2007	31755

Table 1: Start, end and length of daily precipitation

We assume that the set of the generating mechanisms of the precipitations is a process hierarchical unobserved. For the analysis of such a system of data, the hidden Markovs models (HMMs) are more adapted. These models not only take in account the observed precipitations but also the risk to the level of the generating processes of its observations.

Model

A hidden Markov model is a discrete-time stochastic process $\{(X_k, Y_k)\}$ such that (i) $\{X_k\}$ is a finite-state Markov chain, and (ii) given $\{X_k\}, \{Y_k\}$ is a sequence of conditionally independent random variables with the conditional distribution of Y_n depending on $\{X_k\}$ only throught X_n.

In our work Y_t denote the rainfall of day t, X_t indicates the dynamics of rainfall on day t, and E be the state space of dynamics of rain-fall, for example we can take $E = \{1, 2\}$ where the states 1 and 2 are favorables respectively to wet days and dry days. The transition matrix of the Markov chain $(X_t)_{t\geq 0}$ is given by transition probabilities $\Pr(X_t = j|X_{t-1} = i)$ $1 \leq i, j \leq M$, which time dependent. To account for seasonality, logistic transformation of the transition probabilities is modeled by a combination of trigonometric functions:

$$\Phi_{i,j}(t) = \begin{cases} \sum_{k=1}^{K} a_{ij}(k)\cos(W_k t + \phi_{ij}(k)) \; if \; j < M \\ 0 \; if \; j = M. \end{cases}$$

$$\prod_{ij}(t) = \frac{\exp\left(\Phi_{i,j}(t)\right)}{\sum_{l=1}^{M}\exp\left(\Phi_{i,l}(t)\right)}. \tag{1}$$

Knowing $(X_t)_{t\geq 0,}Y_t|X_t = x$ is a mixture of Dirac and an absolutely continuous distribution density with respect to the Lebesgue measure defined by $g(.|\theta_x)$ belonging to $\mathcal{G} = (g_\theta, \theta \in B \subset \mathbb{R}^q)$ a parametric family identifiable by the finished mixtures. The weight of the mixture are denoted $\pi_x = \Pr(Y_t = 0|X_t = x)$, and the parameters of emission law $\Theta = (\theta, \pi_x)$, so we have the final rating:

$$f_{Y_t|X_t}(yt|x, \Theta) = f(y_t|x_t, \theta_x, \pi_x) = \pi_x\delta_0 + (1 - \pi_x)g(y|\theta_x) \tag{2}$$

which is a probability density with respect counting measure and Lebesgue measure.

$$f(y|x) = \pi_x^{I_0}\left((1 - \pi_x)(\frac{1}{y\sigma_x\sqrt{2\pi}}\exp(-\frac{1}{2}(\frac{\ln(y) - \mu_x}{\sigma_x})^2))\right)^{I_1}. \tag{3}$$

The parameters of the Markov chain are: amplitudes $\left(a_{i,j}\right)_{(i.j)\in E^2}$ the phases $(\phi_{ij}(k))_{(i,j)\in E^2,}$ and the complexity parameter $K \in N$. The parameters of the emission law $\Theta = (\theta, \pi)$ are: $(\pi_i)_{i\in E}$ of discrete law, the sharp $(\mu_i)_{i\in E}$ and the scale $(\sigma_i)_{(i.j)\in E}$ of continue law. set λ all the parameters of the model. The hidden Markov chain X_t of our model converge and the model with parameters λ is identifiable. For fit the parameters of model, we use Baum-Welch method [3] To estimate the break, we use the likelihood ratio test.

3. Results

We set $E = \{1, 2\}$, and $K = 1$, and $T = 365$ then we have 8 parameters. With the simulated data, we show that the model estimates the parameters well, and that the SME of the parameters decreases to 0 when the data size is larger.

To analyze the evolution of the daily precipitation, we use series of five years data, ten years data, and twenty year data. From the fitting of the model to these data with each stations we have the following results:

- This impact is the cause of the reduction of the amount of precipitation proved by the decrease of the shape parameters, and the poor quality of the rainy season proved by the fact that the shape parameters (which decrease) are less than the parameters of scales (which increase).
- This poor rainy season quality is due to the very small amount of rain on som rainy days and the high amount of rainfall observed for a low number of rainy days. This is the cause of the floods and the destruction of crops and certain infrastructures.

Station	Breaking	Good rainy season	Bad rainy season
Cotonou	1972	1952-1972	1973-2007
Bohicon	-	1940-1960, 1980-2007	1960-1980
Savè	1973	1921-1973	1974-2007
Parakou	1963	1921-1963	1964-2007
Kandi	1963	1921-1963	1964-2007
Natitingou	1974	1921-1974	1975-1921

Table 2: Results of estimations

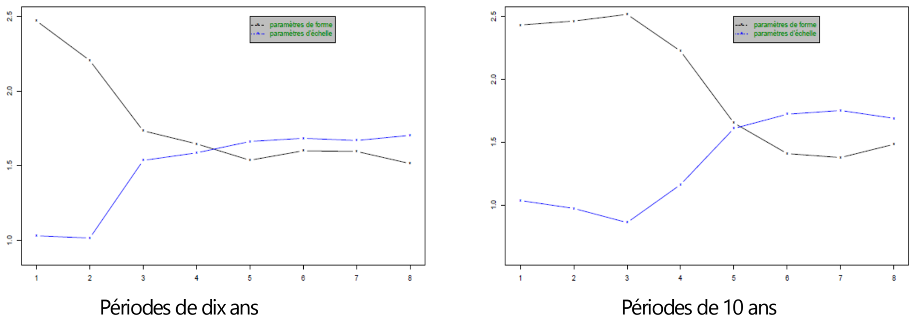

Figure 1: Shape and scale evolution in Kandi and Parakou

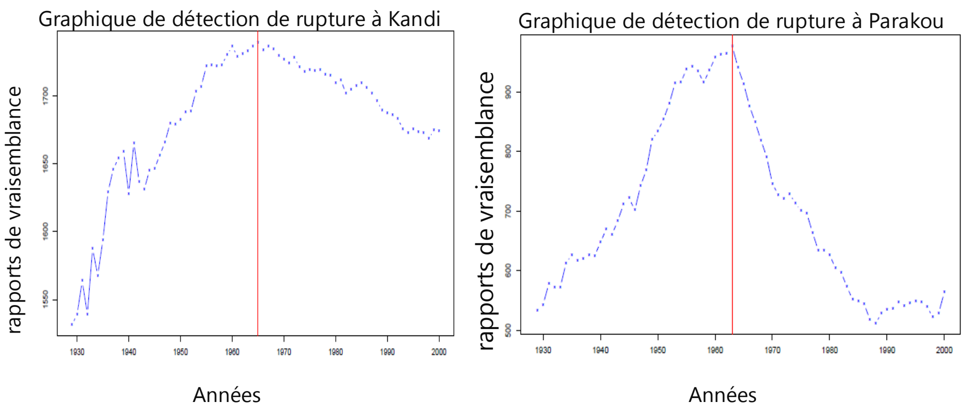

Figure 2: Breaking detection in Kandi and Parakou

From the model the length of state occurency are not significantly different, but are slightly different inside the rainy saison. We have also detected the cities where the number of rainy days and daily precipitation were high.

The fitting of begin, end, of rainy seasons, we noted three periods: The dry season, the rainy season, and the intermediate period. The following figure shows the evolution of the estimate rainy season length of tow cities

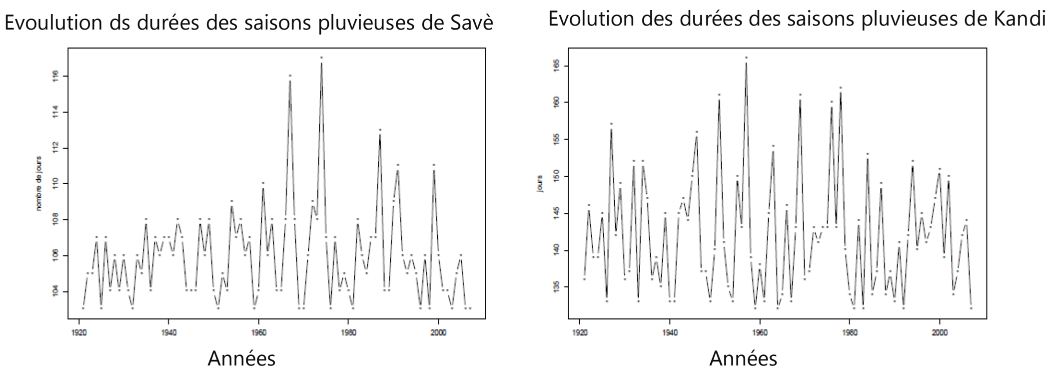

Figure 3: duration of the rainy season of Savé and Kandi

We note also that, in period of good rainy season, the trend of daily priciptation in rainy season increase, and the trend of daily precipitation in intermediate period decrease, but we have the opposite in period of bad rainy season.

4. Conclusions

- The model allows to estimate the impact of climate change on rainfall variability, and can be used for daily precipitation data from any country.

- From the model, we have shown that the break in the precipitation in Benin is around the 70's (precisely between 1964 and 1974). It should be noted that the cities where it rains the least as kandi and Parakou were more quickly affected.
- the model through these parameters, is able to determine the cities where the amount of water by rain and the number of rainy days are better or worse, this can help water managers in decision-making.

Forthcoming Research

Applied the Model to data with $M = 3$ to take account for the intermediate period.

Set up the same model with the period (phase) T variable from one rainy season to another

Asymptotic normality and consistency of model parameter estimators. Determination of Boostrap Confidence Interval for Non Homogeneous Hidden Markov Models.

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Comparative analysis of design-based and synthetic estimates of ownership of farm equipment and facilities for the 2002 Census of Agriculture

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Abstract
This study aims to analyze the feasibility of using synthetic estimator in estimating the total number of farm equipment and facilities for the 2002 Census of Agriculture in the municipal level. The estimation procedures employed were design-based and synthetic estimation. The data used came from the 1991 Census of Agriculture and Fisheries and the 1990 Census of Population and Housing. The variables total number of plows owned, total number of harrows owned, total number of sprayers owned, total number of threshers owned, and total number of handtractors owned were considered in the study. The resulting estimates were evaluated and compared based on the ratio of the absolute bias to the standard deviation, Relative Root Mean Square Error (RRMSE), and Coefficient of Variation (CV). In synthetic estimation, the total number of households was used as an auxiliary variable. Compared to synthetic estimation, estimates generated using the design-based estimator were more accurate and precise; more reliable; and the biases of the estimates were negligible. Synthetic estimator could have work under the assumption that the municipality has the same characteristics as the province but the study has been limited to using one auxiliary variable only.

Keywords
auxiliary variable, design-based estimation, farm equipment and facilities, synthetic estimation

1. Introduction

a. Background of the Study

There is a higher demand nowadays on estimates of various characteristics as more quantitative information required for decision making in government and industry arises. These estimates are often generated from nationwide sample surveys. However, estimation from nationwide survey data has limitations in terms of producing reliable microdata since production of small area statistics has emerged as a pressing and frequently difficult and costly problem.

The Census of Agriculture and Fisheries (CAF) is essential to our development since agriculture remains to be dominant sector of the economy of the Philippines. CAF is a complete count of all farms and fisheries in the

Philippines. The total number of farm equipment and facilities are few of the statistics generated by the National Statistics Office (NSO) through the Census of Agriculture. These statistics however, provide estimates only at the national, regional and provincial levels. Equipment and facilities refer to farm equipment and facilities used for agricultural activities during the reference period January 1, 1991 to December 31, 1991. Equipment and facilities that were unusable or beyond repair during the reference period were excluded.

Due to great cost allotted to this census, it is being conducted once every ten years. In the 1960, 1971, and 1980 census rounds, all barangays in the country were completely enumerated and sampling of farm households was done in each barangay. Complete enumeration of farm households have not been possible in the 1991 and 2002 census rounds since the government trimmed down the national budget in favor of the 1990 Census of Population and Housing (CPH). Due to less support for CAF than CPH in general, the need for extensive use of sampling to reduce costs is more acute in the former.

The 1991 CAF design was a systematic selection of 50% of the barangays in each municipality ordered with respect to total farm area and the selection with certainty of the barangay with the largest farm area based on the 1980 CAF. In each sampled barangay, all farm households were completely enumerated. Moreover, complete enumerations of all farm household were conducted of four provinces namely: Bukidnon, Marinduque, Isabela, and Laguna to validate the results of the study. Results from these provinces yielded precise estimates for most statistics at the provincial level but barely enough at the municipal levels.

The same design was implemented in the 2002 CAF except that 25% of the barangays in each municipality ordered with respect to total farm area and the selection with certainty of the barangay with the largest farm area based on the 1980 CAF are included. In each sampled barangay, all farm households were completely enumerated. Nevertheless, this accounted for a very small sample in the area leading to a lesser precision of estimates at all small areas.

b. Statement of the Problem

According to Morales as cited by Ghosh and Rao (1994), for the past few decades, sample surveys have taken the place of complete enumeration or census as a more cost-effective means of obtaining information on wide-ranging topics of interest at frequent intervals over time. Sample survey data certainly can be used to derive reliable estimates for totals and means for large areas or domains. However, the usual direct survey estimators for small areas based only on the data from the sampled units in the larger area, are likely to yield unacceptably large standard errors due to excessively small size of the sample in the area. With that regard, the field of small area statistics is given more focus on estimating characteristics at small levels.

This study will come up with timely and precise estimates of the total farm equipment and facilities at the municipal level without spending much on gathering information directly from each local area through small area estimation. Synthetic estimator is considered to analyze its feasibility in estimating the total number of farm equipment and facilities in the municipal level. Synthetic estimates will then be evaluated in terms of their precision and be compared with direct estimates.

Results of the study can provide information on the condition and development of farm facilities and equipment in the municipal levels. It can also assist the government in policy-making to further strengthen the agricultural machinery system at small areas. Better condition of the agricultural sector will mean maximizing its contribution to our country's growth.

2. Methodology

2.1 Source of Data

The data used in this study came from the pilot provinces identifies in the 1991 Census of Agriculture and Fisheries (CAF) as population. The pilot provinces are Laguna, Bukidnon, Isabela and Marinduque which represent some statistical properties under varying agricultural activities. Laguna, for example, represents the areas where urbanization is fast encroaching on farm lands, Bukidnon represents areas producing corn and permanent crops, Isabela is mainly on rice production and Marinduque represents small provinces.

Particularly, data on the total farm equipment and facilities owned for the four pilot provinces from the agricultural section of CAF is used in this study to illustrate the properties of synthetic estimator for some selected parameters at the municipal level. The characteristics used in the study pertaining to the total farm facilities and equipment in the country included are the total of plow, harrow, sprayer, thresher, and hand tractor for the four pilot provinces. The auxiliary variable used in this study is the total number of households, which came from the 1990 CPH.

2.2 Simulation of samples

Empirical work was done by simulating 1000 samples for each municipality adopting the 2002 CAF design. Using the 1000 generated samples, synthetic estimates of selected parameters was computed at the municipal level. The 1000 samples would be sufficient enough to give a good picture of the sampling distribution of the statistics to be evaluated.

Samples were generated in each municipality using the 2002 Census of Agriculture (CA). For example, a municipality has 9 barangays. The list of barangays was sorted in descending order with respect on their total farm area

(TFA) based on the 1980 CAF. The set $\{B_1, B_2, B_3, B_4, B_5, B_6, B_7, B_8, B_9\}$ will be represented in the ordered list with $B1$ indicating the barangay with the largest TFA and $B9$ having the smallest TFA.

From the ordered list, $B1$was automatically included in the sample (included with certainty). This means that if the 1991 CAF design have been applied in the list, the other barangays in the sample would have been either $\{, B_2, B_4, B_6, B_8, \}$ or $\{, B_3, B_5, B_7, B_9\}$.

In generating the total number possible samples using the 2002 CA design for each municipality, the possible samples that could have been generated in the 1991 CAF were considered since 2002 CAF design includes the selection with certainty of the barangay with the largest TFA based on the 1991 CAF, 25% systematic selection of the sampled barangays during the 1991 CAF. In the other words, the 2002 CA depends on the 1991 CAF samples. Generally, with the 2002 CA design, there were 32 possible samples for each municipality and each of these samples has an equal chance of being selected. Using the illustration above, the possible samples are:

$S_{k1} = \{B_1, B_2 *, B_3\}$	$S_{k12} = \{B_1, B_6 *, B_9\}$	$S_{k23} = \{B_1, B_5 *, B_6\}$
$S_{k2} = \{B_1, B_2 *, B_5\}$	$S_{k13} = \{B_1, B_8 *, B_3\}$	$S_{k24} = \{B_1, B_5 *, B_8\}$
$S_{k3} = \{B_1, B_2 *, B_7\}$	$S_{k14} = \{B_1, B_8 *, B_5\}$	$S_{k25} = \{B_1, B_7 *, B_2\}$
$S_{k4} = \{B_1, B_2 *, B_9\}$	$S_{k15} = \{B_1, B_8 *, B_7\}$	$S_{k26} = \{B_1, B_7 *, B_4\}$
$S_{k5} = \{B_1, B_4 *, B_3\}$	$S_{k16} = \{B_1, B_8 *, B_9\}$	$S_{k27} = \{B_1, B_7 *, B_6\}$
$S_{k6} = \{B_1, B_4 *, B_5\}$	$S_{k17} = \{B_1, B_3 *, B_2\}$	$S_{k28} = \{B_1, B_7 *, B_8\}$
$S_{k7} = \{B_1, B_4 *, B_7\}$	$S_{k18} = \{B_1, B_3 *, B_4\}$	$S_{k29} = \{B_1, B_9 *, B_2\}$
$S_{k8} = \{B_1, B_2 *, B_9\}$	$S_{k19} = \{B_1, B_3 *, B_6\}$	$S_{k30} = \{B_1, B_9 *, B_4\}$
$S_{k9} = \{B_1, B_6 *, B_3\}$	$S_{k20} = \{B_1, B_3 *, B_8\}$	$S_{k31} = \{B_1, B_9 *, B_6\}$
$S_{k10} = \{B_1, B_6 *, B_5\}$	$S_{k21} = \{B_1, B_5 *, B_2\}$	$S_{k32} = \{B_1, B_9 *, B_8\}$
$S_{k11} = \{B_1, B_6 *, B_7\}$	$S_{k22} = \{B_1, B_5 *, B_4\}$	

The superscript (*) is included to denote that the indicated barangay have been included in the 1991 CAF in addition to$B1$. Each of these samples has a 1 in 32 chance of being selected. A sample from a municipality will be denoted by Skj where k denotes a municipality ($k = 1, 2, \ldots, M$) and j denote a sample ($j = 1, 2, \ldots, 32$). In general, S_{kj} would be in the form $S_{kj} = \{\{B_1\}, \{M_i *\}, \{M_i\}\}$ where $\{B1\}$ is the barangay in the municipality k having the largest TFA; $\{M_i *\} = \{B_i *\}_{i=1}^{(N-1)/8}$ are the barangays which were selected in the 1991 CAF; and $\{M_i\} = \{B_i\}_{i=1}^{(N-1)/8}$ are the barangays not selected in the 1991 CAF.

2.3 Synthetic Estimator with Auxiliary Information

In the generation of the synthetic estimates, estimates of the total number of farm equipment and facilities at the provincial level were first generated. The province estimate was then used in conjunction with an auxiliary variable (total number of households) at the municipality level to generate the synthetic estimate. This means, that there are a total 32^M possible samples that can be generated in estimating the total number of farm equipment and facilities per household farmer at the provincial level. Each provincial sample will be in the form: $S_p = \{S_{kj}\}, k = 1,2, \ldots, M; j = 1,2, \ldots, 32$. For instance, if $M = 5$, a possible sample would be $S_p = \{S_{11},, S_{21}, S_{34}, S_{48},, S_{52}\}$. Each of the possible provincial samples was generated be selecting one sample from each municipality independently and with equal probability.

The synthetic estimates at the municipal level are given by

$$\boldsymbol{Y} *_{\boldsymbol{m}} = \left(\frac{\boldsymbol{N_m}}{\boldsymbol{N_p}}\right) * \boldsymbol{Y_p}$$

where N_m is the total number of households at the municipal level, N_p is the total number of households at the provincial level and Y_p is the estimate of total number of farm equipment and facilities at the provincial level. This estimator works under assumption that the municipality have the same characteristics as the province and is therefore biased. However, the degree of bias decreases as the ratio of the variables in the province becomes identical to the ratios in the municipality (Du-Quiton et.al., 1999).

2.4 Direct Design Based Estimator

The direct estimates for the total farm facilities and equipment per municipality for all the four pilot provinces were computed. The direct estimator for the total farm facilities and equipment for the 2002 CAF is defined as:

$$\hat{Y}_m = \sum_{i=1}^{h} \hat{Y}_h \qquad (2.4.1)$$

where, $\hat{Y}_h = \sum_{j=1}^{n_{hs}} y_{sj}$ (2.4.2)

m = municipality index s = systematic sample
j = barangay index i = stratum index
$k_h = N_h/n_h$ H = total number of strata ($h = 1, 2, 3$)
stratum 1: contains barangays included in the sample with certainty
stratum 2: includes barangays sampled in the 1991 CAF
stratum 3: includes barangays not sampled in the 1991 CAF

2.5 Evaluation of Estimates

Estimates produced using synthetic and direct design-based estimators were evaluated in terms of their accuracy, precision and reliability. The criterions considered in the study in the study include the ratio of the absolute bias to the standard deviation, Relative Root Mean Square Error (RRMSE), and Coefficient of Variation (CV). Thus, estimates were evaluated and compared using the following properties:

(1) Ratio of Absolute Bias to the Standard Deviation

One characteristics of a good estimator is unbiasedness, therefore it is of interest to measure the degree of bias of the two estimators. The ratio of absolute bias to the standard deviation of the estimator was considered to determine if the computed bias is negligible or not, and it is defined as,

$$\boldsymbol{P}_{(Bias,\sigma)} = \frac{\left|Bias(\hat{Y})\right|}{\sqrt{V}(\hat{Y})} \times 100 \tag{2.5.1}$$

If the absolute bias over the standard deviation of the estimator is less than or equal to 0.10 then it can be said that the bias is negligible (Cochran, 1977).

(2) Relative Root Mean Square Error

In here, all possible samples were utilized to generate the statistical properties of estimates. In particular, relative root mean
square errors were computed as:

$$\boldsymbol{RRMSE} = \frac{\sqrt{\boldsymbol{MSE}(\hat{\boldsymbol{Y}})}}{\boldsymbol{Y}} \times \mathbf{100} \tag{2.5.2}$$

where,

$$\boldsymbol{MSE}(\hat{\boldsymbol{Y}}) = \boldsymbol{V}(\hat{\boldsymbol{Y}}) + \{\boldsymbol{Bias}(\hat{\boldsymbol{Y}})\}^{\mathbf{2}} \tag{2.5.3}$$

$$\boldsymbol{Bias}(\hat{\boldsymbol{Y}}) = \boldsymbol{\Sigma}_{\boldsymbol{s=1}}^{\mathbf{1000}}(\hat{\boldsymbol{Y}})_{\boldsymbol{s}}\boldsymbol{p}(\boldsymbol{s}) - \boldsymbol{Y_m} = \boldsymbol{\Sigma}_{\boldsymbol{s=1}}^{\mathbf{1000}}(\hat{\boldsymbol{Y}})_{\boldsymbol{s}}(\mathbf{1/1000}) - \boldsymbol{Y_m} \tag{2.5.4}$$

$$\boldsymbol{V}(\hat{\boldsymbol{Y}}) = \Sigma_{\boldsymbol{s=1}}^{\mathbf{1000}}[(\hat{\boldsymbol{Y}}) - \boldsymbol{E}(\hat{\boldsymbol{Y}})]_{\boldsymbol{s}}^{\mathbf{2}}\boldsymbol{p}(\boldsymbol{s}) = \Sigma_{s=1}^{1000}[(\hat{\boldsymbol{Y}}) - \boldsymbol{E}(\hat{\boldsymbol{Y}})]_{\boldsymbol{s}}^{\mathbf{2}}\left(\frac{\mathbf{1}}{\mathbf{1000}}\right) \tag{2.5.5}$$

$$\boldsymbol{E}(\hat{\boldsymbol{Y}}) = \boldsymbol{\Sigma}_{\boldsymbol{s=1}}^{\mathbf{1000}}(\hat{\boldsymbol{Y}})_{\boldsymbol{s}}(\mathbf{1/1000}) \tag{2.5.6}$$

where $(\hat{\boldsymbol{Y}})_{\boldsymbol{s}}$ is the estimate of the total in a municipality m computed from samples $s(s = 1, 2, \ldots, 1000)$ and Y_m is the population total for municipality m.

According to Rao (2000), mean squared error (MSE) was used to measure the accuracy and precision of an estimator. For comparison purposes Relative Root Mean Square Error (RRMSE) was considered to measure accuracy and precision of the estimates. An estimator which has the minimum relative root mean square error was considered as the more precise estimator to estimate the total number of farm equipment and facilities.

(3) Coefficient of Variation In terms of reliability of the estimate, coefficient of variation was used and these were computed as,

$$\boldsymbol{CV} = (\sqrt{\boldsymbol{MSE}}(\hat{\boldsymbol{Y}})/(\hat{\boldsymbol{Y}}) * 100 \tag{2.5.7}$$

It was used to indicate the “goodness” of the estimates for the total number of farm equipment and facilities. An estimator with smallest value of coefficient of variation was considered as the more reliable estimator to estimate the total number of farm equipment and facilities.

Hence, the estimator with smallest ratio of absolute bias to the standard deviation, relative root mean square error and greater number of municipal estimates with coefficients of variation less than 10% is considered as the better estimator in this study.

3. Result

The study aims to analyze the feasibility of using synthetic estimator in estimating the total number of farm equipment and facilities for the 2002 Census of Agriculture in the municipal level

Table 1. Total Number of Barangays and Total Number of Municipalities in the Provinces of Bukidnon, Marinduque, Isabela and Laguna.

Province	Number of Barangays	Name of Municipalities
Bukidnon	458	22
Isabela	1055	37
Laguna	671	30
Marinduque	218	6

Table 1 shows the total number of barangays and the total number of municipalities for the four provinces. Among the four provinces, Isabela has the largest total number of barangays (1055 barangays) and consists of 37 municipalities. On the other hand, Marinduque which is made up of six municipalities has the smallest total number of barangays (218 barangays).

In synthetic estimation, the provincial estimate was used in conjunction with an auxiliary variable, which is the total number of households at the municipal level. This auxiliary variable was considered in the study since it is the only variable available. This available was correlated to each of the five types of farm equipment and facilities. The Pearson correlation coefficient was employed because the variables under study are of the interval scale. Moreover, correlation was done to determine if the characteristic at the municipal level is the same as that of the provincial level.

Table 2. Correlation coefficients of the total number of farm equipment and Facilities for the four Pilot provinces with the number of households.

Province	Correlation Coefficient				
	Plow	Harrow	Sprayer	Thresher	Hand tractor
Marinduque	0.426	0.368	0.355	0.061	-0.008
Bukidnon	0.679	0.555	0.599	0.364	0.234
Isabela	0.084	0.09	0.157	0.179	0.179
Laguna	0.092	0.075	0.274	0.111	0.108

Moreover, this study aims to investigate the statistical properties of some municipal level estimates of the total number of farm equipment and facilities for the 2002 Census of Agriculture. Two estimation procedures, namely design based and synthetic estimations were employed. The resulting estimates using the two procedures were compared based on their respective Relative Root Mean Square Error (RRMSE), Coefficient of Variation (CV), and the ratio of the absolute bias to the standard deviation. RRMSE was used to measure the accuracy and precision of the design-based and synthetic estimates and CV was used to measure reliability or "goodness" of the estimates. On the other hand, the ratio of the absolute bias to the standard deviation was used to indicate negligibility of the bias of estimates at 10%. The estimator with the highest number of small values of RRMSE and CV was considered as the better estimator to estimate the total number of farm equipment and facilities in this study.

In the province of Bukidnon, estimating the total number of plow, harrow, and sprayer is best represented by synthetic estimation. Estimates gained from these characteristics are more accurate and precise than design-based estimation. This can be attributed to the very strong correlation between variables considered in this study are the auxiliary variable, which is the total number of households. Moreover, these estimates are also reliable through their biases are not negligible. This happens because theoretically synthetic estimator is a biased estimator.

On the other hand, it is evident from the results that the total number of plows, thresher and hand tractor are the best estimated by the design-based estimator in the province of Marinduque, These parameters have weak and moderate correlations with the auxiliary variable. Therefore, it is expected that estimates produced by synthetic estimator are less accurate and precise.

In the province of Isabela, it can be seen in that synthetic estimator is more preferred to be use in estimating the total number of plows, harrows, and sprayers. The estimates are more accurate and precise than direct estimates. Also, these estimates are more reliable. These parameters satisfied the assumption that characteristic of the larger areas is same as that of small areas.

In Laguna, synthetic estimator is more preferred in estimating the total number of sprayers. This characteristic satisfied the assumption that the province ratio have same characteristic as that of the municipal ratio. All other parameters of ownership are best estimated using design-based estimation.

Generally, the results of the estimation procedures employed in this study suggest that design-based estimation has negligible bias compared to synthetic estimation. In addition, design-based estimation produced more accurate and precise estimates. Synthetic estimation failed to give greater number of estimates which are accurate and precise because mainly of the failure in the assumption of small area having same characteristics as that of a larger area. Design-based estimation procedure considered in this study is good enough to be used in estimating the total number of farm equipment and facilities owned.

4. Discussion and Conclusion

This study is limited only in using total number of households as an auxiliary variable in synthetic estimation, it is highly recommended to use other possible variables that might be related to the variable of interest to verify the results of this study. The choice of auxiliary variable greatly affects the resulting estimates of synthetic estimation. Also, the use of other small area estimation procedures such as composite estimation, empirical Bayes estimation and hierarchical estimation is recommended in order to arrive at a more reliable estimate for the total number of farm equipment and facilities in the province under study. One of these procedures could provide unbiased and more precise estimates of the selected parameters on ownership of farm equipment and facilities for the 2002 Census of Agriculture. However, it should be noted that none particular procedure of estimation will be inevitably consistently superior for all small areas. Furthermore, any choice of estimator will most likely result into a loss of precision for some areas as well as gains for others.

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A new regression model for positive random variables

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Abstract
In this paper, we propose a regression model where the response variable is beta prime distributed using a new parameterization of this distribution that is indexed by mean and precision parameters. The proposed regression model is useful for situations where the variable of interest is continuous and restricted to the positive real line and is related to other variables through the mean and precision parameters. The variance function of the proposed model has a quadratic form. In addition, the beta prime model has properties that its competitor distributions of the exponential family do not have. Estimation is performed by maximum likelihood. Finally, we also carry out an application to real data that demonstrates the usefulness of the proposed model.

Keywords
Beta prime distribution; Variance function; Maximum likelihood estimator; Regression models

1. Introduction

The concept of regression is very important in statistical data analysis (Jørgensen, 1997). In this context, generalized linear models (Nelder & Wedderburn, 1972) are regression models for response variables in the exponential family.

The main aim of this paper is to propose a regression model that is tailored for situations where the response variable is measured continuously on the positive real line that is in several aspects, like the generalized linear models. In particular, the proposed model is based on the assumption that the response is beta prime (BP) distributed. We considered a new parameterization of the BP distribution in terms of the mean and precision parameters. Under this parameterization, we propose a regression model, and we allow a regression structure for the mean and precision parameters by considering the mean and precision structure separately. The variance function of the proposed model assumes a quadratic form. The proposed regression model is convenient for modeling asymmetric data, and it is an alternative to the generalized linear models when the data presents skewness. Inference, diagnostic and selection tools for the proposed class of models will be presented.

We summarize below the main contributions and advantages of the proposed BP model over the popular gamma model. With these contributions below, we provide a complete tool for modelling asymmetric data based on our BP regression.

- We allow a regression structure on the precision parameter; in a manner similar to the way the generalized linear models with dispersion covariates extend the generalized linear models.
- The variance function of proposed model assumes a quadratic form similar to the gamma distribution. However, the variance function of proposed model is larger than the variance function of gamma distribution, which may be more appropriate in certain practical situations.
- The BP hazard rate function can have an upside-down bathtub or increasing depending on the parameter values. Most classical two-parameter distributions such as Weibull and gamma distributions have monotone hazard rate functions.
- The skewness and kurtosis of the BP distribution can be much larger than the of the gamma distribution.

The BP distribution (Keeping, 1962; McDonald, 1984) is also known as inverted beta distribution or beta distribution of the second kind. However, only a few works have studied the BP distribution. McDonald (1987) discussed its properties and obtained the maximum likelihood estimates of the model parameters. Tulupyev et al. (2013) used the BP distribution while discussing regression models for positive random variables. However, these works have considered the usual parameterization of the BP distribution.

A random variable Y follows the BP distribution with shape parameters $\alpha > 0$ and $\beta > 0$, denoted by $Y \sim BP(\alpha, \beta)$, if its cumulative distribution function (cdf) is given by

$$F(y|\alpha,\beta) = I_{y/(1+y)}(\alpha,\beta), y > 0, \quad (1)$$

Where $I_x(\alpha,\beta) = B_x(\alpha,\beta)/B(\alpha,\beta)$ is the incomplete beta function ratio, $B_x(\alpha,\beta) = \int_0^x \omega^{\alpha-1}(1-\omega)^{\beta-1}\, d\omega$ is the incomplete function, $B(\alpha,\beta) = \Gamma(\alpha)\Gamma(\beta)/\Gamma(\alpha+\beta)$ is the beta function and $\Gamma(\alpha) = \int_0^\infty \omega^{\alpha-1}e^{-\omega} d\omega$ is the gamma function. The probability density function (pdf) associated with (1) is

$$f(y|\alpha,\beta) = \frac{y^{\alpha-1}(1+y)^{-(\alpha+\beta)}}{B(\alpha,\beta)}, y > 0. \quad (2)$$

The rth moment about zero of Y is given by

$$E[Y^r] = \frac{B(\alpha+r,\beta-r)}{B(\alpha,\beta)}, -\alpha < r < \beta.$$

In particular, the mean and the variance associated with (2) are given by

$$E[Y] = \frac{\alpha}{\beta - 1}, \beta > 1, \qquad and \qquad Var[Y] = \frac{\alpha(\alpha + \beta - 1)}{(\beta - 2)(\beta - 1)^2}, \beta > 2. \tag{3}$$

The rest of the paper proceeds as follows. In Section 2, we introduce a new parameterization of the BP distribution that is indexed by the mean and precision parameters and presents the BP regression model with varying mean and precision. In Section 3, some numerical results of the estimators are presented with a discussion of the obtained results. In Section 4, we discuss an application to real data that demonstrates the usefulness of the proposed model. Concluding remarks are given in the final section.

2. A BP distribution parameterized by its mean and precision parameters

Regression models are typically constructed to model the mean of a distribution. However, the density of the BP distribution is given in Equation (2), where it is indexed by α and β. In this context, in this section, we considered a new parameterization of the BP distribution in terms of the mean and precision parameters. Consider the parameterization $\mu = \alpha \,/\, (\beta - 1)$ and $\emptyset = \beta - 2$, i.e., $\alpha = \mu(1 + \emptyset)$ and $\beta = 2 + \emptyset$. Under this new parameterization, it follows from (3) that

$$E[Y] = \mu \;\; and \;\; Var[Y] \; = \frac{\mu(1 + \mu)}{\phi}.$$

From now on, we use the notation $Y \sim BP(\mu, \phi)$ to indicate that Y is a random variable following a BP distribution with mean μ and precision parameter ϕ. Note that $\mathrm{V}(\mu) = \mu(1 + \mu)$ is similar to the variance function of the gamma distribution, for which the the variance has a quadratic relation with its mean. We note that this parameterization was not proposed in the statistical literature. Using the proposed parameterization, the BP density in (2) can be written as

$$f(y|\mu, \phi) = \frac{y^{\mu(\phi+1)-1}(1 + y)^{-[\mu(\phi+1)+\phi+2]}}{B(\mu(1 + \phi), \phi + 2)}, \qquad y > 0, \tag{4}$$

where $\mu > 0 \; and \; \phi > 0$.

Let $Y_1,\ldots,Y_n$ be n independent random variables, where each $Y_{i,} i = 1, \ldots, n$, follows the pdf given in (4) with mean μ_i and precision parameter ϕ_i. Suppose the mean and the precision parameter of Y_i satisfies the following functional relations

$$g_1(\mu_i) = \eta_{1i} = \mathrm{x}_i^\top \beta and g_2(\phi_i) = \eta_{2i} = \mathrm{z}_i^\top \upsilon \tag{5}$$

where $\beta = (\beta_1, \ldots, \beta_p)^\top$ and $\upsilon = (\upsilon_1, \ldots, \upsilon_q)^\top$ are vectors of unknown regression coefficients which are assumed to be functionally independent, $\beta \in \mathbb{R}^p$ and

$\upsilon \in \mathbb{R}^q$, with $P + q < n, \eta_{1i}$ and η_{2i} are the linear predictors, and $x_i = (x_{i1}, \ldots, x_{ip})^\top$ and $z_i = (z_{i1}, \ldots, z_{iq})^\top$ are observations on p and q known regressors, for $i = 1, \ldots, n$. Furthermore, we assume that the covariate matrices $\mathbf{X} = (\mathbf{x}_1, \ldots, \mathbf{x}_n)^\top$ and $\mathbf{Z} = (\mathbf{z}_1, \ldots, \mathbf{z}_n)^\top$ have rank p and q, respectively. The link functions $g_1: \mathbb{R} \to \mathbb{R}^+$ and $g_2: \mathbb{R} \to \mathbb{R}^+$ in (5) must be strictly monotone, positive and at least twice differentiable, such that $\mu_i = g_1^{-1}(\mathbf{x}_i^\top)\beta$ and $\phi_i = g_2^{-1}(\mathbf{z}_i^\top \upsilon)$, with $g_1^{-1}(\cdot)$ and $g_2^{-1}(\cdot)$ being the inverse functions of $g_1(\cdot)$ and $g_2(\cdot)$, respectively. The log-likelihood function has the form

$$\ell(\beta, \upsilon) = \sum_{i=1}^{n} \ell(\mu_i, \phi_i), \tag{6}$$

Where

$$\begin{aligned}\ell(\mu_i, \phi_i) = {} & [\mu_i(1 + \phi_i) - 1]\log(y_i) - [\mu_i(1 + \phi_i) + \phi_i + 2]\log(1 + y_i) \\ & - \log[\Gamma(\phi_i + 2)] + \log[\Gamma\mu_i(1 + \phi_i) + \phi_i + 2].\end{aligned}$$

The maximum likelihood (ML) estimators $\hat{\beta}$ and $\hat{\upsilon}$ of β and υ, respectively, can be obtained by solving simultaneously the nonlinear system of equations $\mathbf{U}_\beta = 0$ and $\mathbf{U}_\upsilon = 0$. However, no closed-form expressions for the ML estimates are possible. Therefore, we must use an iterative method for nonlinear optimization.

3. Monte Carlo studies

The Monte Carlo experiments were carried out using

$$\log(\mu_i) = 2.0 - 1.6x_{i1} \; and \; \log(\phi_i) = 2.6 - 2.0\, z_{i1} \; i = 1, \ldots, n, \tag{7}$$

where the covariates x_{i1} and z_{i1}, for $i = 1, \ldots, n$ were generated from a standard uniform. The values of all regressors were kept constant during the simulations. The number of Monte Carlo replications was 5,000. All simulations and all the graphics were performed using the **R** programming language (R Core Team, 2017). Regressions were estimated for each sample using the **gamlss()** function.

The goal of this simulation experiment is to examine the finite sample behavior of the MLE's. This was done 5,000 times each for sample sizes (*n*) of 50, 100 and 150. In order to analyze the point estimation results, we computed, for each sample size and for each estimator: mean (E), bias (B) and root mean square error (RMSE).

Table 1: Mean, bias and mean square error

Table 1: Mean, bias and mean square error.

n	Mean parameter						Precision parameter					
	$E(\widehat{\beta}_0)$	$E(\widehat{\beta}_1)$	$B(\widehat{\beta}_0)$	$B(\widehat{\beta}_1)$	$RMSE(\widehat{\beta}_0)$	$RMSE(\widehat{\beta}_1)$	$E(\widehat{\nu}_0)$	$E(\widehat{\nu}_1)$	$B(\widehat{\nu}_0)$	$B(\widehat{\nu}_1)$	$RMSE(\widehat{\nu}_0)$	$RMSE(\widehat{\nu}_1)$
50	1.996	−1.601	−0.004	−0.001	0.114	0.226	2.742	−2.117	0.142	−0.117	0.776	1.019
100	1.999	−1.602	−0.001	−0.002	0.077	0.155	2.661	−2.048	0.061	−0.048	0.654	0.636
150	1.998	−1.601	−0.002	−0.001	0.063	0.122	2.642	−2.025	0.042	−0.025	0.281	0.508

Table 2: Standard errors and standard desviation estimates.

n	Mean parameter				Precision parameter			
	$SD(\widehat{\beta}_0)$	$SD(\widehat{\beta}_1)$	$EP(\widehat{\beta}_0)$	$EP(\widehat{\beta}_1)$	$SD(\widehat{\nu}_0)$	$SD(\widehat{\nu}_1)$	$EP(\widehat{\nu}_0)$	$EP(\widehat{\nu}_1)$
50	0.116	0.225	0.110	0.216	0.763	1.012	3.852	4.291
100	0.080	0.155	0.077	0.150	0.651	0.635	2.713	2.981
150	0.064	0.124	0.062	0.122	0.279	0.508	0.271	0.491

Table 1 presents the mean, bias and RMSE for the maximum likelihood estimators of β_0, β_1, υ_0 and υ_1. The estimates of the regression parameters β_0 and β_1 are more accurate than those of υ_0 and υ_1. We note that the RMSEs tend to decrease as larger sample sizes are used, as expected. Finally, note that the standard deviations (SD) of the estimates very close to the asymptotic standard errors (SE) estimates when n tends towards infinity (see, Table 2).

4. Real data application

The analysis was carried out using the **glmBP** and **gamlss** packages. We will consider a randomized experiment described in Griffiths *et al.* (1993). In this study, the productivity of corn (pounds/acre) is studied considering different combinations of nitrogen contents and phosphate contents (40, 80, 120, 160, 200, 240, 280 and 320 pounds/acre). The response variable Y is the productivity of corn given the combination of nitrogen (x_{1i}) and phosphate (x_{2i}) corresponding to the ith experimental condition ($i = 1, \ldots, 30$) and the data are presented in Figure 1.

In Figure 1, there is evidence of an increasing productivity trend with increased inputs. Moreover, note that there is increased variability with increasing amounts of nitrogen and phosphate, suggesting that the assumption of GA or RBS distributions (both with quadratic variance) for $\log(\mu_i)$,i.e., we consider that Y_i follows $BP(\mu_i, \phi_i)$, $GA(\mu_i, \phi_i)$ and $RBS(\mu_i, \phi_i)$ distributions with a systematic component given by

$$\log(\mu_i) = \beta_0 + \beta_1 \log(x_{1i}) + \beta_2 \log(x_{2i})_{2i} \quad and \quad \phi_i = \upsilon_{0.}$$

We compared the BP regression model with the GA and RBS regression models.

Table 3: Parameter estimates and SE for the BP, GA and RBS models.

Parameter	BP		GA		RBS	
	Estimate	SE	Estimate	SE	Estimate	SE
β_0	0.4471	0.2697	0.4687	0.2808	0.4589	0.2644
β_1	0.3453	0.0399	0.3499	0.0421	0.3473	0.0397
β_2	0.4191	0.0382	0.4100	0.0407	0.4146	0.0384
ν_0	45.650	12.260	46.592	11.987	92.570	23.900
Selection criteria						
Log-likelihood	−112.19		−112.30		−113.86	
AIC	232.38		232.59		232.41	
BIC	237.99		238.20		238.02	

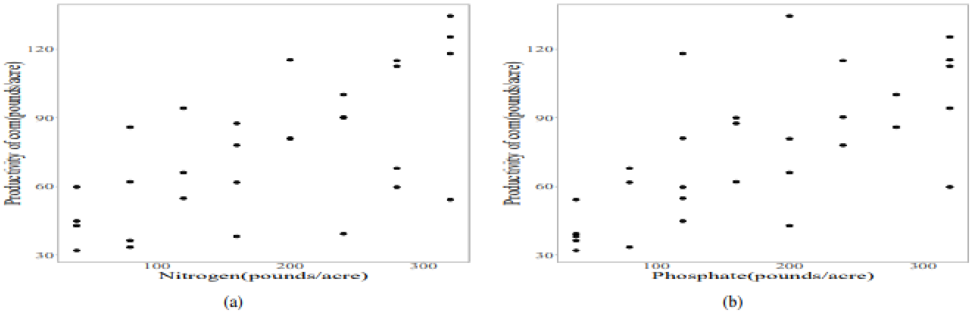


Figure 1: Scatterplots of nitrogen against productivity (a) and phosphate against productivity (b).

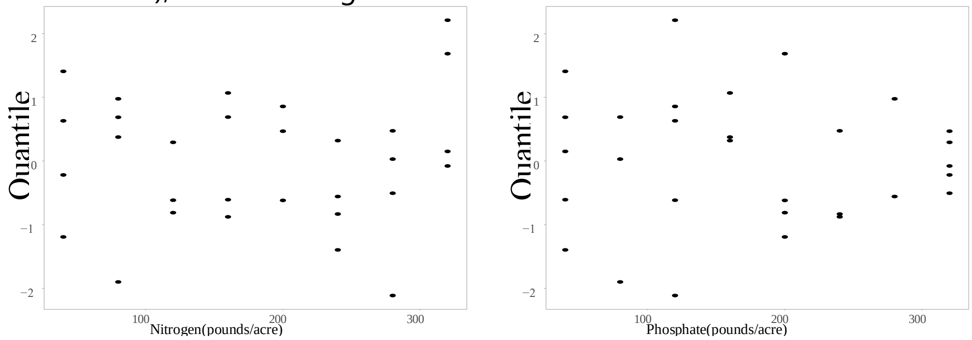
Table 3 presents the estimates, standard errors (SE), Akaike information criterion (AIC) and Bayesian information criterion (BIC) for the BP, GA and RBS models. We can note that the BP, GA and RBS regression models present a similar fit according to the information criteria (AIC and BIC) used.

Non-constant variance in can be diagnosed by residual plots. Figure 2(b) note that the residual plot shows a pattern that indicates an evidence of a non-constant precision because the variability is higher for lower phosphate concentrations. Thus, we will consider the following model for precision of the BP regression model

$$\log(\phi_i) = \upsilon_0 + \upsilon_1\, x_{2i}, \quad i = 1,\ldots,30.$$

The ML estimates of its parameters, with estimated asymptotic standard errors (SE) in parenthesis, are: $\hat{\beta}_0 = 0.5207(0.2788)$, $\hat{\beta}_1 = 0.3506\ (0.0330)$, $\hat{\beta}_2 = 0.3990\ (0.0423)$, $\hat{\upsilon}_0 = 2.7027\ (0.6650)\ and\ \hat{\upsilon}_1 = 0.0072\ (0.0033)$.

Note that the coefficients are statistically significant at the usual nominal levels. We also note that there is a positive relationship between the mean response (the productivity of corn) and nitrogen, and that there is a positive relationship between the mean response and the phosphate. Moreover, the likelihood ratio test for varying precision is significant at the level of 5% (p-value =0.0412), for the BP regression model with the structure above.



(a) (b)

Figure 2: Nitrogen against the residuals $r_i^{\boldsymbol{Q}}(a)$ and phosphate against the residuals $r_i^{\boldsymbol{Q}}(b)$.

5. Concluding remarks

In this paper, we have developed a new parameterized BP distribution in terms of the mean and precision parameters. The variance function of the proposed model assumes a quadratic form. Furthermore, we have proposed a new regression model for modelling asymmetric positive real data. An advantage of the proposed BP regression model in relation to the GA and RBS regression models is its flexibility for working with positive real data with high skewness, i.e., the proposed model may serve as a good alternative to the GA and RBS regression models for modelling asymmetric positive real data. Maximum likelihood inference is implemented for estimating the model parameters and its good performance has been evaluated by means of Monte Carlo simulations. Furthermore, we provide closedform expressions for the score function and for Fisher's information matrix. Diagnostic tools have been obtained to detect locally influential data in the maximum likelihood estimates. We have proposed two types of residuals for the proposed model and conducted a simulation study to establish their empirical properties in order to evaluate their performances. Finally, an application using a real data set was presented and discussed.

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How ICT Statistics facilitate countries for achieving the Sustainable Development Goals (SDGs) with focusing on Iran's ICT Statistics

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Abstract

Information and Communication Technologies (ICTs) now form the backbone of today's economies – providing individuals with access to such vitally important resources as employment opportunities, online banking and healthcare. As such, countries should have turned to ICTs to fast-forward efforts to achieve the United Nations Sustainable Development Goals (SDGs) 2030 agenda and share their perspectives and experiences on how and why ICTs for SDGs is critical. In the other word, ICT sector play a significant role in achieving the SDGs and that the digital revolution can help communities become more sustainable and environmentally friendly and solve their concrete challenges. In this way, ICT statistics can be utilized as functional tools for more effective and efficient monitoring the ICT sector as well as SDGs' progress which it causes to accelerate the developing processes. As a result, countries will need to consider ICT indicators beyond the SDG monitoring framework in order to adequately assess the impact of ICTs in their own sustainable development. In this study, however; with focusing more on Iran's ICT statistics, a comprehensive review on a thematic list of ICT indicators that could be used to measure ICT availability and use in both direct and indirect sectors relevant to the SDGs will be prepared and an investigation on the current challenges will be addressed. In the other side, ICT as a dynamic sector has been changing continuously and new topics such as digital trade, e-commerce, electronic waste, e-government etc. has been added to ICT sector which will be briefly reviewed. Noticeably, the more developed ICT infrastructure in country, the easier it is to reach the SDGs. All in all, highlighting the role of ICT statistics as a significant part of economic statistics on SDGs, this study attempts to provide a new insight for better NSOs' orientations toward ICT statistics more relevant to SDGs.

Keywords

Economic statistics; ICT statistics; Sustainable Development Goals (SDGs); Iran's ICT statistics; the internet penetration rate; ICT Development Index

1. Introduction

The new Sustainable Development Goals, or SDGs, set out a shared global agenda for human development based on prosperity, social inclusion and environmental sustainability. The SDGs include several bold objectives to be achieved by the year 2030, including universal coverage in health, education, poverty eradication and modern energy services. Also, The Internet and mobile phones have spread around the world to such an extent that, according to the World Bank, more households in developing countries own a mobile phone than have access to electricity or clean water. Nearly 70% of the poorest fifth of the population in developing countries own a mobile phone. Global society is more connected than ever before, but the question that has not been asked is how ICT infrastructure can help countries bring an end to extreme poverty, inequality, and climate change by 2030?

Achieving the United Nations' Sustainable Development Goals (SDGs) will require a step change in information and communication technology (ICT) infrastructure, access and affordability. To facilitate achievement of SDGs the cross-cutting Information Communication Technology (ICT) plays an extremely vital catalytic role. The 2030 Agenda for Sustainable Development recognizes the great potential of global connectivity to spur human progress.

2. Review on ICT statistics

The demand for information and communication technology (ICT) statistics has risen sharply as countries recognize the benefits and potential of ICT as a tool for social and economic development. To reap the benefits of the rapidly changing information society, governments need to monitor and benchmark progress based on measurable indicators with a view to designing and reviewing national policies and strategies. ICT should be tracked holistically in different goals of SDGs so as to provide better achieving to the goals and as a result core list of ICT statistics should be updated dynamically. [1]

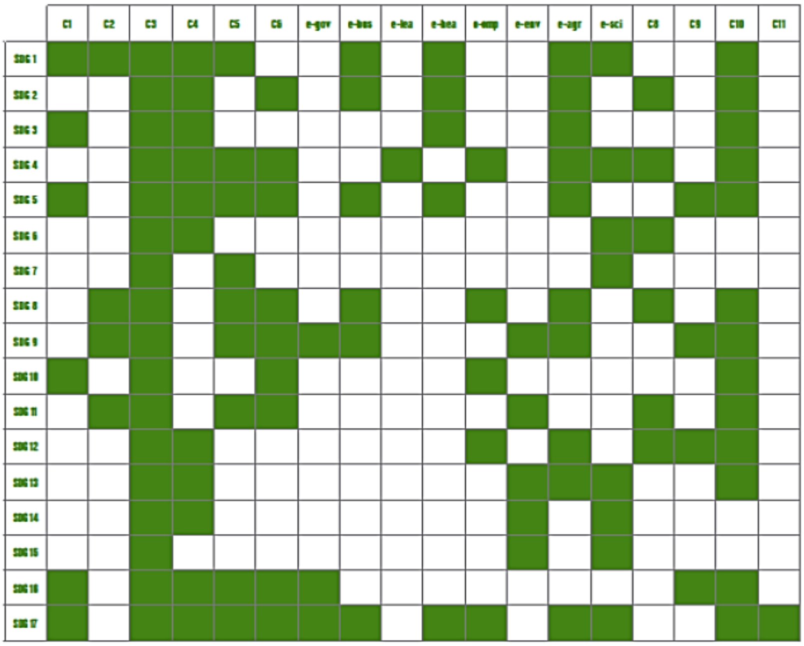
The country-by-country study - thought to be the first of its kind - was carried out by ICT leader Huawei in collaboration with the think tank Sustainability and leading European business network CSR Europe. In recently study on EU countries, the EU ICT-Sustainable Development Goals Benchmark, ranks EU countries on development of their ICT sector and achievements on six of the 17 SDGs. The report said that those EU countries with advanced ICT sectors and information societies perform better on sustainable development - with high-speed broadband at the core of progress. It concludes that the ICT sector "can offer solutions to advance most, if not every single one of the goals." European Commissioner responsible for jobs, growth, investment and competitiveness Jyrki Katainen, said the ICT sector can play a "significant role" in achieving the SDGs and that the report's findings offered "clear evidence that the digital revolution can help communities in Europe become more sustainable and environmentally friendly." [2]

In the other word, ICT development is a major priority for the commission but it is not an objective just in itself. It is a tool for economic growth and has to be for the benefit of everyone. The launch of the publication coincides with the meeting of the United Nations' High-Level Political Forum (HLPF), taking place in New York City, 10-19 July 2017 – which is the voluntary review process of the 2030 Agenda, including the SDGs. With the theme "Eradicating poverty and promoting prosperity in a changing world," the 2017 HLPF is reviewing progress on six of the SDGs, including SDG9, which seeks to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation. While ICTs link most closely to this SDG, as the new publication highlights, ICTs are playing a critical role in achievement of all 17 SDGs. [3]

ICT role in SDGs: Review

No other domain in the recent past had such a strong influence on the development of countries and societies than information and communication technologies (ICTs), especially in driving today's innovation, efficiency and effectiveness across all sectors. ICT has been the fastest growing sector since a generation. The World Summit on Information Societies (WSIS) in 2003 and 2005 was devoted to the potential of ICTs towards the vision of "a people centered, inclusive and development-oriented information society" where everyone can have the potential to access and share information available (on the Web). The fundamental aim of the WSIS process was the improvement of peoples' life through a better use of ICTs. The role of information technology on society has been discussed in different working groups of the Technical Committee 9 "ICT and Society" since 1976. [4]

Already in 2005, an IFIP Working Group for "ICT and Sustainable Development" [5] was established to provide the platform for discussion and research on this eminent important topic for building a global society where nobody should be left behind which is also sustainable for future generations.



*C1: The role of public governance authorities and
all stakeholders in the promotion of ICTs for development
*C2: Information and communication infrastructure
*C3: Access to information and knowledge
*C4: Capacity building
*C5: Building confidence and security in the use of ICTs
*C6: Enabling environment
*C7: ICT applications:
E-government, E- Business, E-learning, E-health,
E-employment, E-environment, E-agriculture, E-science
*C8: Culture diversity and identify, linguistic diversity and local content
*C9: Media
*C10: Ethical dimensions of the information society
*C11: international; and regional cooperation

Figure 1 WSIS action lines - SDGs matrix [6]

In its mapping, WSIS mapped its action lines to the sustainable development goals. For each mapping in the table a detailed rationale is given in the report. In the following we briefly outline the action lines as described by WSIS. [6] The action line C1 ("Role of Government and all Stakeholders in the Promotion of ICT for Development") [7] highlights the importance of the buy-in from governments and stakeholders in order to establish the Information Society. C2 ("Information and communication infrastructure: an essential foundation for the Information Society") [7] demands adequate infrastructure enabling affordable and ubiquitous access to ICT. C3 ("Access to information and knowledge") [7] outlines that individuals and organizations should take advantage from access to information and knowledge using ICT. C4 ("Capacity building") [7] states that every person should have the knowledge and skill set to profit from the Information Society. Further, actions how ICT can support education and lifelong learning activities are outlined. C5 ("Building confidence and security in the use of ICTs") [7] highlights the central value of privacy, trust and security for the Information Society. C6 ("Enabling environment") [7] points out actions to increase the confidence in the Information Society. C7 ("ICT applications: benefits in all aspects of life") [7] highlight that ICT can improve the sustainable development in various areas such as e-government, e-business, e-learning, e-health, e-environment, e-agriculture, and e-science. Within the WSIS-SDG matrix C7 is refined into the individual applications. C8 ("Cultural diversity and identity, linguistic diversity and local content") [7] stresses that cultural and linguistic diversity poses a critical success factor in the development of an Information Society. C9 ("Media") [7] outlines the importance of media in all its forms in the development of an Information Society. C10 ("Ethical dimensions of the Information Society") [7] emphasizes the relevance of ethics within the Information Society to avoid abusive usage of ICT. C11 ("International and regional cooperation") [7] points out that international cooperation is indispensable in order to eliminate the digital divide.

While only one of the SDGs is specifically about ICTs, several targets make references to ICTs and technology. The 2030 Agenda for Sustainable Development also recognizes that "The spread of information and communication technology and global interconnectedness has great potential to accelerate human progress, to bridge the digital divide and to develop knowledge societies". ITU has made a concerted effort to highlight the role that ICTs will play in achieving the SDGs. It is actively participating in the discussions on the indicators that will be used to track the SDGs:

1. ITU participated in the Expert Group Meeting on the indicator framework for the post-2015 development agenda, which took place in February, 2015, in New York. As part of its work within the Partnership on Measuring ICT for Development, it submitted a joint proposal of ICT indicators to help track the Sustainable Development Goals and targets (pdf format).
2. ITU participated in the First Meeting of the Inter-agency and Expert Group on Sustainable Development Goal Indicators (IAEG-SDGs), which took place from 1-2 June 2015, in New York. The IAEG-SDGs was set up by the UN Statistical Commission and is the main group that is in charge of developing the SDG indicators framework. As an input to its first meeting, ITU proposed a list of 8 ICT indicators, covering 8

targets within Goals 1, 4, 5, 9, 16, 17 (pdf format) and technical/metadata information sheets on these proposed indicators (pdf format). [23]

ICT indicators for measuring SDGs

The core list of ICT indicators has evolved over time and now includes over 60 indicators, which were agreed upon through a consultation process involving governments, international organizations, and experts in the field of information society measurement. They cover the following areas:

1. ICT infrastructure and access (A1: A10) by ITU[1]
2. Access and use of ICT by households and individuals (HH1:HH19) by ITU
3. ICT access and use by enterprises (B1: B12) by UNCTAD[2]
4. The ICT sector and trade in ICT goods and services (ICT1:ICT4) by UNCTAD
5. ICT in education (ED1 to EDR1) by ITU
6. ICT in government (EG1:EG7) by ITU
7. ICT development Index (IDI) by ITU
8. The ICT sector by UNCTAD
9. ICT: electronic waste (HH20:HH21) by ITU

The list, which has been endorsed by the UN Statistical Commission (last in 2014), was developed to help guide countries in measuring the information society. [8]

ICTs must play a central role in developing solutions to address climate change, respond to growing global competition, and to meet the rising expectations and needs of all segments of society, including the poorest, least skilled, or otherwise marginalized. Moreover, the context of SDG 11, ITU took the initiative in 2016 to further collaboration with other United Nations agencies and programs through the "United for Smart Sustainable Cities" initiative (U4SSC) which serves as the global platform for smart city discussions and activities. The While none of the SDGs is specifically about ICT, several targets refer to ICT and technology, and ICT will underpin the achievement of every goal. All three pillars of sustainable development economic development, social inclusion and environmental protection— need ICT as a key catalyst; and ICT, particularly broadband, will be absolutely crucial for achieving all 17 SDGs. [10], [12]

From 232 indicators for measuring the progress of 2030 Agenda there are only 7 direct indicators almost equal to 3% on total were defined to measure ICT sector. Furthermore, the February 2016 version of the IAEG-SDGs report

[1] International Telecommunication Union (ITU)

[2] The United Nations Conference on Trade and Development

includes the following 7 ICT indicators covering 6 targets under Goals 4, 5, 9, and 17. (The organization indicated in brackets tracks the indicator at the international level)

1) Target 4a: Proportion of schools with access to the Internet for pedagogical purposes (UIS)
2) Target 4a: Proportion of schools with access to computers for pedagogical purposes (UIS)
3) Target 4.4: Proportion of youth/adults with ICT skills, by type of skills (ITU)
4) Target 5b: Proportion of individuals who own a mobile telephone, by sex (ITU)
5) Target 9c: Percentage of the population covered by a mobile network, broken down by technology (ITU)
6) Target 17.6: Fixed Internet broadband subscriptions, broken down by speed (ITU)
7) Target 17.8: Proportion of individuals using the Internet (ITU)

On the other hand; Background note prepared by the Partnership on Measuring ICT for Development, Joint proposal of ICT indicators for the Sustainable Development Goal (SDG) indicator framework in Feb 2015, resulted to different ICT indicators fit to the SDGs' targets which illustrated in tables 1 to 8. [11]

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Research on the estimation method of reference rate in FISIM accounting

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Abstract
This paper refers to the international reference rate calculation method, for the internal reference rate, we use two reference rates, that are interbank interest rates and the average deposit and lending rates. At the same time, according to the recommendations of the 2008 SNA, two risk-adjusted reference rates were constructed, one is to consider the reference risk (CIR-CCAPM) for term risk and general monetary assets' risk premiums, and the other is to consider term risk, general monetary assets' risk premium and loan default risk (CIR-CCAPM-D rate), the third is accounting reference rate. For external reference rates, refer to the 2010 European System of National Accounts (ESA). Accounting and distributing FISIM outputs between industry and institutional sectors based on four internal reference rates and external reference rates combined with China's actual data. Finally, the total FISIM that computed by reference rate is analyzed as the impact on GDP, the contribution of the final use makes the GDP increase over the traditional method.

Keywords
CIR-CCAPM rate; Accounting Reference Rate; Sector Allocation

1. Introduction

Financial intermediation services include such important services as intermediation between borrowers and lenders, insurance, and payment services. These services comprise a significant and growing part of the national economy. According to professor Liuqiao who is the Vice Dean of Guanghua School of Management and Director of EMBA Center of Peking University, in the first half of the year 2015, China's financial contribution to GDP has exceeded 9.5 %.

Most sectors provide products or services through explicit fees, so the added value of these sectors can be directly calculated. For example, the total output of a second-hand car dealer can be calculated based on the cash of the vehicle sold, and the added value can be calculated by the total output minus the intermediate cost. Certain services provided by the financial sector can also be calculated in this way. For example, investment banks offer pricing to customers when consulting on mergers and acquisitions, and they also charge customers fees or commissions when conducting underwriting operations, but these direct fees account for only a portion of the total revenue of the financial sector. The financial sector, particularly institutions such as banks, uses interest rates as a standard for service charges. Banks provide intermediary services mainly by earning interest margins. To measure the value of financial intermediary services generated by interest margins, the concept of "indirectly measured financial intermediary services (FISIM)" has been widely adopted in various countries around the world. This concept was first introduced by the United Nations System of National Accounts (SNA) 1993. The SNA shows that financial intermediaries provide related services, providing flexible payment mechanisms, providing loans or other investments, to households, enterprises, Governments, etc., but without explicit fees.

Financial instruments related to FISIM are limited to loans and deposits. The FISIM total output is measured by multiplying the difference between the effective interest rate (payable and receivable) and the "reference" rate by the balance of the deposit and loan. According to the 2008 SNA, "the reference rate represents the pure cost of borrowing funds-eliminating the risk premium to the maximum extent and not including any intermediate services". FISIM's calculations have long used risk-free rates, and banks 'risk-bearing earnings are part of nominal output. After the actual test of the financial crisis in 2008, the FISIM measured by the risk-free rate is very different from the actual one. The reason is that in a financial crisis, default risk and liquidity risk have shown an overall upward trend, and banks will rationally respond to the increase in expected losses by raising interest rates. With this FISIM framework, it results in an increase in interest income being an increase in output, so the financial sector's contribution to the real economy might be overestimated.

2. Methodology for measuring reference rate

A. Literature review

The key to FISIM's total accounting is the determination of the reference rate, and the key to the determination of the reference rate is to examine the problem of separating service rates from the deposit and loan interest rates. In terms of international standards, the SNA (1993) considers the reference rate to be the rate representing the net cost of the borrower, i.e. the net "property rate of return" obtained by excluding the full risk cost and the total cost of intermediary services. You can choose the interbank lending rate or the central bank loan rate as the reference rate. The 2008 SNA considers reference rate should take risk factors and liquidity adjustment factors into account. The European System of National Accounts 2010(ESA), the Balance of Payments and International Investment Position Manual (BPM6) and the Manual on Financial Production, Flows and Stocks in the System of National Accounts (2015) are aligned with the 2008 SNA. Other countries also use different interest rates to calculate the total output of FISIM. In the absence of a uniform standard for selecting reference rates, countries generally choose nationally appropriate reference rates based on their economic situation and availability of data.

In terms of empirical research by scholars, Antonio Colangelo (2012) believes that the reference rate should take the risk characteristics of deposits and loans into account, under which the EU's GDP will decline. There is more literature on risk premium and interest rate term risk studies. Typical models include Breeden et al. (1978) and Breeden (1979), the consumer capital asset pricing model (CCAPM), which takes consumption factors into account. Look at the risk premium of a risky asset. The CIR model proposed by Cox-Ingersoll-Ross (1985) is mainly used to examine the term risk of interest rates. Xuxianchun (2002) studied the 1993 SNA methodology for FISIM, which was distributed to depositors as intermediate inputs and as final use, which is mainly for final consumption or imports and exports of the household sector. Duzhixiu (2017) analyzed the FISIM aggregate accounting and sectoral allocation based on the reference rate, its impact on GDP and income distribution were further studied in theory. The Chinese System of National Economic Accounts 2016 proposed to use the reference rate method to account for the total output of FISIM and share it among departments.

With reference to previous experience, this paper studies the selection and determination of the reference rate in FISIM output accounting. Combining with China's actual situation, we constructed three reference rates, then compared these with two traditional reference rates based on Chinese actual data.

B. Construction of reference rate considering risk and liquidity premium

We construct CIR-CCAPM and CIR-CCAPM-D rate by combing the CCAPM model, which considering consumption factors, with the CIR model of the interest rate maturity structure as mentioned earlier. The expected revenue-pricing model of CCAPM is as follows:

$$\begin{aligned} E(R_i)\text{-}R_f &= \left(\frac{\operatorname{cov}(R_i,m)}{\operatorname{var}(m)}\right)\left(-\frac{\operatorname{var}(m)}{E(m)}\right) \\ &= \beta_{i,m}\cdot\lambda_m \\ &= \beta_{i,\Delta c}\cdot\lambda_{\Delta c} \\ &\approx \beta_{i,\Delta c}\cdot\gamma\operatorname{var}(\Delta c) \end{aligned} \tag{1}$$

Where m = $\beta(c_{t+1}/c_t)^{-\gamma}$, $\Delta c = \ln(c_{t+1}/c_t)$.β is reflecting the patience of investors, γ risk aversion coefficient.$R_p = E(R_i) - R_f$is risk premium for assets.

As of the parameters' estimation in equation (1) is used generalized method of moment estimation (GMM). The principle of GMM is as follows:

$$\hat{\theta} \equiv (\hat{\beta},\ \hat{\gamma}) = \arg\min_{\theta}\left(m(\theta)' W^{-1} m(\theta)\right) \tag{2}$$

where m(θ) is sample moment.

The rate of return on financial assets is related not only to the risk premium, but also to the term of the asset, namely liquidity. The most widely used model for simulating interest rate behavior is the square root diffusion process. The expression of the CIR model is as follows:

$$dr_t = \alpha(\mu - r_t)dt + \sqrt{r_t}\sigma dW_t \quad (3)$$

Where rt is the interest rate, μ is the long term mean value of return on assets, α is the mean regression rate, $\sqrt{rt}\sigma$ is the volatility of instantaneous volatility, dWt is standard Brownian motion. Its likelihood function is as follows:

$$\ln L(\theta) = (N-1)\ln c + \sum_{i=1}^{N}\left(-cr_{t_i}e^{-\alpha\Delta t} - cr_{t_{i+1}} + 0.5\ln\left(\frac{cr_{t_{i+1}}}{cr_{t_i}e^{-\alpha\Delta t}}\right) + \ln\left(I_q\left(2\sqrt{cr_{t_i}e^{-\alpha\Delta t}\cdot cr_{t_{i+1}}}\right)\right)\right)$$

The Maximum Likelihood Estimation (MLE) equation of parameters is:

$$\hat{\theta} \equiv (\hat{\alpha}, \hat{\mu}, \hat{\sigma}) = \arg\max_{\theta} \ln L(\theta) \quad (4)$$

The risk of deposit and loan is reflected in the default risk, which is recordedd.The linear sum of the three kinds of risks analyzed above is the reference rate considering risk premium, liquidity premium or default risk, and are denoted as$RCIR-CCAPM$and $RCIR-CCAPM-D$.

$$R_{CIR-CCAPM} = \mu + R_p \quad (5)$$

$$R_{CIR-CCAPM-D} = \mu + R_p + d \quad (6)$$

C. Establishment of the account reference rate model

The SNA 2008 suggests the reference rate should consider risk premiums and not include any service factors. This paper discusses the situation that depositor and loaner face the same risks. This situation is mainly that FIs does not have a higher credit guarantee, and the risks are bound to be transferred to the depositor and lender or other institutions. In this way, the risks of deposits and loans are the same, and the reference rate of both is the same, which is higher than the risk-free rate.

In this case, the determination of the reference rate can be based on the reference rate of the loan. According to the principle of opportunity cost, the reference rate of the loan can be considered from the perspective of the rate of return of other assets. Build FIs capital flow and stock table, as shown in table 4. The code in the table is the code of each indicator of SNA 2008. FIs owns deposits, bonds and equity capital other than loans. The FIs use only deposits, bonds and equity capital, not loans.$\overline{\text{AFA}}$ is the column vectors of other financial assets other than loans, $\overline{\text{AFL}}$is the column vectors of other financial liabilities other than loans. r_{AFA} is the yield column vector of other financial instruments other than loans; r_{AFL} is the yield column vector for the payment of financial liabilities other than loans.

Table1 Financial institutions capital flow and stock table

concept	flow		stock	
	use	source	assets	lability
Total production		P1		
Price vectors of direct output		p		
Volume vectors of direct output		y		
Intermediate consumption	$P2$			
Remuneration of employees	D1			
Production tax	D29			
Depreciation of fixed capital	-P51c			
Property income	$r'_{AFL}\cdot\overline{AFL}$	$r'_{AFA}\cdot\overline{AFA}$		
Non-financial assets			AN	
Financial instruments			AFA	AFL
Non-equity capital				AFL
deposit			AF2DA	AF2DL
debt			AF3A	AF3L
loan			AF4A	AF4L
equity capital			AF51A	AF5CL

The reference rate is introduced. According to the principle that FIs loans come from liability instruments, the reference rate is equal to the cost of capital, which is equal to its real interest rate. As shown in table 1,

$$R_{ac}=\frac{p'y+r'_{AFA}\overline{AFA}-\left(P2+D1+D29-P51c\right)}{\iota'\overline{AFL}} \tag{7}$$

Where, ι is the column vector whose component is 1. Equation (7) refers to the reference rate when deposits and loans face the same risks. For the convenience of analysis in the following text, this reference rate is named as "account reference rate". According to equation (7), the reference rate includes risk premium.

3. Results

At present, most countries adopt interbank lending rate as reference rate in practice. In China, the interbank lending rate is the main interest rate variety in the money market, so the weighted average interest rate of inter-bank lending can be selected as the representative of China's reference rate for FISIM calculation. Besides, some countries use the average deposit and loan rate as the reference rate. For China, we use the weighted average deposit and loan interest rate with the balance of deposit and loan as the weight as the reference rate.

The reference rate is calculated based on equations (5), (6) and (7) combined with actual Chinese data. Data is derived from RESEET database, CEN statistical database, wind consulting database, China National Bureau of Statistics database and so on. The data processing software is SAS 9.1 and MATLAB R 2016.The GMM and MLE method of parameter estimation results for CIR-CCAPM-D rate model is showed as Table2. Figure1 outlays five reference rates. Table3 appears FISIM output and allocation in 2012 for three reference rate calculations. For import and export of FISIM, using external reference rates, which referred to the 2010 ESA. As of output, the result of the average deposit and loan rate and CIR-CCAPM rate are higher than the account reference rate.

Table2 GMM and MLE parameter estimation results

	Estimation	Std.Error	t	Pr>|t|	lnL	Method
β	0.33	0.0179	18.61	<0.0001		GMM
γ	0.19	0.0704	2.72	0.0077		GMM
α	0.4747					MLE
μ	0.0462					MLE
σ	0.0328				954000	MLE

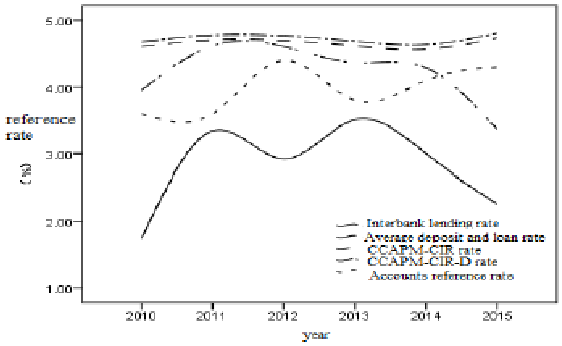

Figure1 Comparison of five reference rates

Table3 FISIM output and allocation in 2012 for three reference rate calculations

	code	Average deposit and loan rate	CIR-CCAPM rate	R_{ac}
Domestic FISIM output	1	23582.93	23669.43	23381.09
Institutional share				
Non-financial businesses and institutional groups	2	14295.05	14157.61	14615.73
Financial enterprises	3			
household	4	9287.88	9511.82	8765.36
consumer	5	6926.1	7288.79	6126.50
homeowners	6	1342.5	1275	1500.00
Non-corporate and NIPHS	7	1019.28	948.03	1138.86
FISIM for export	8	422.92	422.92	422.92
FISIM for import	9=10+11	630.64	630.64	630.64
Enterprise	10	294.05	294.05	294.05
Government and household	11	336.09	336.09	336.09
Total use of FISIM	12=1+9	24213.57	24300.07	24011.73
Intermediate use	13	16528.46	16252.27	17124.22
Final use	14=11+5	7262.19	7624.88	6462.59
FISIM for export	15=8	422.92	422.92	422.92
total supply of FISIM	16=17+18	24213.57	24300.07	24011.73
Domestic production	17=1	23582.93	23669.43	23381.09
import	18=9	630.64	630.64	630.64
Impact on GDP	19=5+8-	7012.93	7375.62	6213.33
Impact on GNI	20=14	7262.19	7624.88	6462.59

4. Conclusion

In this paper, five reference rates are used to calculate the FISIM output in China, and some reference rates are used to share the FISIM output. The total FISIM that computed by reference rate is analyzed as the impact on GDP, the contribution of the final use makes the GDP increase over the traditional method. In comparison, the interbank lending rate and the average deposit and loan rate are relatively simple to calculate, and the latter three interest rates are relatively complex. For the interbank lending rate, the difference between the reference rate and the deposit rate has negative values in certain years, which is contrary to the FISIM calculation concept. The reason for the negative value may be related to the fact that Chinese interest rates are not yet fully market. The CIR-CCAPM rate is a kind of reference rate that includes the risk premium of general financial assets and considers the interest rate maturity risk based on the 2008 SNA's idea of reference rate. The CIR-CCAPM-D interest rate is a reference rate that considers the risk of loan default. The account reference rate is constructed from the perspective of financial institution's capital flow and inventory table, considering various financial assets. Although it is theoretically perfect, the actual required data is provided by the input-output table, because the input-output table is compiled every five years. Therefore, the reference rate of the account method will be affected by the data source. By comparison, the account reference rate and the CIR-

CCAPM reference rate are quite different. Theoretically, both methods determine the reference rate are based on the reference rate should contain risk factors. The account reference rate is calculated from the opportunity cost of the loan, and the return rate of financial instruments such as bonds, equity investments, and deposits is selected. The CIR-CCAPM reference rate examines the risk premium from the perspective of the asset portfolio return rate and considers the term risk of the interest rate. In theory, the difference between the two should be whether the interest rate term risk is considered or not. The interest rate based on the CIR model is 0.0462, which is higher than the account reference rate, which may be the main reason for the large difference between the two values.

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Using machine learning technique to classify geographic areas with socioeconomic potential for broadband investment

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Abstract

The telecommunication service providers (telco) commonly use the return on investment (ROI) model for techno-economic analysis to strategize their network investment plan in their intended markets. The numbers of subscribers and average revenue per user (ARPU) are two dominant contributions to a good ROI. Certain geographic areas, especially the rural areas are lacking in both dominant factors and thus very often fall outside the radar of telco's investment plans. The government agencies, therefore, shoulder the responsibility to provide broadband services in rural areas through the implementation of national broadband initiatives and regulated policies and funding for universal service provision. This paper outlines a framework of machine learning technique which the telco and government agencies can use to plan for broadband investments in Malaysia and other countries. The framework is implemented in four stages: data collection, machine learning, machine testing and machine application. In this framework, a curve-fitting technique is applied to formulate an empirical model by using prototyping data from the World Bank databank. The empirical model serves as a fitness function for a genetic algorithm (GA) to generate large virtual samples to train, validate and test the support vector machines (SVM). Real-life field data from the Department of Statistics Malaysia (DOSM) for geographic areas in Malaysia are then provided to the trained SVM to predict which areas have the socioeconomic potential for broadband investment. By using this technique as a policy tool, telco and government agencies will be able to prioritize areas where broadband infrastructure can be implemented using a government-industry partnership approach. Both public and private parties can share the initial cost and collect future revenues appropriately as the socioeconomic correlation coefficient improves.

Keywords

Socioeconomic; Broadband Investment; Machine Learning; Support Vector Machine; Genetic Algorithm

1. Introduction

According to the World Bank's report (2009), every 10% increase in broadband penetration in developing countries will accelerate economic GDP growth by about 1.38% [1]. According to the International Telecommunication Union's (ITU) 2012 report, a 10% increase in broadband penetration will contribute to a 0.7% increase in Malaysia's GDP [2]. Many researches have addressed the different magnitudes of the positive impacts of BS, depending on the current economic situations of those geographic areas. However, only the developing and developed economies are normally assumed to be commercially viable for private investments. The underdeveloped economies require legislative support for broadband development because quick profits are unattainable in these areas. Collectively, the various research results provide confidence to the privately-owned telco to provide broadband services in urban and selected suburban but not rural areas. Furthermore, there are no empirical models made available for the telco to predict the economic potential of certain geographic areas so that they can prioritize their network investments in promising rural areas. As a result, the telco continues using the ROI model to strategize their network investment plans and to deploy their BS in urban or suburban areas only.

This paper aims to provide a framework of machine learning technique (MLT) which can help the telco and government agencies to predict if a selected geographic area has the socioeconomic potential for broadband investments. The proposed machine learning technique is an SVM which is a classifier that predicts the socioeconomic potential in correspondence to the local features or characteristics of a geographic area. In this framework, a curve-fitting technique will be applied to formulate the empirical model by using prototyping data from the World Bank databank. The empirical model is then used as a fitness function for a GA to generate large virtual data to train, validate and test the SVM. Real-life field data for geographic areas in Malaysia is then provided to the SVM to predict which areas have the socioeconomic potential for broadband investment. The curve-fitting technique is a statistical model to formulate the empirical model by establishing the interdependency of the geographical features with the socioeconomic status of geographic areas. The curve-fitting examines the relationship between given sets of independent and dependent variable features. The fitted curves obtained can be used in data visualization, and finding relationships between two or more variable features [3].

The data on local features of rural areas are lacking or difficult to obtain. Hence data on local features of countries from the World Bank database is applied in this research. The availability of data from the World Bank's database is limited by the number of countries worldwide. The few hundred data sets in the World Bank's database provide a small sample available to train and optimize the accuracy of the SVM. The limited sample size will affect the accuracy of machine learning. Large virtual samples are essential to address the issue of insufficient raw data, which will help overcome the problem for the poor and unreliable performance of machine learning and data mining techniques [4]. This paper proposes to use GA to generate more training data by using the model obtained from the curve fitting software as a fitness function in GA. GA can generate large virtual samples when only small amounts of data are available for machine learning [5]. Training data is used as input for the SVM to learn the pattern of the data. The ability to identify the patterns of the data allows better understanding and optimization of the learning process [6]. The SVM model is often preferred due to its high computational efficiency and good generalization theory, which prevents over-fitting through the control of hyperplane margins and Structural Risk Minimization [7].

2. Methodology

This paper proposes a research methodology which will be implemented in 4 stages: data collection, machine learning, machine testing and machine application.

a. Data Collection

There are four steps to collect the data required in this stage:

a) *Defining data*: Firstly, feature sets are defined, and the feature response is labeled. The geographical features obtained from the World Bank's database and the Department of Statistics Malaysia (DOSM) are categorized according to the PESTEL model. PESTEL denotes political, economic, social, technical, environmental and legal.

b) *Collecting data*: Data is collected according to the feature sets and pre-defined feature response. The feature sets are PESTEL factors whereas the feature response is the socioeconomic status in response to the factors. For each PESTEL category, the relevant features of each country are extracted from the World Bank's National Accounts data. The country's GNI per capita is taken as the response the geographical features.

c) *Generating data co-relationship*: Thirdly, the collected data and labeled response are provided to a curve-fitting software to build an empirical model which is a fitness function that correlates the selected features to the labeled response. Curve-fitting is a form of statistical modeling. The Design Expert (DEX) curve-fitting software by Stat-Ease Inc. is used to implement this step. The curve-fitting modeling in DEX is based on Analysis of Variance (ANOVA). During the implementation, DEX generalizes the data collected.

d) *Simulating large virtual data for machine training*: Lastly, the equation generated by the DEX is used as a fitness function for GA to simulate more data that will be used to train the SVM.

b. Machine Learning

In this stage, the World Bank's data and GA generated data are used to train the SVM. This paper proposes to use LIBSVM as the target SVM to be trained for generalization. The SVM will learn from the training samples collected from the World Bank databank and generated by GA.

There are two steps in the machine learning process:

a. *Splitting data for training and test*: The data is divided into different proportions for machine training and testing.
b. *Training and Validating SVM*: The training datasets are further divided into three different scales of cross-validation to validate the accuracy of the training.

c. Machine Testing

The testing data sets are provided to the SVM that have been trained using different machine kernels such as linear, polynomial, and RBF. The testing data sets are unseen to the SVM. The SVM with different kernels will classify the data sets, and the accuracy of the classification results will be observed. The testing accuracy represents the SVM's capabilities of recognizing the pattern of unseen data and classifying the data into either class +1 (having socioeconomic potential) or -1 (not having socioeconomic potential). If an SVM can perform accurately in the samples given, it is assumed that the SVM can also perform accurately outside the samples (e.g., real-life data that is unknown to the SVM).

d. Machine Application

Finally, real-life field data sets from DOSM for states and federal territories in Malaysia are provided to the SVMs that have been tested. The SVMs will classify the real-field data sets, and the results will be observed.

3. Result

There are 20 PESTEL features (including 1 response) concluded for use in research with complete data of 174 countries being extracted from the World Bank databanks of World Development Indicators online. Countries of high income and upper middle income are labelled as having socioeconomic potential (+1); countries of low income and lower middle income are labeled as not having socioeconomic potential (-1). In response to GNI per capita, it has been observed that GDP per capita has the highest-impact (0.981) directional relationship, followed by broadband penetration. The fixed telephony penetration and life expectancy have a relatively moderate co-relationship impact with ratings above 0.500. The birth rate also has a relatively moderate co-relationship impact to GNI per capita but in the reverse direction. The features of the length of tar road, tourism activity, GDP, GNI and % of the population with electricity access have some co-relationship impact, with impact ratings ranging between 0.271 and 0.454.

The features of the agriculture land size, population size, population density, labor force, number of secondary school students, average monthly rainfall and average daily temperature, have low co-relationship impacts (below 0.200) to GNI per capita. Fixed broadband (0.746), wireless broadband (0.712) and telephony services (0.665) are key elements in ICT ecosystems that boost the socioeconomic status. The research results show that these features have a high impact on GNI per capita, and the results are in line with the World Bank and ITU reports which indicate that broadband penetration will accelerate economic GDP growth.

Life expectancy and birth rate are the two features of social nature with the highest impact on GNI per capita. Life expectancy has a directional impact whereas birth rate has reversed directional impact to GNI per capita. It is observed that telephony penetration has the highest-impact (0.881) directional relationship in response to fixed broadband penetration. GNI per capita (0.746), GDP per capita (0.738), life expectancy (0.735) and wireless broadband penetration (0.678) have moderately high co-relationship impacts to broadband penetration. Birthrate (-0.741) also has a moderately high impact co-relationship to fixed broadband penetration but in the reverse direction. The length of tar road, tourism activity, % of the population with electricity access, GDP, and GNI have some co-relationship impact to broadband penetration, with the impact ratings ranging between 0.206 and 0.499. Those features with relatively low impacts to fixed broadband penetration are population density, land size, agriculture land size, labor force, average monthly rainfall, population size, number of secondary school students and average daily temperature.

Life expectancy and birth rate are the two features of social nature with the highest impact on fixed broadband penetration. The birthrate is the only feature that has a significant impact in the reversed direction. The result of the coefficient correlations can serve as a guideline when applying the empirical model to further study the game theory in public-private-partnerships (PPP). The data for geographical conditions with medium to high impact, if missing, will affect the distortion of the empirical model. In other words, if the collaborative efforts are put in to improve the data points of those features with high impact, together the PPP will also improve the socioeconomic response in favor of broadband investment. In this research, GA successfully generated 64,200 samples. Each sample is labelled with a fitness value which virtually represents the socioeconomic status. The fitness breakpoint is the fitness value that separates the label for the generalized datasets. Through the training and cross-validation process, it is observed that the SVM has been trained with high accuracy, ranges from 96% to 99% depending on the kernel used. The cross-validation accuracy is better when the machine is trained with a larger sample size.

The result is in line with the behavior of machine learning where large training samples will improve machine's performance. With the framework of the machine learning technique being established and proven, the trained and tested SVM is then successfully applied to classify real-life field data in the context of geographic areas in Malaysia.

4. Discussion and Conclusion

SVM does not memorize the data given. Instead, it learns the pattern from the training datasets and classifies the response for the testing datasets. The two obvious evidence of machine learning are:

- Consistency and accuracy of the cross-validation and testing with WB and GA data
- Consistency and accuracy of the testing results with real-life data for states in Malaysia.

Both learning algorithm and hypothesis sets are the solution tools (or components) in the machine learning process. And the solution tools worked successfully in this research. Together, the learning algorithm and the hypothesis sets are named as the learning model. The research results showed that a learning model had been successfully established. The SVM is the hypothesis H, whereas the kernels (linear, polynomial and RBF) are the sub-sets {h} of the hypothesis which is used for pattern recognition. The quadratic programming is the learning algorithm used in the research.

$$h = X \rightarrow \{+1, -1\}$$

$$h = \{x_1, x_2, , , x_N\} \rightarrow \{+1, -1\}$$

where,

- h denotes the hyperplane that generalizes the data of geographical features in the feature space
- X denotes data that are transformed from input space into features space with higher dimensions.
- $x_1, x_2, , , x_N$ are the specific data points of X
- {+1,−1} is the binary class, where +1 denotes areas having socioeconomic potential; and -1 denotes areas without socioeconomic potential.

Through the experiment, it is found that larger training samples deliver higher training accuracy. This result is in line with the machine learning theory of "*when N is small, the delta in error is high*." It is also observed that, in line with another machine learning. "*when N is big, both sample-in and sample-out will have about the same error*." The sample-in are data used for machine training whereas sample-out are unseen data for machine testing. It the case of this paper, it is true to say the SVM is doing well within the data sets provided, and the framework of machine learning technique works. Of the 19

PESTEL features selected in this paper for experiments, 12 features demonstrated some impact or high impact to broadband development. These features are *GDP per capita, fixed broadband penetration, wireless broadband penetration, telephony penetration, life expectancy, length of roads, economic activity, GDP, GNI, electricity access, population density, and birth rate.* This observation is in line with findings in past research. However, the impact of the *labor force and secondary education are* found to be in contrary with the literature review. As broadband technology is evolving, the tertiary education might be a better indicator than secondary education. Goldfarb (2006) found that university education improved the diffusion of the Internet. The low correlation coefficient for labour force might open up an area of new research or further literature review if the occupation is a better feature to replace labour force. *Land size, agricultural land size, population size, rainfall* and *average temperature* are found to have minimum impact on broadband development. The literature reviewed does not reveal the correlation between these five features against broadband development. The research experiment shows that % of agricultural land has a high impact as compared to land size or agricultural land by itself.

It is concluded that the machine learning technique is a feasible model for use in the telecom industry to classify geographic areas according to their socioeconomic potential. Training data are available from the World Bank databank and the Department of Statistics Malaysia to initiate the process of machine learning. Even though there are shortcomings in the data sets regarding feature sets and sample size, the existing data are good enough to be used as prototyping data to be put through statistical modeling which results to the formulation of interdependencies (correlation coefficient) among the features and targeted response. The statistical modeling has been successful in generalizing the data and screening for important factors to establish the optimal product formulation, which is an equation that correlates the geographical features corresponding to the socioeconomic response. By applying the equation to a genetic algorithm, virtual samples in a large size have been generated for SVM training and testing. The high accuracy achieved in cross-validation and testing are good evidence that the SVM has been properly trained. Finally, when real-life field data for states in Malaysia are provided to the SVM, the machine can successfully classify the states according to their socioeconomic potential.

The research results show that the land size and population size have a low co-relationship impact to GNI per capita and fixed broadband penetration, thus, this machine learning model can be applied to classify countries, states, urban and rural areas. Using a machine learning technique (MLT) to classify the socioeconomic potential of a geographic area according to its geographical features is a novelty of this research. The MLT is relatively more objective as compared to the ROI method. MLT can perform independently, as well as compliment the ROI model for business decision making, either helping the telco to expand its broadband investment in new geographic areas or helping the policymakers to increase the efficiency of broadband policy and use of universal service funding.

By combining the application of the curve-fitting theory and machine learning technique, a game theory can be developed. Telco and policymakers may develop a game theory with a 2-prong approach:

- Work across government agencies to set goals to improve the features of the rural areas, especially on those features with a high correlation efficient to the growth of economic or broadband diffusion.
- Use the econometric methodology to measure the effect of public policies on broadband adoption.

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Evaluation and comparison of patterns of maternal complications using generalised linear models of count data time series

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Abstract
Studying patterns of maternal complications is critical before, during and after childbirth. However, there is limited information on comparative trends of different maternal complications, particularly, in a resource-limited setting. In this study we fit six different types of maternal complications namely ante-partum haemorrhage (APH), eclampsia, obstructed labour, post-partum haemorrhage (PPH), ruptured uterus and sepsis to time series generalized linear model. We systematically compare the performance of the model in light of real data by checking its flexibility and serial correlation and the conditional distribution. We then, compute model fitting, assessment and prediction analysis for each maternal complication. Additionally, we provide a comparative review of the results by assessing the effect of basic emergency obstetric and new-born care (BEmONC) and comprehensive emergency obstetric and new-born care (CEmONC) services on trends in maternal complications. Results show that women with APH, eclampsia and obstructed labour at the time of delivery are significantly high. Complication rates did not vary by maternal regions. Providers who perform obstetrical care should be alert to the high rate of maternal medical complications associated with obstructed labour. Introduction BEmONC and CEmONC package improved performance of providers in reducing maternal and newborn complications and mortality.

Keywords
Maternal complications; Count Data time series; Trends, Goodness-of-fit; Conditional distribution

1. Introduction

Maternal complications namely ante-partum haemorrhage (APH), eclampsia, obstructed labour, post-partum haemorrhage (PPH), ruptured uterus and sepsis constitute to one of the leading causes of the burden of disease for women of reproductive age throughout the world and contribute to high levels of mortality and disability in developing regions 1. Maternal conditions dominate the burden of reproductive ill-health, accounting for at least 25% of the global burden of diseases, particularly in Kenya.

Despite there being large number of women, who suffer from maternal complications, little is known about pattern and predictive trends. Understanding timely and accurate patterns and trends of maternal complication is critical to health programmes particularly, to reduce the burden of consequent morbidity, which affects a large proportion of women8.

Count data time series are applied in various areas whenever a number of events per time period are observed over time. A practical example is monthly number of maternal complications reported, which is routinely collected by ministry of health at private and public hospitals. The critical feature of such data analysis are the prediction of future values for adequate planning in resource-limited settings and the detection of unusual patterns pointing at some adverse description of e.g. seasonal patterns for better understanding and interpretation of data generating mechanisms. In practice, the generalized linear model (GLM) method is used for modelling observations conditionally on the past information, where the GLM model is implemented by choosing a suitable distribution for count data and an appropriate link function.

This paper is concerned with methods for count time series based on GLM models with application to maternal complications. The aim is to shed light on regular trends and patterns of maternal complications occurring before, during and after delivery. The specific objectives of the study is to compare the trends of six different maternal complications occurring around the time of delivery and to identify patterns associated with BEmOC/ CEmOC intervention

2. Methodology

a. Data Description

We carried out a retrospective study of data from 3 major cities in Kenya, namely Nairobi, Mombasa and Kisumu. Our definition for maternal complication was based on WHO guideline for ante-partum haemorrhage (APH), eclampsia, obstructed labour, post-partum haemorrhage (PPH), ruptured uterus and sepsis.

We retrieved mother, neonatal and child health (MNCH) data from Kenya Health Information system called District Health Information System 2 (DHIS2). DHIS2 is a publicly available database that captures health related indicator regularly on a monthly basis. We specifically retrieved data from three major counties in Kenya from December 2014 to January 2017. The two tables below shows the general statistics of data retrieved.

Table 1. General Descriptive Statistics of Maternal, Neonatal and Child Health Data of Nairobi, Mombasa and Kisumu retrieved from DHIS2 for the period Dec 2014 to Jan 2017					
	N	Min (monthly)	Max (monthly)	Mean (monthly)	Std. Deviation
Live birth	60	49,810	87,329	72,711	9,263
Normal Deliveries	60	43,822	77,991	64,246	8,366
Neonatal deaths	60	406	1,038	804	169
Caesarean Sections	60	6,685	12,023	9,848	1,249
Assisted vaginal delivery	60	198	1,609	653	270
Babies discharge Alive	60	46,129	82,571	68,588	8,794
Maternal Deaths 20+ years	60	45	337	84	36
Maternal Deaths Audited	60	21	93	53	19

During the period December 2014 to January 2017, maternal complication data from 896 facilities were retrieved with 48% of the facilities having either basic emergency obstetric and new-born care (BEmONC) or comprehensive emergency obstetric and new-born care (CEmONC) services.

Table 2. General Descriptive Statistics of Maternal Complications Data retrieved from DHIS2 for the period Dec 2014 to Jan 2017					
	N	Min (monthly)	Max (monthly)	Mean (monthly)	Std. Deviation
APH (Ante partum Haemorrhage)	60	231	773	485	100
Eclampsia	60	204	533	393	79
Obstructed Labour	60	646	3001	973	290
PPH (Post-Partum Haemorrhage)	60	541	1260	902	185
Ruptured Uterus	60	47	93	66	11
Sepsis	60	53	236	135	31

b. Time series Model

Let a count time series be Λ_t: $t \in N$ and $\gamma_t : t \in N$ be a time-varying r-dimensional covariate vector, say $\gamma_t = (\gamma_{t,1}, \gamma_{t,2}, \cdots, \gamma_{t,r})$. We can model the conditional expectation $E(\Lambda_t | \mathcal{J}_{t-1})$ of the count time series by a process, $\lambda_t : t \in N : E(\Lambda_t | \mathcal{J}_{t-1} = \lambda_t)$. $\mathcal{J}_t$ is the history of the joint process $\Lambda_t, \lambda_t, \gamma_t : t \in N$ up to time t including the covariate information at time t-1. The models' general form will be

$$\phi(\lambda_t) = \beta_0 + \sum_{k=1}^{p} \beta_k \widehat{\emptyset}(\Lambda_{t-i_k}) + \sum_{l=1}^{q} \alpha_k \emptyset(\Lambda_{t-j_i}) + \eta^T \gamma_t$$

Where $\emptyset: \mathbb{R}^+ \rightarrow \mathbb{R}$ is a link function and $\widehat{\emptyset} : \mathbb{N}^+ \rightarrow \mathbb{N}$ is a transformation function. The parameter vector $\eta = (\eta_1, \eta_2, \ldots, \eta_r)^T$ corresponds to the effects of covariates. To allow for regression on arbitrary past observations of the response, define a set $P = \{i_1, i_2, \ldots, i_p\}$and integers $0 < i_1 < i_2 < \ldots\infty$, with $P \epsilon \mathbb{N}$. This formulation is useful particularly when dealing with modeling stochastic seasonality. Estimation and inference is derived by quasi conditional maximum likelihood.

3. Result

Ante-Partum Haemorrhage

An antepartum haemorrhage (APH) refers to bleeding from the vagina that occurs after the 20th week of pregnancy and before child-birth. The common causes of bleeding during pregnancy are cervical ectropion, vaginal infection, placental edge bleed, placenta praevia or placental abruption Cervix.

Count GLM for APH with SE and CI (level = 95 %) obtained by normal approximation. Link function is log and distribution family is negative binomial. The Log-likelihood value is -255. Score test on intervention(s) of given type at given time is has p-value of < 0. Over dispersion coefficient σ^2 was estimated to be 0.018				
Coefficient	Estimate	Std. Error	CI(Lower)	CI(Upper)
(Intercept)	3.033	0.6676	1.724	4.3412
B_1	0.367	0.139	0.095	0.6398
Intervention1 (BeMOnC)	-0.189	0.0555	-0.298	-0.0805
Intervention2 (CeMOnC)	0.162	0.1653	-0.162	0.4858
σ^2	0.017	N/A	N/A	N/A

Eclamsia

Refers to severe complication where high blood pressure results in seizures during pregnancy. Seizures are periods of disturbed brain activity that can cause episodes of staring, decreased alertness, and convulsions.

Count GLM for Eclamsia with SE and CI (level = 95 %) obtained by normal approximation. Link function is log and distribution family is negative binomial. The Log-likelihood value is -291. Overdispersion coefficient σ^2 was estimated to be 0.0622				
Coefficient	Estimate	Std. Error	CI(Lower)	CI(Upper)

(Intercept)	3.6577	0.5855	2.51	4.8053
B_1	0.2507	0.1203	0.015	0.4865
Intervention1 (BeMOnC)	-0.2127	0.0759	-0.361	-0.0639
Intervention2 (CeMOnC)	0.2046	0.2704	-0.325	0.7346
σ^2	0.0622	N/A	N/A	N/A

Post-Partum Haemorrhage (PPH)

Postpartum haemorrhage, defined as the loss of more than 500 mL of blood after delivery, occurs in up to 18% of births. Blood loss exceeding 1,000 mL is considered physiologically significant and can result in hemodynamic instability.

Count GLM for PPH with SE and CI (level = 95 %) obtained by normal approximation. Link function is log and distribution family is negative binomial. The Log-likelihood value is -293. Overdispersion coefficient σ^2 was estimated to be 0.0135				
Coefficient	Estimate	Std. Error	CI(Lower)	CI(Upper)
(Intercept)	3.2288	0.6034	2.046	4.411
B_1	0.4257	0.1075	0.215	0.636
Intervention1 (BeMOnC)	-0.17	0.0449	-0.258	-0.082
Intervention2 (CeMOnC)	-0.0567	0.1391	-0.329	0.216
σ^2	0.0135	N/A	N/A	N/A

Obstructed Labour

Labour is considered obstructed when the presenting part of the fetus cannot progress into the birth canal, despite strong uterine contractions.

Count GLM for Obstructed Labor with SE and CI (level = 95 %) obtained by normal approximation. Link function is log and distribution family is negative binomial. The Log-likelihood value is -306. Score test on intervention(s) of given type at given time is has p-value <0. Overdispersion coefficient σ^2 was estimated to be 0.0267				
Coefficient	Estimate	Std. Error	CI(Lower)	CI(Upper)
(Intercept)	2.998	0.7485	1.531	4.4649
B_1	0.4629	0.134	0.2	0.7256

Intervention1 (BeMOnC)	-0.123	0.0558	-0.232	-0.0137
Intervention2 (CeMOnC)	-0.0271	0.1883	-0.396	0.342
σ^2	0.0267	N/A	N/A	N/A

Ruptured Uterus

Ruptured uterus refers to serious childbirth complication that occurs during vaginal birth. It causes a mother's uterus to tear so her baby slips into her abdomen. It is often catastrophic with a high incidence of fatal and maternal morbidity.

Count GLM for Ruptured Uterus with SE and CI (level = 95 %) obtained by normal approximation.
Link function is log and distribution family is negative binomial. The Log-likelihood value is -298.
Overdispersion coefficient σ^2 was estimated to be 0.2096

Coefficient	Estimate	Std. Error	CI(Lower)	CI(Upper)
(Intercept)	2.4444	0.515	1.435	3.454
B_1	0.1733	0.174	-0.167	0.514
Intervention1 (BeMOnC)	-0.4108	0.153	-0.711	-0.111
Intervention2 (CeMOnC)	-0.0415	0.58	-1.179	1.096
σ^2	0.2096	N/A	N/A	N/A

Sepsis

Sepsis develops when the chemicals the immune system releases into the bloodstream to fight an infection cause in inflammation throughout the entire body instead.

Count GLM for Sepsis with SE and CI (level = 95 %) obtained by normal approximation. Link function is log and distribution family is negative binomial. The Log-likelihood value is -220.
Overdispersion coefficient σ^2 was estimated to be 0.047

Coefficient	Estimate	Std. Error	CI(Lower)	CI(Upper)
(Intercept)	3.089	0.4993	2.1106	4.0679
B_1	0.165	0.1345	-0.0986	0.4285
Intervention1 (BeMOnC)	-0.249	0.0795	-0.405	-0.0933

Intervention2 (CeMOnC)	0.101	0.2833	-0.4544	0.6562
σ^2	0.047	N/A	N/A	N/A

4. Discussion and Conclusion

This work provides a unified formulation and comprehensive treatment of the class of count time series following GLM models with application to maternal complication. An integral part of this model is the dependence on past values of the conditional mean, which allows for modelling of temporal correlation. In this work we present the first study on trends of maternal complications incorporating covariate effects (CeMOnC and BeMonC) within this framework. Quality care is a major determinant of health outcomes and is adversely affected when the health care facility is overcrowded with limited BeMonC interventions. Government programmes are still focusing on antenatal care, high-risk approach, trained birth attendants neglecting delivery care and EmOC. With the assumption of Poisson or Negative Binomial conditional distribution we facilitate model-based prediction and model assessment. We utilize likelihood-based methods for model fitting and assessment, prediction and intervention analysis for this model.

PPH was seen in 10% of cases and haemorrhage requiring blood transfusion occurred in 3%. This is slightly higher than most literature review which reported a 6-8% rate of PPH and a 1-2% rate of blood transfusion.

Quality care remains a major determinant of health outcomes and is adversely affected when the health care facility is overcrowded; a situation that is common in resource-limited setting. Government programmes are still focusing on antenatal care, high-risk approach, trained birth attendants neglecting delivery care, basic emergency obstetric and new-born care (BEmONC) and comprehensive emergency obstetric and new-born care (CEmONC) services. Lack of facilities to perform a CS, facilities for blood transfusion or paediatrician, with only one medical officer to look after all kinds of cases every day and the lack of transport facilities in remote places are some of the barriers which contribute to high maternal mortality. Provision of comprehensive emergency obstetric services within the reach of all pregnant women is one of the strategies employed to reduce the maternal mortality worldwide. The public is made aware of the availability of such services free of cost in government institutions.

In this study, we have observed levels, patterns, and trends of the utilization of maternal complications in the three major cities for the period Dec 2014 to Jan 2017. From this study, it can be said that the proportion of women who had eclamsia, APH, PPH and sepsis has increased over that past 2 years. Effects of interventions were significant in BeMOnC compared to CeMonC. Complication rates did not vary by maternal regions. Providers who perform obstetrical care should be alert to the high rate of maternal medical complications associated with APH, PPH and obstructed labour. Introduction BEmONC package improved performance of providers in reducing maternal and new-born complications and mortality.

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Statistical impact of merger and acquisition in a banking industry: A new generalized time series model

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Abstract

Present paper proposes a new autoregressive time series model to study the behaviour of merger and acquire concept which is equally important as other available theories like structural break, de-trending etc. The main motivation behind newly proposed merged autoregressive (M-AR) model is to study the impact of merger in the parameters as well as in acquired series. First, we recommend the estimation setup using popular classical least square estimation and posterior distribution under Bayesian method with different loss functions. Then, find Bayes factor, full Bayesian significance and credible interval test to know the significance of the merger series. An empirical study on merger in banking system is illustrated for more information about the proposed model/ methodology.

Keywords

Autoregressive model; Break point; Merger & acquire series; Bayesian inference

1. Introduction

Time series models are preferred to analyze and establish the functional relationship considering it's own dependence (Box and Jenkins (1970)) as well as some other covariate(s)/ explanatory series which alike parallel influence the series. However, these covariates may not survive for long run because of merger with dependent series. Such type of functional relationship is not explored by researchers yet but there are so many linear or non-linear models proposed in time series to analysis in a distinctly circumstances see Chan and Tong (1986), Haggan and Ozaki (1981), Chon and Cohen (1997). On the basis of efficiency and accuracy, preferred time dependent model is chosen of further analysis and doing forecasting. In daily real-life situations, we have a time series which is recorded as a continuous process for every business and organization. In present competitive market, all financial institutions feed upon the growth of their business by utilizing the available information and follow some basic business principles. But rate of consolidations has been increasing tremendously to achieve the goal of higher profitability and widen business horizon. For this, higher capability institutions have a significant impact directly to weaker institutions. With the change on market strategies, some financial institutions are continuously working as well as growing well but there are few firms which are not efficiently operating as per public/state/owner's need and may be acquired or possibly consolidated by other strong company. This may be due to not getting high-quality performance in the market and also covers it's financial losses. So, these companies are merged in well-established company to meet out economical and financial condition with inferior risk. For that reason, merger is a long run process to combine two or more than two companies freely which are having better understanding under certain condition.

In last few decades, researchers are taking inference to do research in the field of merger concept for the development of business and analyzed the impact and/or performance after the merger. Lubatkin (1983) addressed the issues of merger and shows benefits related to the acquiring firm. Berger et al. (1999) provided a comprehensive review of studies for evaluating mergers and acquisitions (M&As) in banking industry. Maditinos et al. (2009) investigated the short as well as long merger effects of two banks and it's performance was recorded from the balance sheet. Golbe and White (1988) discussed time dependence in M&As and concluded that merger series strongly follows autoregressive pattern. They also employed time series regression model to observe the simultaneous relationship between mergers and exogenous variables. Choi and Jeon (2011) applied time series econometric tools to investigate the dynamic impact of aggregate merger activity in US economy and found that macroeconomic variables and various alternative measures have a long-run equilibrium relationship at merger point. Rao et al. (2016) studied the M&As in emerging markets by investigating post-M&A performance of ASEAN companies and found that decrease in performance is particularly significant for M&As and gave high cash reserves. Pandya (2017) measured the trend in mergers and acquisitions activity in manufacturing and non-manufacturing sector of India with the help of time series analysis and recorded the impact of merger by changes with government policies and political factors.

The above literatures have discussion on economical and financial point of view whereas merged series can be explored to know the dependence on time as well as own past observations. So, merger concept may be analyzed to model the series because merger of firms or companies are very specific due to failure of a firm or company. This existing literature argued that merger is effective for economy both positively and negatively as per limitations. Therefore, a time series model is developed to model the merger process and show the appropriateness and effectiveness of the methodology in present scenario. We have studied an autoregressive model to construct a new time series model which accommodate the merger/acquire of series. First proposed the estimation methods in both classical and Bayesian framework then, tested the effectiveness of the merger model using various significance tests. The performance of constructed model is demonstrated for recorded series of merger of mobile banking transaction of SBI and its associate banks.

2. Merger Autoregressive (M-AR) Model

Let us consider {y_t: t = 1, 2, ……, *T*} is a time series from ARX($_{p1}$) model associated with k time dependent explanatory variables up to a certain time point called merger time T*m*. After a considerable period, associated variables are merged in the dependent series as AR model with different order p_2. Then, the form of time series merger model is We retrieved mother, neonatal and child health (MNCH) data from Kenya.

$$y_t = \begin{cases} \theta_1 + \sum_{i=1}^{p_1} \phi_{1i} y_{t-i} + \sum_{m=1}^{k} \sum_{j=1}^{r_m} \delta_{mj} z_{m,t-j} + \varepsilon_t & t \le T_m \\ \theta_2 + \sum_{i=1}^{p_2} \phi_{2i} y_{t-i} + \varepsilon_t & t > T_m \end{cases} \tag{1}$$

Where δ_m is merging coefficient of m^{th} series/variable and ε_t assumed to be *i.i.d.* normal random variable. Without loss of generality one may assume the number of merging series *k* as well as their merger time T*m* and orders (p_i: i=1, 2) to be known. Model (1) can be casted in matrix notation before and after the merger as follows

$$Y_{T_m} = \theta_1 l_{T_m} + \beta_1 X_{T_m} + \delta Z_{T_m} + \varepsilon_{T_m} \tag{2}$$

$$Y_{T-T_m} = \theta_2 l_{T-T_m} + \beta_2 X_{T-T_m} + \varepsilon_{T-T_m} \tag{3}$$

Combined eq^n (2) and eq^n (3) in vector form, produce the following equation

$$Y = l\theta + X\beta + Z\delta + \varepsilon \tag{4}$$

Model (4) is termed as merged autoregressive (M-AR(p_1, m, p_2)) model. The purpose behind M-AR model is to make an impress about merger series with acquisition series.

3. Inference for the Problem

The fundamental inference of any research is to utilize the given information in a way that can easily understand and describe problem under study. In time series, one may be interested to draw inference about the structure of model through estimation as well as conclude the model by testing of hypothesis. Thus, objective of present study is to establish the estimation and testing procedure for which model can handle certain particular situation.

3.1 Estimation under Classical Framework

Present section considers well known regression based method namely, classical least square estimator (OLS). To make M-AR model more compact, one can write model (4) in further matrix form as

$$Y = \begin{pmatrix} l & X & Z \end{pmatrix} \begin{pmatrix} \theta \\ \beta \\ \delta \end{pmatrix} + \varepsilon = W\Theta + \varepsilon \tag{5}$$

For a given time series, estimating parameter(s) by least square and its corresponding sum of square residuals is given as

$$\hat{\Theta} = \begin{pmatrix} \hat{\theta} \\ \hat{\beta} \\ \hat{\delta} \end{pmatrix} = (W'W)^{-1} W'Y \tag{6}$$

and

$$SSR = \left(Y - W\hat{\Theta}\right)' \left(Y - W\hat{\Theta}\right) = \left(Y - W(W'W)^{-1}W'Y\right)' \left(Y - W(W'W)^{-1}W'Y\right) \tag{7}$$

3.2 Estimation under Bayesian Framework

Under Bayesian approach, posterior distribution can be obtained from the joint prior distribution with combined information of observed series. Let us consider an informative conjugate prior distribution for all model parameters. For intercept, autoregressive and merger coefficient, adopt multivariate normal distribution having different mean but common variance depending upon the length of vector and error variance is assume inverted gamma prior. Using the posterior distribution, explicit form of estimators is not getting due to multiple integrals. So, an alternative approach such as MCMC technique is used for obtaining the estimators. For that, we derived the conditional posterior distribution/ probability of model parameters which is represent as

$$\theta \,|\, \beta, \delta, \sigma^2, y \sim MVN\left(\left((Y - X\beta - Z\delta)' l + \mu' I_2^{-1}\right)\left(l'l + I_2^{-1}\right)^{-1}, \left(l'l + I_2^{-1}\right)^{-1}\sigma^2\right) \tag{8}$$

$$\beta \,|\, \theta, \delta, \sigma^2, y \sim MVN\left(\left((Y - l\theta - Z\delta)' X + \gamma' I_{p_1+p_2}^{-1}\right)\left(X'X + I_{p_1+p_2}^{-1}\right)^{-1}, \left(X'X + I_{p_1+p_2}^{-1}\right)^{-1}\sigma^2\right) \tag{9}$$

$$\delta \,|\, \theta, \beta, \sigma^2, y \sim MVN\left(\left((Y - l\theta - X\beta)' Z + \alpha' I_R^{-1}\right)\left(Z'Z + I_R^{-1}\right)^{-1}, \left(Z'Z + I_R^{-1}\right)^{-1}\sigma^2\right) \tag{10}$$

$$\sigma^2 \,|\, \theta, \beta, \delta, y \sim IG\left(\frac{T + R + p_1 + p_2}{2} + a + 1, S\right) \tag{11}$$

where

$$S = \frac{1}{2}\Big[(Y - l\theta - X\beta - Z\delta)'(Y - l\theta - X\beta - Z\delta) + (\theta - \mu)' I_2^{-1} (\theta - \mu)$$
$$+ (\beta - \gamma)' I_{p_1+p_2}^{-1} (\beta - \gamma) + (\delta - \alpha)' I_R^{-1} (\delta - \alpha) + 2b\Big]$$

From a decision theory view point, an optimal estimator must be specified by a loss function and it is used to represent a penalty associated with each possible estimate. Since, there is no specific analytical procedure that allows identifying the appropriate loss function. Therefore, we have considered symmetric and asymmetric loss function. We are not getting closed form expressions of Bayes estimators under assumed loss function. Hence, Gibbs sampling, an iterative procedure is used to get the approximate values of the estimators using conditional posterior distribution and then, computed the credible interval.

3.3 Significance Test for Merger Coefficient

This section provides testing procedure to test the impact of merger series in model and targeting to analysis the impact on model as associate series may be influencing the model negatively or positively. Therefore, null hypothesis is assumed that merger coefficients are equal to zero *H0: δ=0* against the alternative hypothesis that merger has a significant impact to the observed series *H1: δ≠0*. The models under hypothesis is

Under H0: $Y = l\theta + X\beta + \varepsilon$ (12)

Under H1: $Y = l\theta + X\beta + Z\delta + \varepsilon$ (13)

There are several Bayesian methods to handle the problem of testing the hypothesis. The commonly used testing strategy is Bayes factor, full Bayesian significance test and test based on credible interval. Bayes factor is the ratio of posterior probability under null versus alternative hypothesis.

$$BF_{10} = \frac{P(y|H_1)}{P(y|H_0)} = |A_3|^{-\frac{1}{2}} \left(\frac{S_0}{S_1} \right)^{\frac{T}{2}+c} \tag{14}$$

where

$$A_1 = \left(l^{'} l + I_2^{-1} \right)$$

$$A_2 = X^{'} X + I_{p_1+p_2}^{-1} - X^{'} l A_1^{-1} l^{'} X$$

$$A_3 = Z^{'} Z + I_R^{-1} - Z^{'} l A_1^{-1} l^{'} Z - \left(Z^{'} X - Z^{'} l A_1^{-1} l^{'} X \right)^{'} A_2^{-1} \left(Z^{'} X - Z^{'} l A_1^{-1} l^{'} X \right)$$

$$B_{21}^{'} = Y^{'} X + \gamma^{'} I_{p_1+p_2}^{-1} - \left(Y^{'} l + \mu^{'} I_2^{-1} \right)^{'} A_1^{-1} l^{'} X$$

$$B_3 = Y^{'} Z + \alpha^{'} I_R^{-1} - \left(Y^{'} l + \mu^{'} I_2^{-1} \right)^{'} A_1^{-1} l^{'} Z - B_{21}^{'} A_2^{-1} \left(Z^{'} X - Z^{'} l A_1^{-1} l^{'} X \right)$$

$$S_0 = Y^{'} Y + \gamma^{'} I_{p_1+p_2}^{-1} \gamma + \mu^{'} I_2^{-1} \mu + 2b - \left(Y^{'} l + \mu^{'} I_2^{-1} \right)^{'} A_1^{-1} \left(Y^{'} l + \mu^{'} I_2^{-1} \right) - B_{21}^{'} A_2^{-1} B_{21}$$

$$S_1 = S_0 + \alpha^{'} I_R^{-1} \alpha - B_3^{'} A_3^{-1} B_3$$

Using the Bayes factor, we easily have taken decision regarding the acceptance or rejection of hypothesis. For large value of BF_{10}, we lead to rejection of null hypothesis. With the help of BF_{10}, posterior probability of proposed model is also obtained. In recent time, a full Bayesian significance test (FBST) is mostly used for testing the significance of a hypothesis or model. This test determines in respect to null hypothesis and concluded that small value of evidence measure support the alternative hypothesis. The evidence measure of FBST test is described by Ev =1- γ where γ=P ($\delta:\pi(\delta|Y) > \pi(\delta_0|Y)$). Another procedure for testing is based on credible interval. Using the posterior probability, the highest posterior density region is obtained as follows

$$HPD = \{\delta \in R; P(\delta \mid y) \geq \alpha\} \quad s.t.\ P(HPD \mid y) = \alpha \tag{15}$$

4. Merger and Acquire in Banking Industry: An application

It is well defined that banking sector has strong contribution in any economy. It has been adopted various approaches to smooth working in the global front. Merger and acquisition is one of the finest approaches of consolidation that offers potential growth in Indian banking. State bank of India (SBI) is the largest bank in India. Recently SBI merged with five of its associate banks and Bharatiya mahila bank is becoming the largest lender in the list of top 50 banks in the world. The combined base of SBI is expected to increase productivity, reduce geographical risk and enhance operating efficiency. In India, there are various channels to transfer the payment online. Mobile banking is one of the important channels to transfer the money using a mobile device which is introduced since 2002 and become popular after demonization as it is a very fast and effective performed using smart phone and tablet. For examine purpose, we have taken monthly data series of mobile banking of SBI and its associate banks over the period from November 2009 to November 2017. Data series gives information about the number of transactions with its payment in a specific month for a particular bank. In analysis, we have converted data into payment per transactions.

The objective of the proposed study is to observe the impact of merger series. First, fitted an autoregressive model to mobile banking series to find out the most prefer order (lag) of SBI and its associate merger banks and then study more inferences. Table 1 shows the descriptive statistics and lag of AR model with estimated coefficients for each series. Once getting the lag (order) of each associate series, apply M-AR model to estimate the model parameters using OLS and Bayesian approach which are recorded in Table 2 and observed that there may be change in estimated value when considering merger in the series. From Table 1-2, we observed that there is a negative change happened due to SBBJ and SBP series because the sign of coefficient value is transform whereas other remaining series have a positive impact but not much affect on the SBI series. To know the impact of associate banks series, testing the presence of merged series and reported in Table 3. Table 3 explained the connection between associate banks with SBI and observed that banks merger has a significantly impact of SBI series and after the merger point, there is a decrease in the mobile banking transactions. All assumed test is correctly identifying the effect of merger.

Table 1: Descriptive statistics and order of the mobile banking series

Series	Mean	St. deviation	Skewness	Kurtosis	Order	φ_1	φ_2	φ_3
SBI	4.4983	8.3656	2.1974	3.5764	1	0.9297	-	-
SBBJ	0.7745	0.6569	2.4332	5.3273	2	1.0845	-0.2113	-
SBH	0.7125	0.8462	2.7081	6.6017	2	1.044	-0.1683	-
SBM	0.9295	0.8768	2.1176	4.0361	1	0.8934	-	-
SBP	0.985	1.1079	2.215	3.7352	3	0.7663	0.2626	-0.1646
SBT	0.8781	0.7335	2.432	5.5085	1	0.8909	-	-
M-SBI	10.2032	4.6229	0.4149	-1.8709	1	0.5768	-	-

Table 2: Bayes and OLS estimates based on mobile banking series

	SELF			LLF			ALF			OLS		
	θ_1	θ_2	σ^2	θ_1	θ_2	σ^2	θ_1	θ_2	σ^2	θ_1	θ_2	σ^2
	-0.1170	5.2540	2.9672	-0.1326	5.1345	2.8947	-0.1120	5.1070	3.1220	-0.2840	4.6410	2.3110
Series	φ_1	φ_2	φ_3	φ_1	φ_2	φ_3	φ_1	φ_2	φ_3	φ_1	φ_2	φ_3
SBI	0.9630	-	-	0.9630	-	-	0.9590	-	-	0.9590	-	-
SBBJ	-2.7872	2.0816	-	-3.7244	1.3773	-	-2.0700	1.6700	-	-5.0600	4.6140	-
SBH	0.9102	-2.2504	-	0.4315	-2.7448	-	1.4500	-2.0230	-	1.7640	-3.9340	-
SBM	1.0344	-	-	0.9453	-	-	1.0180	-	-	1.4570	-	-
SBP	-0.7404	-0.1806	1.8968	-0.7770	-0.2423	1.8704	-0.8750	-0.2230	1.8920	-0.9260	0.0030	2.0160
SBT	0.3318	-	-	0.2763	-	-	0.1770	-	-	0.3870	-	-
M-SBI	0.3344	-	-	0.3341	-	-	0.3390	-	-	0.3180	-	-

Table 3: Testing the hypothesis for on mobile banking series and its confidence interval

Testing Procedure	BF	PP	FBST
	1.53E+76	0.7467	0.0404
Confidence Interval	θ_1	θ_2	σ^2
	(-0.45-0.08)	(2.74-6.68)	(2.31-3.35)
Series	φ_1	φ_2	φ_3
SBI	(0.96-1.66)	-	-
SBBJ	(-3.28-0.56)	(0.06-5.06)	-
SBH	(0.60-6.86)	(-4.37-1.76)	-
SBM	(-5.21-3.93)	-	-
SBP	(-1.82-1.46)	(-0.55-0.49)	(1.29-2.26)
SBT	(-2.66-0.46)	-	-
M-SBI	(0.28-0.56)	-	-

5. Discussion and Conclusion

Time series modeling, sole is to establish/know the dependency with past observation(s) as well as other associated observed series(s) which are partially or fully influencing the current observation. After merger, few series are not recorded due to discontinuation of series because of many reasons like inadequate performance, new technology changes, increasing market operation etc. This is dealt by various econometrician and policy makers and termed merger. Since few decades it's becoming very popular to handle the problem of weaker organization to improve its functioning or acquire it to help the employees as well as continue the ongoing business. Therefore, a model is proposed in time series to classify the merger and acquire scenario in modeling. A classical and Bayesian inference is obtained for estimation and its confidence interval. Various testing methods are also used to observe the presence of merger series in the acquire series. Simulation study is verifying the use and purpose of model. Recently, SBI associate banks are merged in SBI to strengthen the Indian Banking. Thus, mobile banking data of these banks was used to analysis the empirical presentation of the model and recorded that merger has a significant effect for the SBI series in terms of reducing the transactions.

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Instrumental variable analysis in healthcare delivery science: Underutilized yet valuable

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Abstract
Need for adjustment of confounders is necessary in answering queries of comparative and association effect of treatment or policies with patient or healthcare utilization outcomes. Various methods exist for confounder adjustments. Three primary methods are 1) regression-based adjustment, 2) propensity score-based adjustment, and 3) Instrumental Variable (IV) analysis. Although conceptually superior due to the fact that only IV analysis adjust for unmeasured confounders, it has remained underutilized in healthcare delivery science research. Reason for underutilization include the fact that 'instruments' are difficult to formulate needing strict assumptions and the wrong perception that the analysis is more complex than the other two methods. However, in the era of easy availability of administrative claims-based databases and open data sharing of national registries, formulation of IV has become easier. We use the clinical question of whether there is increased risk for blood transfusion after closed wound drainage are used for patients who have undergone total shoulder arthroplasty to introduce the reader to an useful administrative database (Premier Healthcare), compare the three statistical methods discussed above, and provide codes and guidance for easy implementation of IV analysis.

Keywords
Instrumental Variable; Administrative claims-based databases; Unmeasured confounders; Closed wound drainage; Shoulder arthroplasty

1. Background

Unlike randomized clinical trials (RCTs)[4], observational studies must acknowledge confounding; this can be addressed by multivariable approaches such as regression modeling1 and propensity score analyses[2]. These, however, can only address known confounding factors, not unobserved confounders. In contrast, IV analysis does address both known and unknown confounders, a major advantage.

Instrumental Variable Analysis

The basic principle behind IV analysis[3,5] is choosing an IV to represent a mechanism for assigning treatment to patients. It should be closely associated with the treatment/intervention of interest but not the outcome. The concept is presented in **Figure 1**, where **IV** represents the IV, **T** the treatment, **U** the measured and unmeasured confounders, and **Y** the outcome. The principal (and most challenging) task is to choose an IV that fulfills these assumptions:

1. **IV** is positively associated with **T**
2. IV is independent of U

IV is associated with **Y** only through **T**

Here, there are two paths from **T** to **Y**:

1. T→Y (the direct treatment effect on outcome)
2. T←U→Y (the effect contributed by confounders).

The second path indicates the potential bias involved in estimating a treatment effect when confounding is present. For example, if we adjust for **U** in a regression model, the **T←U→Y** path is eliminated; in this case, we can obtain an unbiased estimate of **T** on **Y**. However, in observational studies, **U** may not be available. An **IV** is independent of **Y** and the effect of **IV** on **Y** can only be estimated through the effect of **IV** on **T**; therefore, the effect of **IV** on **Y** represents the effect of **T** on **Y**. Indeed, as **IV** should also be independent of **U**, there is only one viable path from **IV** to **Y: IV→T→Y**.

Conceptually, an IV analysis resembles the so-called 'intention-to-treat' approach, where patients randomized to a treatment group are analyzed regardless of actual treatment received.

Types of Instrumental Variables: Although several types of IVs exist, among those most applicable to observational studies are the following:

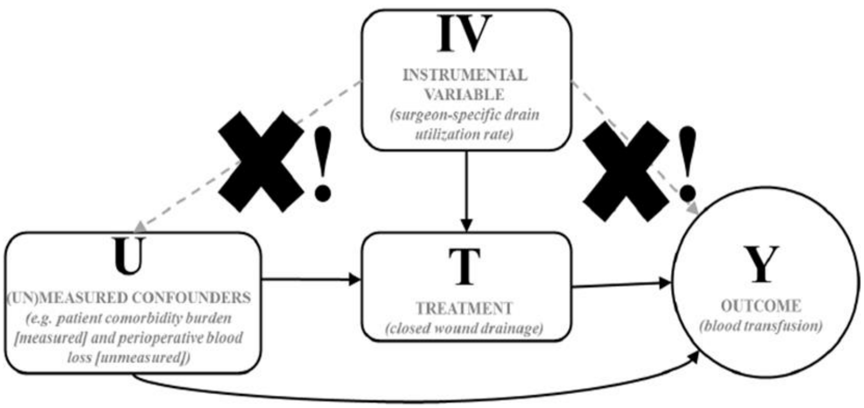
- Distance to (specialty) providers is a commonly used IV, since it may be highly related to the chance of getting a specific treatment. In an observational study on the type of anesthesia used in hip fracture repair surgery, the IV was patients' distance to hospitals that either specialize in regional anesthesia (RA) or general anesthesia[6]. Someone who lives closer to a hospital with a high RA utilization rate was assumed to be more likely to receive RA, compared to someone who lives closer to a hospital where RA is avoided or not offered.
- Preference-based IVs are suitable if treatment patterns (e.g. preferences for surgical approaches or interventions) are recognizable at the hospital or physician level. One observational study chose as their IV the surgeons' preference for managing the posterior cruciate ligament in total knee arthroplasty (either minimally or posterior-stabilized) to investigate effects on time to revision surgery[7]. Patients treated by surgeons with a specific preferred surgical approach were assumed to be more likely to have that procedure.
- Calendar time could be an IV, such as time to adopt a new treatment or policy. One relevant example is the recent introduction of mandatory participation in bundled payment programs for lower extremity joint

arthroplasty[8]. Patients who had the procedure before this requirement by definition cannot be exposed to these bundled payments; thus, calendar time is highly associated with the program.

Two-Stage Least-Square (2SLS) Procedure

After identifying an appropriate IV, the next step is to estimate the effect of the treatment (**T**) on the outcome (**Y**). In IV analysis, to estimate the effect of **IV** on **Y**, a two-stage least-square (2SLS) procedure is typically used[9]. In the first stage, **T** is predicted from the **IV** via a regression model. Then, the predicted value of **T** for each patient is applied to a regression model to estimate effects of **IV** on **Y**. All observed confounders should be adjusted for in models at both stages of the 2SLS procedure to increase precision.[6]

Figure 1. Graphic representation of the causal pathway in instrumental variable analysis



Example: Closed Wound Drainage and Transfusion Risk in Total Shoulder Arthroplasty

We examined claims data from the Premier Healthcare Database[10] to investigate the impact of closed wound drainage (CWD) after TSA on the odds of blood transfusion. Use of CWD could be influenced by confounders that may (e.g. comorbidity burden) or may not be available (e.g. hemoglobin value, blood loss, local protocols). Therefore, an IV analysis would be conceptually superior over other methods.

The surgeon-specific rate of drain utilization, a preference-based IV, appears to be a reasonable choice, because it may be closely related to patients' chances of receiving a drain and is not directly associated with the outcome, blood transfusion, except through its association with the treatment, CWD. Patients undergoing a procedure performed by surgeons in the ≥80th percentile of drain usage were labeled as 'receiving a drain'; the rest were labeled as 'not receiving a drain' (i.e. treatment allocation according to the IV and not actual drain use; cut-off of 80% chosen to match observered drain utilization).

Assessing the **first assumption** – that the IV is associated with the likelihood of actually receiving a drain – is straightforward. The study showed a significant correlation between the IV and treatment variable (r=0.78, P<0.0001). The **second assumption**, i.e., the IV is independent of (unobserved) confounders, cannot be assessed directly, but the relationship between the IV and observed confounders can suggest whether the second assumption is violated. This relationship can be calculated by comparing covariate differences between IV-based treatment allocation groups (see **Table 1** for a simplified selection). Compared to the original cohort where groups were compared based on actual drain use, characteristics of patients and hospitals appear to be more balanced between groups created by the IV, as demonstrated by standardized differences of <0.111,12 This is what would be expected in an RCT.

To assess the validity of the **third assumption** (the IV is associated with the outcome only through treatment), we need to explore whether other treatments that may influence the outcome are given concomitantly with drain use. For example, patients taking anticoagulants may be at increased risk of bleeding and subsequent blood transfusion. Therefore, the third assumption would be violated if the IV is associated with anticoagulant usage, a confounder. In our example, the correlation between anticoagulant usage and the percentage of drain utilization was not significant (r=0.0048, P=0.12), suggesting that the third assumption holds.

After checking the validity of assumptions underlying the chosen IV, we applied a 2SLS technique to estimate the effect of drains on blood transfusion risk. In the first stage, each patient's probability of receiving a drain was predicted from the IV, adjusted for all observed confounders. Then the odds of blood transfusion was calculated based on the estimated probability of receiving a drain, again adjusted for all observed confounders except for the IV. Patients receiving drains (allocation based on the IV) had significantly higher odds of blood transfusion (OR: 1.61, 95% CI; 1.37-1.91). This finding was consistent across all methods examined by Chan et al.

2. Discussion and Conclusion

Double-blind RCTs, the gold standard, are not always feasible. Alternatively, administrative databases (e.g., electronic medical records, claims, or registries) often lack information on important confounders. This gap may be addressed by IV analysis. Here, IV analysis provided results comparable to multivariable regression and propensity score analysis. However, since the IV method also addresses unmeasured confounders, it is conceptually superior.

IV analysis is not commonly used in healthcare delivery research. Researchers may believe that identifying an IV that fulfills all three assumptions is difficult, or that the method is overly complicated. Both obstacles can be overcome by early collaboration with statistical collaborators. Moreover, statistician-collaborators can assist in examining IV assumptions via formal statistical tests and sensitivity analyses, discussing each step of the analysis with the study team. Indeed, our 2-stage analysis is no more complex than propensity score analyses. In conclusion, IV analysis may complement other analytic approaches for observational studies and thereby increase the overall value of such studies.

For this retrospective cohort study data from the Premier Healthcare Database10 (Premier Healthcare Solutions, Inc., Charlotte, NC) was used. This database contains administrative claims data on approximately 20-25% of US hospital discharges. Records include International Classification of Disease-9th revision (ICD-9) codes, Current Procedural Terminology (CPT) codes, and complete inpatient billing items. Preparing analytic dataset with patient as unit using these codes is a valid way to perform healthcare delivery research projects.

Table 1. Baseline characteristics of patients in the Instrumental Variable-derived cohort

		Drain Use				
		Yes (n=21,218)		**No (n= 83,898)**		
		n	**%**	**n**	**%**	**Standardized difference****
PATIENT DEMOGRAPHICS						
Median Age*		70	(63, 76)	70	(63, 76)	0.0071
Gender						0.0056
	Male	9,075	42.77	35,650	42.49	
	Female	12,143	57.23	48,248	57.51	
Race / Ethnicity						0.0554
	White	17,426	82.13	70,469	83.99	
	Black	975	4.60	3,579	4.27	
	Hispanic	89	0.42	432	0.51	
	Other	2,728	12.86	9,418	11.23	
HEALTHCARE-RELATED						
Insurance Type						0.0435
	Commercial	5,022	23.67	19,514	23.26	
	Medicaid	449	2.12	2,039	2.43	
	Medicare	14,554	68.59	58,259	69.44	
	Uninsured	118	0.56	331	0.39	

	Unknown	1,075	5.07	3,755	4.48	
Hospital Location						0.0091
	Rural	1,898	8.95	7,724	9.21	
	Urban	19,320	91.05	76,174	90.79	
COMORBIDITY-RELATED						
Charlson-Deyo Comorbidity Index (Categorized)						0.0162
	0	10,943	51.57	43,894	52.32	
	1	6,202	29.23	24,186	28.83	
	2	2,466	11.62	9,465	11.28	
	2+	1,607	7.57	6,353	7.57	

*Continuous variable median and interquartile range reported, instead of N and %, respectively.
**Standardized difference of >0.1 suggests a clinically meaningful covariate distribution between groups

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Indicators of schooling development

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Abstract
In Social Science, the indicators are often built empirically (Unesco, 1974). That is, the quality and quantity of the data determines, in this field also, the construction of indicators and their robustness. Because of insufficient information, one often proceeds by approximation to find the parameters of the theoretical distribution law. This also holds for education. The results obtained in this way should be readjusted when one has more information. One cannot, for example, continue to use the gross rate of admission or schooling when the age distribution of pupils exists. It is now unacceptable to find in some scientific publications a rate of schooling over hundred percent when we are sure that there are children out of school!

Such indicators, even if they are useful for an international comparability, are mathematically not very robust and may not correspond to local reality. That is, they would not correspond to the national needs for planning statistics. In the following, we propose another estimator to give the number of children registered at school by generation (children having the same age). Considering the quality of the educational data existing now in a great number of countries, one can achieve this goal with more statistical robustness. We have just to find the statistical law, which would generate these data in order to find their parameters. Once these are found, it will be easy to represent more accurately the reality studied and to better plan for educational policy.

Keywords
Statistics; estimator; education; rate; access

1. Introduction

With the UN Sustainable Development Goal 4 (SDG4): "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all by 2030", after the UNESCO goal: "Education for All (EFA) by 2015", it become necessary, for the countries that are not yet reach the universal schooling, which is the case of most African ones, to conduct a continuous assessment for determining the level of educational development. That is to know the scale of the effort to be furnished for that purpose. In other words, one tries in these countries to know how the schooling level evolves by generation.

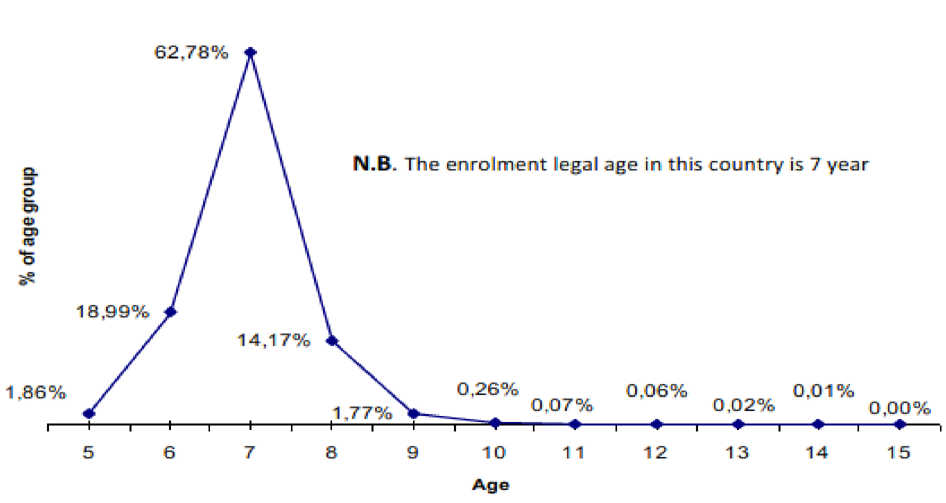
The Admission Gross Rate (AGR) and the Admission Net Rate (ANR) are, until now, used as the indicators which give an idea about the proportion of the children in school per generation. But, these two indicators do not always reflect the reality. So they can lead policymakers or planners to mistake.

The Admission Gross Rate, which is a ratio, not a proportion in percentage, between two incomparable populations on the basis of age, can be biased from the statistical point of view. Representing the number of all children who are in the first year at elementary school, its use will overestimate the proportion of children admitted at school. Its value can be hundred percent even if the total target population is not yet at school (Senegal, 1998).

The Admission Net Rate, if the legislation about the minimum age for admission to the first school class was respected, would be a better estimation of the schoolchildren proportion per generation. But, this is not the case in many countries concerned by UN goal. The group of children having the legal age to be in school can be scattered in different level. One can find them in the first, second, third or fourth year of study (See Graphic I). Hence, when one limits oneself only to the pupils enrolled in the first school class with the required age, he underestimates the genuine number. Knowing that the value of this indicator will never reach hundred percent, even if all the target population is at school.

These two indicators, when the information can't be improved, might be used to have an idea of the reality. They could also be used for international comparability (Mingat A, Rakotomolala R.) & Ton J.-P, 2001).

Graphic I : Pyramid of ages in the first year at elementary school (CI)



But, one must be aware that they are not statistically robust. That is mean, if there are more complete data about the studied reality, one can find better indicators.

Hereafter, we propose a less biased estimator of the number of children enrolled per generation, say the Generational Admission Rate (GAR). Considering the quality of the school data existing at the moment in many countries, even the African ones, and the computer software development, it should not be difficult to calculate this indicator.

2. Methodology

To build an educational access indicator, one must take into account four parameters: the level in which students are enrolled, the school year, the different ages of students and also the entry date into School, which gives formally:

the population of **k** years at time **t** $P_{t,\ k}$ (1)

$P_{t,\ k,\ d}$ (2)

the number of schoolchildren among them at date d. Hence, the admission rate will be, by definition:

$$AR = \frac{\sum_{d}^{D} P_{t_o,k_o,d}}{P_{t_o,k_o}} \quad (3)$$

corresponding to the proportion of children of k_o years old, during the school year t_0, found in the school at various date d. This includes all members of the generation getting into school at the normal age k_o, before this age or after. It is clear here that, simple observations don't permit to get the accurate number. To have this, it will be necessary to organize a census beginning from the enrolment of the first member in the target group (generation) to the last one. Doing this may take many years. Of course this duration is not suitable for policymakers. Because of this difficulty, we must use statistical estimators as indicators. To fix the ideas, let's consider now one cycle of school, with six levels of study and seven years as normal age for the enrolment. So, the Admission Gross Rate (AGR), which is the usual approximation of the admission rate defined above, is:

$$AGR = \frac{\sum_{k=k_m}^{n} s_{1,t_o,k}}{P_{t_o,7}} \quad (4)$$

Where, $s_{i,\ t,\ k}$ is the number of children of k years old, enrolled during the school year t, at level i. K_m being the youngest student's age. We can rewrite the AGR as following,

$$AGR = \frac{s_{1,t_o,k_n}}{p_{t_o,7}} + \frac{\sum_{\substack{k=k_m \\ k\neq k_n}}^{n} s_{1,t_o,k}}{p_{t_o,7}} \tag{5}$$

K_n , representing the normal age to access school.
It is clear that, the value of the second term, corresponding to the number of students not belonging to the age group, can be very important. That is, this approximation is not the better one. The legislation about the age of school access, being not always respected, notably in most African countries, the following relation is always true:

$$k_m < k_n \leq n$$

The other estimator of the ***AR*** is the Admission Net Rate (ANR) noted as follows:

$$ANR = \frac{s_{1,t_0,7}}{P_{t_0,7}} \tag{6}$$

$$\Leftrightarrow ANR = AGR - \frac{\sum_{\substack{k=k_m \\ k\neq 7}}^{n} s_{1,t_0,k}}{P_{t_0,7}} \tag{7}$$

As we see, here the superfluous term is removed from the AGR. But, we don't take into account the members of the target group who came into school late, after the normal age. This means that, the value of this estimator is still less than the number to be found.

Taking into account these two flaws, we propose another estimator, **generational admission rate (GAR)**. It will be written:

$$GAR = \frac{\sum_{i=1}^{6} s_{i,t_o,7}}{p_{t_o,7}} + \frac{\sum_{k>7}^{n} s_{1,t_o,k}}{p_{t_o,7}} \tag{8}$$

Here, we consider all members of the age group who are at school, at all levels (classes), as well as the pupils in the first school class who have exceeded the required age. The second part of this relation is the estimated number of latecomers in the target group, those who registered after the school year t_0. We try to take into account all those who are not registered at the normal access age. So we reduce the biases existing with the usual estimators.

The difference between this indicator and the admission gross rate (**AGR**) is that part noted I_R.

$$GAR = AGR - I_R \tag{9}$$

where

$$I_R = \frac{\sum_{k<7} s_{1,t_O,k} - \sum_{i=2}^{6} s_{i,t_O,7}}{p_{t_O,7}} \tag{10}$$

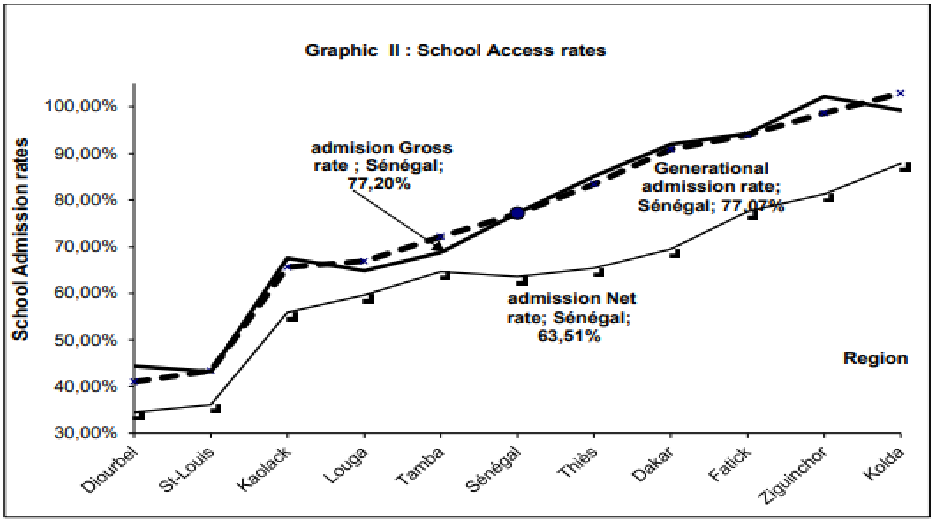
This part enables us to see the evolution of early entries, the children admitted before the required age. $I_R > 0$, means that the number of children who have the preschool age continue to increase in primary school. In other words, there is a rejuvenation of the entire primary pupils. Thus

$$ANR < GAR < AGR \tag{11}$$

$I_R < 0$, means the reverse of the above phenomenon, which gives

$$ANR < AGR < GAR \tag{12}$$

Below (See Graphic II) we use the data of an African country to illustrate this difference between the tree indicators.



3. Result

This indicator will help the policy maker or the planner to better appreciate the level of enrolment per generation and hence the schooling development. Add to this it characterize the policy of school recruitment. It shows how one fills the deficit about the request for access at the legal age. This can be done by the recruitment of children who have not yet got the required age or children who have exceeded this one.

4. Discussion and Conclusion

The usual indicators of school access, namely the gross rate or net rate of admission would give, in absence of good information about school, an idea of educational development in a country. But, by planning on this basis only, one runs the risk to miss the target. The generational admission rate permits to better approximate the true measure of school access per generation; to know how the schooling grows in a society and to what extent the state respects its commitments to achieve quality education for all. In addition to this, it is sufficient to have the distribution of schoolchildren by age to be able to calculate this indicator and deduce other useful information such as the recruitment policy.

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A new Robust Ridge Estimator in high-dimensional Linear Models

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Abstract
In classical regression analysis, the ordinary least-squares estimation is the best estimation method if the essential assumptions such as normality and independency to the error terms as well as a little or no multicollinearity in the covariates are met. More importantly, in many biological, medical, social, and economical studies, nowadays carry structures that the number of covariates may exceed the sample size (high-dimension or wide data). In this situation, the least-squares estimator is not applicable. However, if any of these assumptions is violated, then the results can be misleading. Especially, outliers violate the assumption of normally distributed residuals in the least-squares regression. Robust ridge regression is a modern technique for analyzing data that are contaminated with outliers in high-dimensional case. When multicollinearity exists in the data set, the prediction performance of the robust ridge regression method is higher than rank regression method. Also, The efficiency of this estimator is highly dependent on the ridge parameter. Generally, it is difficult to give a satisfactory answer about how to select the ridge parameter. Because of the good properties of generalized cross validation (GCV) and its simplicity, we use it to choose optimum value of the ridge parameter. The proposed GCV function creates a balance between the precision of the estimators and the biasness caused by the ridge estimation. It behaves like an improved estimator of risk and can be used when the number of explanatory variables is larger than the sample size in high-dimensional problems. Finally, some numerical illustrations are given to support our findings for the analysis of gene expression and prediction of the riboflavin production in Bacillus subtilis.

Keywords
Generalized cross validation; High-dimension data; Multicollinearity; Rank regression; Robust ridge regression; Spare model

1. Introduction

Many data problems nowadays carry structures that the number of covariates may exceed the sample size,i.e., $p > n$. In such a setting, a huge amount of work has been pursued addressing prediction of a newresponse variable, estimation of an underlying parameter vector and variable selection, see Hastie et al. (2009) and Buhlmann and van de Geer (2011), in this respect. In a nutshell, we consider ridge regression estimation in sparse semiparametric models in which the condition $p > n$ makes some difficulties for classical analysis.

Let $(y_1, x_1, t_1), \cdots, (y_n, x_n, t_n)$ be observations that follow the semiparametric regression model (SRM)

$$y_i = x_i^T \beta + f(t_i) + \epsilon_i, \quad i = 1, \ldots, n \tag{1.1}$$

where $x_i^T = (x_{i1}, x_{i2}, x_{i3})$ is p-dimensional vector of observed covariates or explanatory variables, $\beta = (\beta_1, \beta_2, \ldots, \beta_p)^T$ is an unknown p-dimensional vector of unknown parameters, the $t_i's$ are known and non-random in some bounded domain $D \subset \mathbb{R}$, $f(t_i)$ is an unknown smooth function and $\epsilon_i's$ are independent and identically distributed random errors with mean 0, variance σ^2, which are independent of (x_i, t_i). The theory of linear models is well established for traditional setting $p < n$. With modern technologies, however, in many biological, medical, social, and economical studies, p is equal or greater than n and making valid statistical inference is a great challenge. In the case of $p < n$, there is a rich literature on model estimation.

However, classical statistical methods cannot be used for estimating parameters of the model (1.1) when $p > n$, because they would overfit the data, besides severe identifiability issues. A way out of the ill-posedness of estimation in model (1.1) is given by assuming a sparse structure, typically saying that only few of the components of β are non-zero. Estimation of full parametric regression model in the case of $p > n$ and statistical inference afterwards, started about a decade ago. See, for example, Fan and Lv (2010), Shao and Deng (2012), Buhlmann (2013), Buhlmann et al. (2014) to mention a few. Now, consider a semiparametric regression model in the presence of multicollinearity. The existence of multicollinearity may lead to wide confidence intervals for the individual parameters or linear combination of the parameters and may produce estimates with wrong signs. For our purpose we only employ the ridge regression concept due to Hoerl and Kennard (1970), to combat multicollinearity. There are a lot of works adopting ridge regression methodology to overcome the multicollinearity problem. To mention a few recent researches in full-parametric and semiparametric regression models, see Roozbeh and Arashi (2013), Amini and Roozbeh (2015), Roozbeh (2015).

2. Classical Estimators Under Restriction

Consider the following semiparametric regression model

$$\mathcal{Y} = \mathrm{X}\beta + f(t) + \epsilon, \tag{2.1}$$

where $\mathcal{Y} = (\mathcal{Y}_1, \ldots, \mathcal{Y}_n)^T$, $\boldsymbol{X} = (x_1, \ldots, x_n)^T$ is an $n \times p$ matrix, $f(t) = (f(t_1), \ldots, f(t_n))^T$ and $\epsilon = (\epsilon_1, \ldots, \epsilon_n)^T$. We assume that in general, ϵ is a vector of disturbances, which is distributed as a multivariate normal, $N_n(\mathbf{0}, \sigma^2\mathbf{V})$, where $\mathbf{V}$ is a symmetric, positive definite known matrix and σ^2 is an unknown parameter. To estimate the parameters of the model (2.1), we first remove the non-parametric effect, apparently. Assuming β to be known, a natural nonparametric estimator of *f(.)* is $\hat{f}(t)= \boldsymbol{k}(t)(\boldsymbol{\mathcal{Y}} - \boldsymbol{X\beta})$, with $\boldsymbol{k}(t) = (\boldsymbol{K}_{\omega n}(t,t_1), \ldots, \boldsymbol{K}_{\omega n}(t,t_n))$, where $\boldsymbol{K}_{\omega n}(.)$ is a kernel function of order m with bandwidth parameter ω_n. For the existence of $\hat{f}(t,\beta)$ at the optimal convergence rate $n^{-4/5}$, in semiparametric regression models with probability one, we need some conditions on kernel function. See Muller (2000) for more details. Replacing *f(t)* by $\hat{f}(t)$ in (2.1), the model is simplified to

$$\tilde{\mathcal{Y}} = \tilde{X}\beta + \epsilon, \tag{2.2}$$

Where $\widetilde{\boldsymbol{\mathcal{Y}}} = (\boldsymbol{l_n} - \boldsymbol{K})\boldsymbol{\mathcal{Y}}. \widetilde{\boldsymbol{X}} = (\boldsymbol{l}_n - \boldsymbol{K})\boldsymbol{X}$ *and* $\boldsymbol{K}$ is the smoother matrix with *i,jth* component $K_{wn}(t_{i,}t_j)$. We can estimate the linear parameter β in (2.1) under the assumption cov $(\epsilon) = \sigma^2\boldsymbol{V}$, by minimizing the generalized sum of squared errors

$$SS(w_{n,}\beta = (\widetilde{\boldsymbol{\mathcal{Y}}} - \widetilde{\boldsymbol{X}}\,\beta)^T\boldsymbol{V}^{-1}(\tilde{\mathcal{Y}} - \tilde{X}\beta). \tag{2.3}$$

The unique minimizer of (2.3) is the partially generalized least squares estimator (PGLSE) given by

$$\hat{\boldsymbol{\beta}}_{PG}(\omega_n) = \text{argmin}_{\boldsymbol{\beta}}\, SS(\omega_n, \boldsymbol{\beta}) = \boldsymbol{C}^{-1}(\omega_n)\widetilde{\boldsymbol{X}}^T\boldsymbol{V}^{-1}\tilde{\boldsymbol{y}}^{-1}, \quad \boldsymbol{C}(\omega_n) = \widetilde{\boldsymbol{X}}^T\boldsymbol{V}^{-1}\widetilde{\boldsymbol{X}}. \tag{2.4}$$

Motivated by Fallahpour et al. (2012), we partition the regression parameter β as $\beta = (\beta_1^T, \beta_2^T)^T$, where the subvector β_i has dimension pi, i = 1, 2 and $p_1 + p_2 = p$. Thus the underlying model has form

$$\tilde{\boldsymbol{y}} = \widetilde{\boldsymbol{X}}_1\boldsymbol{\beta}_1 + \widetilde{\boldsymbol{X}}_2\boldsymbol{\beta}_2 + \boldsymbol{\epsilon}, \tag{2.5}$$

where $\tilde{X}$ is partitioned according to $(\tilde{X}_{1,}\tilde{X}_2)$ in such a way that $\tilde{X}i$ is a $n \times p_i$ submatrix, i = 1, 2. With respect to this partitioning, the PGLSEs of β_1 and β_2 are respectively given by

$$\begin{aligned} \hat{\beta}_{PG1}(\omega_n) &= \boldsymbol{C}_1^{-1}(\omega_n)\widetilde{\boldsymbol{X}}_1^T\boldsymbol{\Sigma}_2^{-1}(\omega_n)\tilde{\boldsymbol{y}}, \quad \boldsymbol{C}_1(\omega_n) = \widetilde{\boldsymbol{X}}_1^T\boldsymbol{\Sigma}_2^{-1}(\omega_n)\widetilde{\boldsymbol{X}}_1 \\ \hat{\beta}_{PG2}(\omega_n) &= \boldsymbol{C}_2^{-1}(\omega_n)\widetilde{\boldsymbol{X}}_2^T\boldsymbol{\Sigma}_1^{-1}(\omega_n)\tilde{\boldsymbol{y}}, \quad \boldsymbol{C}_2(\omega_n) = \widetilde{\boldsymbol{X}}_2^T\boldsymbol{\Sigma}_1^{-1}(\omega_n)\widetilde{\boldsymbol{X}}_2 \end{aligned} \tag{2.6}$$

where

$$\boldsymbol{\Sigma}_i^{-1}(\omega_n) = \boldsymbol{V}^{-1} - \boldsymbol{V}^{-1}\widetilde{\boldsymbol{X}}_i(\widetilde{\boldsymbol{X}}_i^T\boldsymbol{V}^{-1}\widetilde{\boldsymbol{X}}_i)^{-1}\widetilde{\boldsymbol{X}}_i^T\boldsymbol{V}^{-1}, \quad i = 1, 2. \tag{2.7}$$

The sparse model is defined when H_o: $\beta_2 = 0$ is true. In this paper, we refer restricted semiparametric regression model (RSRM) to the sparse model. For the RSRM, the partially generalized restricted least squares estimator (PGRLSE) has form

$$\hat{\boldsymbol{\beta}}_{PGR1}(\omega_n) = (\widetilde{\boldsymbol{X}}_1^T\boldsymbol{V}^{-1}\widetilde{\boldsymbol{X}}_1)^{-1}\widetilde{\boldsymbol{X}}_1^T\boldsymbol{V}^{-1}\tilde{\boldsymbol{y}}. \tag{2.8}$$

According to Saleh (2006), the PGRLSE performs better than PGLSE when model is sparse, however, the former estimator performs poorly as β_2 deviates from the origin. In the following result, the relation between the submodel and fullmodel estimators of β_1 will be obtained.

Proposition 2.1. *Under the assumptions of this section,*

$$\hat{\boldsymbol{\beta}}_{PG1}(\omega_n) = \hat{\boldsymbol{\beta}}_{PGR1}(\omega_n) - (\widetilde{\boldsymbol{X}}_1^T \boldsymbol{V}^{-1}\widetilde{\boldsymbol{X}}_1)^{-1}\widetilde{\boldsymbol{X}}_1^T \boldsymbol{V}^{-1}\widetilde{\boldsymbol{X}}_2\hat{\boldsymbol{\beta}}_{PG2}(\omega_n).$$

3. Sparse Multicollinear Model

Under situations in which the matrix C(ωn) is ill-conditioned due to linear relationship among the covariates of $\tilde{X}$ matrix (multicollinearity problem) or the number of independent variables (p) is larger than sample size (n), the proposed estimators in previous section are not applicable, because, we always find a linear combination of the columns in $\widetilde{\boldsymbol{X}}$ which is exactly equal to one other column. Mathematically, the design matrix has not full rank, rank ($\widetilde{\boldsymbol{X}}$) ≤ min ($n$, p) < p for p > n, and one may write $\widetilde{\boldsymbol{X}}\boldsymbol{\beta}$ = $\widetilde{\boldsymbol{X}}(\boldsymbol{\beta} + \boldsymbol{\zeta})$ for every $\boldsymbol{\zeta}$ in the null space of $\widetilde{\boldsymbol{X}}$.

Therefore, without further assumptions, it is impossible to infer or estimate β from data. We note that this issue is closely related to the classical setting with $p < n$ but rank ($\widetilde{\boldsymbol{X}}$) < p (due to linear dependence among covariables) or ill-conditioned design leading to difficulties with respect to identifiability. We note, however, that for prediction or estimation of $\widetilde{\boldsymbol{X}}\boldsymbol{\beta}$ (that is the underlying semiparametric regression surface), identifiability of the parameters is not necessarily needed. From a practical point of view, high empirical correlations among two or a few other covariables lead to unstable results for estimating β or for pursuing variable selection. To overcome this problem, we follow Roozbeh (2015) and obtain the restricted ridge estimator by minimizing the sum of squared partial residuals 3 with a spherical restriction and a linear restriction $\beta_2 = 0$, i.e., the RSRM is transformed into an optimal problem with two restrictions:

$$\min_{\boldsymbol{\beta}} \; (\widetilde{\boldsymbol{y}} - \widetilde{\boldsymbol{X}}\boldsymbol{\beta})^T \boldsymbol{V}^{-1}(\widetilde{\boldsymbol{y}} - \widetilde{\boldsymbol{X}}\boldsymbol{\beta}) \quad \text{subject to} \;\; \boldsymbol{\beta}^T\boldsymbol{\beta} \le \phi^2 \;\; \text{and} \;\; \boldsymbol{\beta}_2 = \boldsymbol{0}.$$

The resulting estimator is partially generalized restricted ridge estimator (PGRRE), given by

$$\begin{aligned}
\hat{\beta}_{PGR1}(\omega_n, k_n) &= (\widetilde{\boldsymbol{X}}_1^T \boldsymbol{V}^{-1}\widetilde{\boldsymbol{X}}_1 + k_n \boldsymbol{I}_{p_1})^{-1}\widetilde{\boldsymbol{X}}_1^T \boldsymbol{V}^{-1}\widetilde{\boldsymbol{y}} \\
&= \left(\boldsymbol{I}_{p_1} + k_n(\widetilde{\boldsymbol{X}}_1^T \boldsymbol{V}^{-1}\widetilde{\boldsymbol{X}}_1)^{-1}\right)^{-1} \hat{\beta}_{PGR1}(\omega_n) \\
&= \boldsymbol{T}_1(\omega_n, k_n)\hat{\beta}_{PGR1}(\omega_n), \quad \boldsymbol{T}_1(\omega_n, k_n) = \left(\boldsymbol{I}_{p_1} + k_n(\widetilde{\boldsymbol{X}}_1^T \boldsymbol{V}^{-1}\widetilde{\boldsymbol{X}}_1)^{-1}\right)^{-1}, \qquad (3.1)
\end{aligned}$$

where $k_n \geq 0$ is the ridge parameter as a function of sample size n. In a similar fashion as in previous section, partially generalized unrestricted ridge estimators (PGUREs) of β_1 and β_2 respectively have forms

$$\begin{aligned}\hat{\boldsymbol{\beta}}_{PG1}(\omega_n,k_n) &= (\widetilde{\boldsymbol{X}}_1^T\boldsymbol{\Sigma}_2^{-1}(\omega_n,k_n)\widetilde{\boldsymbol{X}}_1+k_n\boldsymbol{I}_{p_1})^{-1}\widetilde{\boldsymbol{X}}_1^T\boldsymbol{\Sigma}_2^{-1}(\omega_n,k_n)\widetilde{\boldsymbol{y}}\\ &= \left(\boldsymbol{I}_{p_1}+k_n(\widetilde{\boldsymbol{X}}_1^T\boldsymbol{\Sigma}_2^{-1}(\omega_n,k_n)\widetilde{\boldsymbol{X}}_1)^{-1}\right)^{-1}\hat{\boldsymbol{\beta}}_{PG1}(\omega_n)\\ &= \boldsymbol{R}_1(\omega_n,k_n)\hat{\boldsymbol{\beta}}_{PG1}(\omega_n),\quad \boldsymbol{R}_1(\omega_n,k_n)=\left(\boldsymbol{I}_{p_1}+k_n(\widetilde{\boldsymbol{X}}_1^T\boldsymbol{\Sigma}_2^{-1}(\omega_n,k_n)\widetilde{\boldsymbol{X}}_1)^{-1}\right)^{-1}, \quad (3.2)\end{aligned}$$

$$\begin{aligned}\hat{\boldsymbol{\beta}}_{PG2}(\omega_n,k_n) &= (\widetilde{\boldsymbol{X}}_2^T\boldsymbol{\Sigma}_1^{-1}(\omega_n,k_n)\widetilde{\boldsymbol{X}}_2+k_n\boldsymbol{I}_{p_2})^{-1}\widetilde{\boldsymbol{X}}_2^T\boldsymbol{\Sigma}_1^{-1}(\omega_n,k_n)\widetilde{\boldsymbol{y}}\\ &= \left(\boldsymbol{I}_{p_2}+k_n(\widetilde{\boldsymbol{X}}_2^T\boldsymbol{\Sigma}_1^{-1}(\omega_n,k_n)\widetilde{\boldsymbol{X}}_2)^{-1}\right)^{-1}\hat{\boldsymbol{\beta}}_{PG2}(\omega_n)\\ &= \boldsymbol{R}_2(\omega_n,k_n)\hat{\boldsymbol{\beta}}_{PG2}(\omega_n),\quad \boldsymbol{R}_2(\omega_n,k_n)=\left(\boldsymbol{I}_{p_2}+k_n(\widetilde{\boldsymbol{X}}_2^T\boldsymbol{\Sigma}_1^{-1}(\omega_n,k_n)\widetilde{\boldsymbol{X}}_2)^{-1}\right)^{-1}, \quad (3.3)\end{aligned}$$

where

$$\boldsymbol{\Sigma}_i^{-1}(\omega_n,k_n)=\boldsymbol{V}^{-1}-\boldsymbol{V}^{-1}\widetilde{\boldsymbol{X}}_i(\widetilde{\boldsymbol{X}}_i^T\boldsymbol{V}^{-1}\widetilde{\boldsymbol{X}}_i+k_n\boldsymbol{I}_{p_i})^{-1}\widetilde{\boldsymbol{X}}_i^T\boldsymbol{V}^{-1},\quad i=1,2. \quad (3.4)$$

Similar to Proposition 2.1, we have the following result without proof. **Proposition 3.1.** The partially generalized restricted and unrestricted ridge estimators of β_1 have the following relation

$$\hat{\boldsymbol{\beta}}_{PG1}(\omega_n,k_n)=\hat{\boldsymbol{\beta}}_{PGR1}(\omega_n,k_n)-(\widetilde{\boldsymbol{X}}_1^T\boldsymbol{V}^{-1}\widetilde{\boldsymbol{X}}_1+k_n\boldsymbol{I}_{p_1})^{-1}\widetilde{\boldsymbol{X}}_1^T\boldsymbol{V}^{-1}\widetilde{\boldsymbol{X}}_2\hat{\boldsymbol{\beta}}_{PG2}(\omega_n,k_n).$$

Up to this point, we supposed that the null hypothesis H$_o$: $\beta_2=0$ is true, however, it must be tested that one can incorporate the PGURE in practice. For this purpose, following Saleh (2006) and Yuzbashi and Ahmed (2015), we use the following test statistic for testing the sparsity hypothesis H$_o$

$$\pounds_n=\frac{\hat{\boldsymbol{\beta}}_{PG2}^T(\omega_n,k_n)\boldsymbol{C}_2(\omega_n,k_n)\hat{\boldsymbol{\beta}}_{PG2}(\omega_n,k_n)}{(n-p_1)s^2}, \quad (3.5)$$

where,

$$s^2=\frac{1}{n-p_1}\left(\widetilde{\boldsymbol{y}}-\widetilde{\boldsymbol{X}}_1\hat{\boldsymbol{\beta}}_{PG1}(\omega_n,k_n)\right)^T\boldsymbol{V}^{-1}\left(\widetilde{\boldsymbol{y}}-\widetilde{\boldsymbol{X}}_1\hat{\boldsymbol{\beta}}_{PG1}(\omega_n,k_n)\right). \quad (3.6)$$

Later, it will be shown that the test statistic $\pounds_n$ has asymptotic chi-square distribution with p_2 degrees of freedom. The following result is a direct conclusion of Theorem 2 of Knight and Fu (2000).

Proposition 3.2. Let $\hat{\beta}_{PG}(w_n k_n)=(\tilde{X}^T V^{-1}\tilde{X}+k_n I_P)^{-1}\tilde{X}^T V^{-1}\tilde{\mathcal{Y}}$. Then, under the regularity conditions (A1)-(A3), $\sqrt{n}(\hat{\beta}_{PG}(w_{n,}k_n)-\beta)\xrightarrow{\mathcal{D}}N_p(-k_0A^{-1}\beta,\sigma^2A^{-1})$. According to Saleh (2006), the test statistic diverges as $n\to\infty$, under any fixed alternatives $A_\xi:\beta_2=\xi$. To overcome this difficulty, in sequel, we consider the local alternatives

$$K_{(n)}:\boldsymbol{\beta}_2=\boldsymbol{\beta}_{2(n)}=n^{-\frac{1}{2}}\boldsymbol{\xi}, \quad (3.7)$$

where $\xi=(\xi_1,\ldots\ldots,\xi_{p2})^T\in\mathbb{R}^{p2}$ is a fixed vector. For notational convenience, let

$$
\begin{aligned}
-k_o \boldsymbol{A}^{-1}\boldsymbol{\beta} &= \boldsymbol{\mu} = (\boldsymbol{\mu}_1^T, \boldsymbol{\mu}_2^T)^T, \\
\boldsymbol{\delta} &= \boldsymbol{A}_{11}^{-1}\boldsymbol{A}_{12}\boldsymbol{\xi}, \\
\boldsymbol{\mu}_{11.2} &= \boldsymbol{\mu}_1 - \boldsymbol{A}_{12}\boldsymbol{A}_{22}^{-1}\left((\boldsymbol{\beta}_2 - \boldsymbol{\xi}) - \boldsymbol{\mu}_2\right), \\
\boldsymbol{\gamma} &= \boldsymbol{\mu}_{11.2} + \boldsymbol{\delta}, \\
\boldsymbol{A}_{22.1} &= \boldsymbol{A}_{22} - \boldsymbol{A}_{21}\boldsymbol{A}_{11}^{-1}\boldsymbol{A}_{12}, \\
\boldsymbol{B} &= \boldsymbol{A}_{21}\boldsymbol{A}_{11}^{-2}\boldsymbol{A}_{12}\boldsymbol{A}_{22.1}^{-1}.
\end{aligned} \tag{3.8}
$$

In the following, similar to approaches by Saleh (2006) and Yuzbashi and Ahmed (2015), some asymptotic distributional results involving the proposed estimators are given.

Lemma 3.1. *Under the regularity conditions (A1)-(A3) and local alternatives* $\{K_{(n)}\}$

$$(i)\ \boldsymbol{V}_{(n)}^{(1)} = \sqrt{n}\left(\hat{\boldsymbol{\beta}}_{PG1}(\omega_n, k_n) - \boldsymbol{\beta}_1\right) \xrightarrow{\mathcal{D}} N_{p_1}(-\boldsymbol{\mu}_{11.2}, \sigma^2\boldsymbol{A}_{11.2}^{-1})$$

$$(ii)\ \boldsymbol{V}_{(n)}^{(2)} = \sqrt{n}\left(\hat{\boldsymbol{\beta}}_{PGR1}(\omega_n, k_n) - \boldsymbol{\beta}_1\right) \xrightarrow{\mathcal{D}} N_{p_1}(-\boldsymbol{\gamma}, \sigma^2\boldsymbol{A}_{11}^{-1})$$

$$(iii)\ \boldsymbol{V}_{(n)}^{(3)} = \sqrt{n}\left(\hat{\boldsymbol{\beta}}_{PGR1}(\omega_n, k_n) - \hat{\boldsymbol{\beta}}_{PG1}(\omega_n, k_n)\right) \xrightarrow{\mathcal{D}} N_{p_1}(-\boldsymbol{\gamma} + \boldsymbol{\mu}_{11.2}, \sigma^2(\boldsymbol{A}_{11}^{-1} - \boldsymbol{A}_{11.2}^{-1}))$$

where $\boldsymbol{A}_{11.2} = \boldsymbol{A}_{11} - \boldsymbol{A}_{12}\boldsymbol{A}_{22}^{-1}\boldsymbol{A}_{21}$.

The following result is a direct conclusion of Proposition 3.2 and Lemma 3.1.

Theorem 3.1. *Under the regularity conditions (A1)-(A3) and local alternatives* $\{K_{(n)}\}$, $\pounds_n$ *is asymptotically distributed according to a non-central chi-square distribution with* p_2 *degrees of freedom and noncentrality parameter* $\frac{1}{2}\Delta*$, *where*

$$\Delta^* = \frac{1}{\sigma^2}\boldsymbol{\xi}^T\boldsymbol{A}_{22.1}\boldsymbol{\xi}, \quad \boldsymbol{A}_{22.1} = \boldsymbol{A}_{22} - \boldsymbol{A}_{21}\boldsymbol{A}_{11}^{-1}\boldsymbol{A}_{12}.$$

4. Improved Estimation Strategies

In many practical situations, along with the model one may suspect that β belongs to the sub-space defined by $\beta_2 = 0$. In such situation one combines the estimate of β and the test-statistic to obtain improved estimators of β. First, we consider the preliminary test partially generalized restricted ridge estimator (PTPGRRE) defined by

$$
\begin{aligned}
\hat{\boldsymbol{\beta}}_{PGR1}^{PT}(\omega_n, k_n) &= \hat{\boldsymbol{\beta}}_{PGR1}(\omega_n, k_n) + \left[1 - I(\pounds_n \le \chi_{p_2}^2(\alpha))\right]\left(\hat{\boldsymbol{\beta}}_{PG1}(\omega_n, k_n) - \hat{\boldsymbol{\beta}}_{PGR1}(\omega_n, k_n)\right) \\
&= \boldsymbol{T}_1(\omega_n, k_n)\hat{\boldsymbol{\beta}}_{GR1}(\omega_n) + \left[1 - I(\pounds_n \le \chi_{p_2}^2(\alpha))\right]\left(\boldsymbol{R}_1(\omega_n, k_n)\hat{\boldsymbol{\beta}}_{G1} - \boldsymbol{T}_1(\omega_n, k_n)\hat{\boldsymbol{\beta}}_{GR1}(\omega_n)\right)
\end{aligned} \tag{4.1}
$$

where $\mathcal{X}_{p2}^2(\alpha)$ is the upper α-level critical value (0 < α < 1) from the central chi-square distribution and I(A) is the indicator function of the set A. The PTPGRRE has the disadvantage that it depends on α, the level of significance, and also it yields the extreme results, namely $\hat{\beta}_{GR1}(k)$ and $\hat{\beta}_{G1}(k)$ depending on the outcome of the test. Later, we will discuss in detail of the Stein-type partially generalized restricted ridge estimator (SPGRRE) defined by

$$\begin{aligned}\hat{\beta}^{S}_{PGR1}(\omega_n,k_n) &= \hat{\beta}_{PGR1}(\omega_n,k_n)+(1-d\pounds_n^{-1})\big(\hat{\beta}_{PG1}(\omega_n,k_n)-\hat{\beta}_{PGR1}(\omega_n,k_n)\big), \quad d=p_2-2>0\\ &= \boldsymbol{T}_1(\omega_n,k_n)\hat{\beta}_{PGR1}(\omega_n)+(1-d\pounds_n^{-1})\big(\boldsymbol{R}_1(\omega_n,k_n)\hat{\beta}_{PG1}-\boldsymbol{T}_1(\omega_n,k_n)\hat{\beta}_{PGR1}(\omega_n)\big) \quad (4.2)\end{aligned}$$

The SPGRRE has the disadvantage that it has strange behavior for small values of $\pounds_n$. Also, the shrinkage factor $(1-d\pounds_n^{-1})$ becomes negative for $\pounds_n < d$. Hence, we consider the positive-rule Stein-type partially generalized restricted ridge estimator (PRSPGRRE) defined by

$$\hat{\beta}^{S+}_{PGR1}(\omega_n,k_n) = \hat{\beta}^{S}_{PGR1}(\omega_n,k_n)-(1-d\pounds_n^{-1})I(\pounds_n\le d)\big(\hat{\beta}_{PG1}(\omega_n,k_n)-\hat{\beta}_{PGR1}(\omega_n,k_n)\big). \quad (4.3)$$

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Forecast Error Variance Analysis on the impact of foreign exchange rate volatility on Nigeria export growth

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Abstract
This paper focus on forecast error variance analysis on the impact of foreign exchange volatility on Nigeria export growth using annually time series data for the period 1980 – 2017. The export is segregated into non – oil, total and oil export. Under the constant term assumption provided by the data generating mechanism of each variable (non – oil, oil, total export, and naira/dollar exchange rate) each were I (1) which was established from Augmented Dickey Fuller (ADF) test. Positive relationships were examined at both aggregate and disaggregate level of export based on the result provided by unrestricted vector auto-regression (dynamic model). The error derived from the VAR model explained all the forecast error variance of non – oil, oil and total export at all forecast time horizon indicating that non – oil, oil, and total export can be treated as endogenous variables. With this view, naira/dollar exchange rate had slight effect on export at both aggregate and disaggregates level. The policy recommendation for this is to put a proper mechanism in place either through the use of devaluation or currency restructuring which will aid business attribute and investors to have efficient productivity on Nigeria export growth.

Keywords
Forecast error variance decomposition; Total Export, Exchange rate volatility; Unrestricted Vector Auto regression; Oil Export; Non-oil Export

1. Introduction

The term volatility means the relative rate at which the price of a security moves up and down. This volatility; is found or measured by its analysed standard deviation of daily change in price. If the price of a stock moves up and down rapidly over the short time period, it has high volatility. If the prices almost never change, it has low volatility. Exchange rate in terms of finance means the exchange rates between two currencies specifies how much one currency is worth in terms of the other. It is the value of a foreign nation's currency in terms of the home nation's currency. Exchange rate volatility is described to be the relative rate at which the value of a foreign nation's currency in terms of the home nation's currency moves up and down. This foreign exchange rate volatility thus has a great effect on once nation economy, which lead to trade imbalance and global imbalance. This statement was verified by Hooper et.al (1998) found out that trade flows are significantly affected by real exchange rate, also Chin (2004) also found out similar result. Various studies on the affection of exchange rate volatility on trade was established in developed countries like US and Japan, Breuer and Clement (2003,2004) concluded that trade between the these two countries are affected by changes in price of exchange rate. Because changes in exchange rate has significant effect on countries economy like Nigeria (developing country), the government established a market determined nominal exchange rate using interbank foreign exchange (IFEM), autonomous foreign exchange rate (AFEM), Dutch auction system (DAS) and structural adjustment program (ASAP) at different period of time for evaluation of naira exchange rate and boosting of non –oil, and oil export. This introduction of the above programs has a powerful effect on imports and exports of the country concerned through effects on relative price of goods. But there are some factors that lead to the changes in naira exchange rate, which allows a pitfall on non – oil export like weak production base and undiversified nature of the economy, import – dependent production structure, sluggish foreign capital flow, instability of earnings from crude oil, upon which the economy depends very heavily, unguided trade liberation, fiscal imbalance, speculative activities and sharp practices of authorized foreign exchange dealers.

At the foreign exchange rate market, the naira depreciated consistently against major other foreign currency which is the theory should increase export performance as witness in other countries like US and China. Findings from Granwa (1998) of the effect of individual European currency depreciation on individual country export trade support this thought: national currency depreciation affecting export trade positively. But question still comes in "does frequent changes in price of exchange rate do have great effect on export growth?" Chukwu (2007) observed that the instability exchange rate as a determent of trade in Nigeria has a positive influence on export trade, this makes a suggestion that changes in its value has a long run effect on export and despite also on its economic growth. Also Osuntogun et.al (1993), Obadan (1994) also have similar results. However, this paper seeks to address the question on the impact of changes of exchange rate on export growth using time series technique "variance decomposition" to aim us know the proportion explained by exchange rate in both long run and short run relationship for the period 1980 – 2010. The paper is organized as section 2 focuses on methodology, section 3 focuses on result, section 4 is discussion and conclusion.

2. Methodology

A forecast error variance analysis was carried out to study the proportion explained by the impact of foreign exchange rate volatility on Nigeria export growth, which is carried out by forecast error variance decomposition technique. In other not to have a spurious regression which may arise as a result of carrying regression on time series data, we first subject each variable (exchange rate (naira/us dollar), and export which is segregated into non- oil and oil export) to Argumented Dickey Fuller (ADF) test (1979) under the assumption of constant and no constant and in the presence of serial correlation. The model for ADF test is as follows:

$$\Delta Z_t = \alpha_0 + \delta Z_{t-1} + \sum_{i=1}^{k} B_i \Delta Z_{t-i} + \varepsilon_{1t} \quad (1)$$

$$\Delta Z_t = \delta Z_{t-1} + \sum_{i=1}^{k} B_i \Delta Z_{t-i} + \varepsilon_{2t} \quad (2)$$

Where ΔZ_t = the first difference of series interested, α_0 = constant term parameter, δ = drift term, B_i =coefficient associated to each of the first difference of lagged series, and ε_{1t}, ε_{2t}, are the residual errors. The equation (1) and (2) above is described as ADF test around a constant term and with no constant term respectively. The null hypothesis for equation (1) is stated as:

H_0: $\delta=0$ (unit root around a constant term)

H_1: $\delta<0$ (presence of no unit root i.e stationary)

The null hypothesis for equation (2) is stated as:

H_0: $\delta=0$ (unit root around a constant term)

H_1: $\delta<0$ (presence of no unit root i.e stationary around no constant term)

Each of the above null hypotheses is not rejected when the absolute value of ADF test statistics is less than the MacKinnon critical value; hence otherwise we reject and conclude that the series interested is stationary. If found that each of the series were not stationary, a proper logarithm transformation or difference method for each of the series will be stationary and by subjecting or making use of the above ADF test (1979) on the transformation method used. The next procedure is to fit a dynamic model but this dynamic model is based on stationary variables. The dynamic model encompasses in this research study is unrestricted vector auto regression model. This model was first introduced by Sims (1980) where he treated all the variables as pure endogenous variables, and expressed as a linear combination of their lagged values. Sims (1980) obtained a VAR (p) model from the primitive system called SVAR model (structural vector auto regression) through the use of normalization technique which is been incorporated in this research studies. We consider a two variable (naira/dollar exchange rate) and export (non- oil, total, oil exports) at both aggregate and disaggregate level of export.

At aggregate level $y_t = b_{10} - b_{12}z_t + c_{11}y_{t-1} + c_{12}z_{t-1} + \varepsilon_{yt}$.......................(3)

$z_t = b_{20} - b_{21}y_t + c_{21}y_{t-1} + c_{22}z_{t-1} + \varepsilon_{zt}$.......................(4)

Where ε_{i1} □ $i.i.d\ (0,\ \delta^2{}_{\varepsilon i})$ and $\text{cov}(\varepsilon_{yt}, \varepsilon_{zt}) = 0$.

In matrix form,

$$\begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix}\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix} + \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix}\begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix} \text{.........} eq(5)$$

More simply,

$BX_t = \gamma_0 + \gamma_1 X_{t-1} + \varepsilon_t \rightarrow$ structural VAR model or simply called primitive system

Through normalization technique, we multiply $eq(5)$ by B^{-1}, we have

$$B^{-1}X_t B = B^{-1}\gamma_0 + B^{-1}\gamma_1 X_{t-1} + B^{-1}\varepsilon_t$$

$$X_t = A_0 + A_1 X_{t-1} + e_t \text{...} eq(6)$$

Y_t = total export, z_t=naira dollaer exchange rate, and e_{1t}, e_{2t} are the error terms which are composite to the structural innovation from the restricted vecto auto regression.

$$\text{Where } e_t = B^{-1}\varepsilon_t = \frac{1}{1 - b_{21}b_{12}}\begin{bmatrix} 1 & -b_{12} \\ -b_{21} & 1 \end{bmatrix}, \text{ and}$$

$$B^{-1} = \frac{1}{|B|}\left(B^c\right)^T,$$

where B^c = cofactor of B, $(B^c)^T$ Transpose

Further, the study of dynamic relationship at disaggregate level between (non – oil, oil export) and naira dollar exchange rate is forwarded by repeating $eq(3)$ to $eq(7)$, and the procedure is carried in the say way.

$$e_{1t} = \frac{\varepsilon_{yt} - b_{12}\varepsilon_{zt}}{\Delta}, e_{2t} = \frac{-b_{21}\varepsilon_{yt} + \varepsilon_{zt}}{\Delta}$$

Now where $\Delta = 1 - b_{21}b_{12}$,

ε's are white noise, thus $e'^s(0, \sigma^2 i)$

$$E(e_t) = 0,\ Var(e_{1t}) = E(e^2{}_{1t}) = E\left(\frac{\varepsilon^2{}_{yt} + b^2{}_{12}\varepsilon^2{}_{zt}}{\Delta^2}\right) =$$

Where $\dfrac{\sigma^2{}_y + b^2{}_{12}\sigma^2{}_z}{\Delta^2}$

is time dependent, and same as for Var (e_{2t})

$eq(7)$ is estimated with ordinary least square regression model since the right hand side consists of predetermined variables and the error are due to white noise. When fitting of the dynamic model is done, we proceed ahead and determine how much of a change in a variable is due to its own shock and due to shock of other variables at both aggregate and disaggregate level. This has been the interest in this research studies, and this is achieved by the forecast error variance decomposition. Most of the variation is due to its shock. We consider a VMA (vector moving average) representation of *eq*(7) at aggregate level which is given as: Where, $y_{t=}$ total export, z_t naira dollaer exchange rate, and e_{1t},e_{2t} are the error terms which are composite to the structural innovation from the restricted vecto auto regression.

$$e_t = B^{-1}\varepsilon_t = \frac{1}{1-b_{21}b_{12}}\begin{bmatrix} 1 & -b_{12} \\ -b_{21} & 1 \end{bmatrix},$$ Where and

$$B^{-1} = \frac{1}{|B|}\left(B^c\right)^T,$$

where B^c = cofactor of B, $(B^c)^T$ = Transpose

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εs are white noise, thus e'^{s} $(0,\sigma^2 i)$

$$E(e_t) = 0,\ Var(e_{1t}) = E(e^2{}_{1t}) = E\left(\frac{\varepsilon^2{}_{yt} + b^2{}_{12}\varepsilon^2{}_{zt}}{\Delta^2}\right) =$$

Where

$$\frac{\sigma^2{}_y + b^2{}_{12}\sigma^2{}_z}{\Delta^2}$$ is time dependent, and same as for Var (e_{2t})

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$$x_{t+n} - E_t x_{t+n} = \phi_0\varepsilon_{t+n} + \phi_1\varepsilon_{t+n-1} + \phi_2\varepsilon_{t+n-2}$$
$$+ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\phi_{n-1}\varepsilon_{t+1} = \sum_{i=0}^{n-1}\varepsilon_{t+n-i}$$

Now, the n[th] period forecast of total export (aggregate level) in favour of naira/ dollar exchange rate is given as: Now, the n[th] period forecast of total export (aggregate level) in favour of naira/ dollar exchange rate is given as:

$$y_{t+n} - E\left(y_{t+n}\right) = \left(\phi_{11,0}\varepsilon_{y,t+n} + \phi_{11,1}\varepsilon_{y,t+n-1} + \ldots\ldots + \phi_{11,n-1}\varepsilon_{y,t+1}\right) + \left(\phi_{21,0}\varepsilon_{z,t+n} + \phi_{21,1}\varepsilon_{z,t+n-1} + \ldots\ldots \phi_{21,n-1}\varepsilon_{z,t+1}\right)$$

Where its variance is given as:

$$\sigma^2_{y,n} = \underbrace{\sigma^2_{y}\left(\phi^2_{11,0} + \phi^2_{11,1} + \ldots\ldots + \phi^2_{11,n-1}\right)} + \underbrace{\sigma^2_{z}\left(\phi^2_{21,0} + \phi^2_{21,1} + \ldots\ldots + \phi^2_{21,n-1}\right)}$$

Proportion due to its own shock Proportion of variance due to naira dollar Now, the n[th] period forecast of total export (aggregate level) in favour of naira/ dollar exchange rate is given as:

$$y_{t+n} - E\left(y_{t+n}\right) = \left(\phi_{11,0}\varepsilon_{y,t+n} + \phi_{11,1}\varepsilon_{y,t+n-1} + \ldots\ldots + \phi_{11,n-1}\varepsilon_{y,t+1}\right) + \left(\phi_{21,0}\varepsilon_{z,t+n} + \phi_{21,1}\varepsilon_{z,t+n-1} + \ldots\ldots \phi_{21,n-1}\varepsilon_{z,t+1}\right)$$

Where its variance is given as:

$$\sigma^2_{y,n} = \underbrace{\sigma^2_{y}\left(\phi^2_{11,0} + \phi^2_{11,1} + \ldots\ldots + \phi^2_{11,n-1}\right)} + \underbrace{\sigma^2_{z}\left(\phi^2_{21,0} + \phi^2_{21,1} + \ldots\ldots + \phi^2_{21,n-1}\right)}$$

Proportion due to its own shock Proportion of variance due to naira dollar

If ε_Z (error due naira dollar exchange rate) explains none of the forecast error variance of the sequence total export (at aggregate level) at all forecast error horizon $\frac{\partial \sigma^2_{y,m}}{\partial^2_z}$ 0, then total export is treated as pure exogenous.

But if ε_z(error due naira dollar exchange rate) explains the forecast error variance of the sequence (at aggregate level) at all forecast time horizon $\frac{\partial \sigma^2_{y,m}}{\partial^2_z}$ 0.9, then total export is treated as *pure endogenous variable*.

This means that a proportion was explained by naira/dollar exchange rate in favour total export. For disaggregate level, the same procedure is followed. A time series data for foreign exchange rate (Naira/US dollar), export were collected from the central bank of Nigeria statistical bulletin from the period 1980 to 2017. The export data is segregated into non- oil, total, oil exports.

3. Result

From analysis results the dynamic relationship between total export and naira/ dollar exchange rate showed a positive relationship, this means that one unit change in one time period of naira/dollar exchange rate at aggregate level (total export) will increase by 16932.16 units. This value indicates a large magnitude. Also at disaggregate level (non-oil, oil export), a positive relationship to naira/dollar Page 6 of 6 exchange rate was present; a one unit change in naira/dollar will lead to 17190.48 increase in non-oil export while

17889 unit increase will lead to oil export. Since the dynamic mode was fixed and a positive relationship were examined, we go ahead and studied the forecast error variance decomposition i.e. the variation explained due to shock on each other using eight forecast time horizon. Tables 1, displace the forecast error variance decomposition at both aggregate and disaggregate level.

Period	Non – oil export	Oil export	Total export
1	18.39643	8.868136	9.996062
2	18.42322	14.85511	13.61430
3	18.44418	15.18785	13.62520
4	18.47710	15.27060	13.63614
5	18.52831	15.27970	13.63624
6	18.60795	15.28121	13.63628
7	18.73163	15.28140	13.63629
8	18.9234	15.28143	13.63730

Table 1: Forecast error variance of naira/dollar exchange rate on total export, non- oil, and oil export from 1980 -2010 using eight forecast time horizons

4. Discussion and Conclusion

In other not to have a spurious regression results from a time series data, we subjected each variable to unit root test through the use of ADF test under two different assumptions that the data generating mechanisms followed. We address the forecast error variance decomposition on the impact of foreign exchange rate volatility on Nigeria export growth using annual time series data for period 1980 to 2010 using time series technique which encompasses unit root test, vector auto regression to look at the dynamic relationship and variance decomposition to study the changes in variation of variable to one another. The error derived from $eq(7)$ showed that it explained all the forecast error variance of non – oil, total oil and oil export at all eight forecast time horizon, indicating that non – oil, oil, and total export can be treated as pure endogenous variables. In this sense, past and current values of naira/dollar exchange rate can be used in predicting each of the dependent variables. Naira/dollar exchange rate had slight effect on export at both aggregate and disaggregates level. For improvement on Nigeria export growth, a well appreciable mechanism should be adopted either through devaluation or currency restructuring which will aid policy decision makers, investors and other business attributes to have efficient productivity on Nigeria export growth.

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On jumps models and newly asymmetric innovations in volatility models and applications

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Abstract

Generalised Autoregressive Conditional Heteroskedasticity (GARCH) models have been used to model non-constant variances in financial time series models. Previous works have assumed error innovations of GARCH models of order (p,q) as: Normal, Student-t and Generalised Error Distribution (GED), but these distributions failed to capture conditional volatility series adequately, leading to low forecast performance. This study is therefore aimed at developing variants of GARCH(p,q), Asymmetric Power ARCH (APARCH(p,q)) models, Exponential GARCH EGARCH(p,q) model and comparison with Jumps GARCH models such as Generalized Autoregressive Score (GAS) , the Exponential GAS (EGAS) and the Asymmetric Exponential GAS (AEGAS)) with asymmetric error innovations for improved forecast estimates. The two error innovations considered were the Generalised Length Biased Scaled-t (GLBST) and Generalised Beta Skewed-t (GBST) distributions, obtained by remodifying Fisher Concept of Weighted Distribution and McDonald Generalised Beta Function, respectively, in the Student-t distribution. The properties of the proposed distributions were investigated. The proposed innovations were imposed on GARCH(1,1), EGARCH(1,1) APARCH(1,1) models to obtain GARCH-GLBST(1,1) and APARCH-GLBST(1,1), EGARCH-GLBST(1,1) models, respectively. Similarly, GARCH-GBST(1,1), EGARCH -GBST(1,1), APARCH-GBST(1,1) models were also obtained by incorporating proposed innovations into GARCH(1,1), EGARCH(1,1) APARCH(1,1) models. Data from the Central Bank of Nigeria All Share Index (ASL) were used to illustrate the models. The proposed models were compared with jumps and classical models. The performance of the proposed models over the existing ones were investigated using the Log-likelihood function, Root Mean Square Error (RMSE), Adjusted Mean Absolute Percentage Error (AMAPE) and Akaike Information Criterion (AIC). Out of the 18 models in consideration, EGARCH-GLBST(1,1) was the best, followed by APARCH-GLBST(1,1) and EGAS models, in terms of the AIC values (7.856,7.988 and 9.984).The forecast evaluation criteria (RMSE, AMAPE), EGARCH-GLBST(1,1) model also ranked best (RMSE =0.281, AMAPE = 0.280), followed by APARCH-GLBST(1,1) model (RMSE = 0.291, AMAPE = 0.290) and EGAS model (RMSE = 0.309, AMAPE = 0.301). The least performing in terms of forecasts was the GARCH(1,1)-Normal model. The proposed volatility models with error innovations outperformed existing models in terms of fitness of conditional volatility and forecasts. The proposed models will be good alternatives for volatility modelling of symmetric and asymmetric stock returns.

Keywords
GARCH models; Generalised beta skewed–t distribution; Generalised length biased Scaled distribution; Root mean square error; Jumps Models

1. Introduction

Volatility models are dynamic models that address unequal variances in financial time series, the first and formal volatility model is the Autoregressive Conditional Heteroskedasticity (ARCH) model by Engle Robert (1982). The history of ARCH is a very short one but its literature has grown in a spectacular fashion. Engle's Original ARCH model and it various generalization have been applied to numerous economic and financial data series of many countries. The concept of ARCH might be only a decade old, but its roots go far into the past, possibly as far as Ba0chelier (190), who was the first to conduct a rigorous study of the behaviour of speculative prices. There was then a period of long silence. Mandelbrot (1963,1967) revived the interest in the time series properties of asset prices with his theory that random variables with an infinites population variance are indispensable for a workable description of price changes. His observations, such as unconditional distributions have thick tails, variance change over time and large(small) changes tend to be follow by large(small) changes of either sign are stylized facts for many economic and financial variables. Empirical evidence against the assumption of normality in stock return has been ever since the pioneering articles by Mandelbrot (1963), Fama (1965), and Clark (1973) which they argued that price changes can be characterized by a stable Paretian distribution with a characteristic exponent less than two, thus exhibiting fat tails and an infinite variance. Volatility clustering and leptokurtosis are commonly observed in financial time series (Mandelbrot, 1963). Another phenomenon often encountered is the so called “leverage effect” (black 1976) which occur when stock price change are negatively correlated with changes in volatility. Such studies is scared in Nigeria Stock Exchange Market and observations of this type in financial time series have led to the use of a wide range of varying variance models to estimate and predict volatility.

In his seminal paper, Engle (1982) proposed to model time-varying conditional variance with Autoregressive Conditional Heteroskedasticity (ARCH) processes using lagged disturbances; Empirical evidence based on his work showed that a high ARCH order is needed to capture the dynamic behaviour of conditional variance. The Generalised ARCH (GARCH) model of Bollerslev (1986) fulfils this requirement as it is based on an infinite ARCH specification which reduces the number of estimated parameters from infinity to two. Both the ARCH and GARCH models capture volatility clustering and Leptokurtosis, but as their distribution is symmetric. They fail to model the leverage effect. To address this problem, many nonlinear extensions of GARCH have been proposed, such as the Exponential GARCH (EGARCH) model by Nelson (1991), the so-called GJR model by Glosten et al (1993) and the Asymmetric Power ARCH (APARCH) model by Ding et al (1993).

Another problem encountered when using GARCH models is that they do not always fully embrace the thick tails property of high frequency financial times series. To overcome this drawback Bollerslev (1987), Baille and Bollerslev (1987) and Beine et al (2002) have used the Student's t-distribution. Similarly to capture skewness Liu and Brorsen (1995) used an asymmetric stable density. To model both skewness and kurtosis Fernandez and Steel (1998) used the skewed Student's t-distribution which was later extended to the GARCH framework by Lambert and Laurent (2000, 2001). To improve the fit of GARCH and EGARCH models into international markets, Harris et all (2004) used the skewed generalised Student's t-distribution to capture the skewness and leverage effects of daily returns.

The Beta probalility distribution missed with the student- t distribution and the resulting mixed- distribution applied to the GARCH model, with little modification to obtain the volatility model that is robust in modelling jumps. The Oil and stock markets stress of 1987 and 2008-2009, respectively are good examples of jumps in volatility series (see Bates, 2000, Pan, 2002). Eraker, Johnannes and Polson (2003) apply continuous time stochastic volatility models with jumps components in returns and volatility of S&P500 and Nasdaq stocks indices ad observe significant evidence of jumps components, both in the volatility and in the returns. Generalized Autoregressive Score (GAS), the Exponential GAS (EGAS) and the Asymmetric Exponential GAS (AEGAS) are new classes of volatility models that simultaneously account for jumps and asymmetry.

These jumps in ASI were experience as a result of influence of news, politics and global crisis on Nigeria economy. This project seek to estimate volatility in the Nigeria Stock Market along with forecasting performance of GARCH and new classes of volatility models that simultaneously account for jumps and asymmetry together with different density functions and recommending the most robust model for financial analysts and portfolio managers in the finance market. These jumps in ASI were experience as a result of influence of news, politics and global crisis on Nigeria economy.

DATA SOURCE: A daily data of the All Share Index (ASL) from the period January 3, 2000 to December 22, 2017 were obtained from CBN statistical bulletin 2018.

2. Methodology

We define r_t as a (t x1) vector of assests log- returns up to time t that is:

$$r_t = \varepsilon_t = \sigma_t z_t \quad (1)$$

where z_t follows a particular probability distribution, and σ_t is the square root of the conditional variance. The mean equation of the model ie the deterministic aspect of the series follows Autoregressive Model, AR(p),

$$y_t = \phi_1 y_{t-1} + \varepsilon_t \quad (2)$$

the Standard GARCH (p,q) model by Bollerslev in (1986) is given as :

$$\sigma_t^2 = \alpha_0 + \sum_{t=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{t=i}^{p} \beta_i \sigma_{t-i}^2 \quad (3)$$

where $\alpha_0 > 0$, $\alpha_i \geq 0$ (for i=1, ---, q), $\beta_j \geq 0$ (for j=1, ..., p) is sufficient for conditional variance to be positive and stationarity.

To capture asymmetry observed in series, a new class of ARCH model was introduced: The asymmetric power ARCH (APARCH) model by Ding et'al (1993), the exponential GARCH (EGARCH) model by Nelson (1991), the GJR by Glosten et al. (1993). This model can generate many model when the parameters are relaxed and is expressed as:

$$\sigma_t^\delta = \alpha_0 + \sum_{i=1}^{q} \alpha_i \left(|\varepsilon_{t-i}| - \gamma_i \varepsilon_{t-i} \right)^\delta + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^\delta \quad (4)$$

where $\alpha_0 > 0$, $\delta \geq 0$, $\alpha_i \geq 0$, $i = 1,\ldots q$, $-1 < \gamma_i < 1$, $i=1,\ldots q$, $\beta_j \geq 0$, $j = 1,\ldots p$

The γ_i parameter permit us to catch the asymmetric effects. The conditional standard deviation process and the asymmetric absolute residuals in the model were imposed in term of a Box-transformation. The well-known Leverage effect is the asymmetric response of volatility to negative and positive shocks. Harvey (2013) developed three sets of volatility models that take into account robust capturing occasional changes in financial series known as jumps, he considered the EGARCH and AEGARCH types of the Beta-GARCH models each with two distributions assumptions applied.

The BetaEGARCH model specified without the leverage effect is given:

$$\log\sigma_t^2 = \omega + \alpha\mu_{t+1} + \varphi_1 log\sigma_{t-1}^2 \quad (5)$$

Introducing the leverage effect we have the Beta-AEGARCH model (ie EGAS):

$$\log\sigma_t^2 = \omega + \alpha\mu_{t+1} + \gamma I_{t-1}\varphi_1 + log\sigma_{t-1}^2 \quad (6)$$

where $I_{t-1} = sgn(-z_t)(\mu_t+1)$ when student-t distribution is considered and $I_{t-1} = sgn(-z_t)(\mu_t+1)$ *for skewed student-t distribution. Again, combing the same student-t with EGAS model leads to Beta-t AEGARCH ie AEGAS model.*

The generalized beta distribution of the first kind was introduced by McDonald (1984), with link function

$$g(y) = \frac{c}{\beta(a,b)}\left[F(y)\right]^{ac-1}\left[1-F(y)^{c}\right]^{b-1} f(y) \quad (7)$$

Where a, b, c are the shape parameter, f(y) is the probability function of student –t distribution, F(y) is the incomplete beta function and g(y) is the link function of Generalized Beta Skew-t distribution. The log-likelihood for estimation is:

$$l = LogL = n\log c - n\log B(a,b) + n\log\sqrt{\frac{v+1}{2}} - n\log\sqrt{\frac{v}{2}} - \frac{n}{2}\log\left[\pi(v-2)\sigma_t^2\right]$$
$$+(ac-1)\sum_{t=2}^{n} LogI + (b-1)\sum_{t=2}^{n}\log(1-I^{c}) - \left(\frac{v+1}{2}\right)\sum_{t=2}^{n}\log\left[1+\frac{\varepsilon_t^2}{\sigma_t^2(v-2)}\right] \quad (8)$$

Fisher (1934) introduce the concept of weighted distribution, w(y) be a non–negative weighted function satisfying

$\mu_w = E(w(y)) < \infty$ then the random variables of Y_w having pdf

$$f_w(y) = \frac{w(y)f(y)}{E\left(w(y)\right)}, a < y < b$$

Where $E(w(y)) = \int_{-\infty}^{\infty} w(y)f(y)dy$, $-\infty < y < \infty$

is said to have weighted distribution. length biased distribution is derived when the weighted function depend on the length of units of interest (i.e. w(y) = y). The pdf of a length biased random variable is defined as:

$$g(y) = \frac{yf(y)}{\mu} \quad (9)$$

The log-likelihood of equation (4) when the pdf is student-t is obtained as

$$L = \log\prod_{i=1}^{n} g(y) = n\log\sqrt{\frac{v+1}{2}} - n\log\mu - n\log\sqrt{\frac{v}{2}} - \frac{n}{2}\log\left[\pi(v-2)\sigma^2\right] + \sum_{i=1}^{n}\log y_i - \left(\frac{v+1}{2}\right)\sum_{i=1}^{n}\log\left[1+\frac{(y-\mu)^2}{(v-2)\sigma^2}\right] \quad (10)$$

These two newly distributions will be incorporated into conventional and Jumps GARCH models. In the literature the most recent error innovation used along with volatility models are Normal, Student-t and GED. Below are parameter estimations of the three innovation: see Yaya et al, (2013), for Normal distribution, the Log-likelihood is

$$l_t = -\frac{1}{2}\left[N\log(2\pi) + \sum_{i=1}^{N}\frac{\varepsilon_t^2}{\sigma_t^2} + \sum_{i=1}^{N}\log\sigma_t^2\right]$$
$$\varepsilon_t = z_t\sigma_t \text{ where } z_t = \frac{\varepsilon_t}{\sigma_t} \quad (11)$$

Equation (9) is the log-likelihood l_t of Normal, N is the sample sizes of the series, ε_t is the white noise, z_t is sequence of identical independent random variables and $\sigma_t{}^2$ is the conditional variance.

The Log-likelihood for Student-t distribution is

$$l_t = -\frac{1}{2}\left[N\log\left(\frac{\pi(v-2)\gamma\left(\frac{v}{2}\right)^2}{\gamma\left(\frac{v+1}{2}\right)^2}\right) + \sum_{i=1}^{N}\log\sigma_t^2 + (v-1)\sum_{i=1}^{N} log\left(1+\frac{\epsilon_t^2}{\sigma_t^2(v-1)}\right)\right] \tag{12}$$

In the estimation in equation (10) v is the degree of freedom and $\gamma(.)$ Is the gamma function, for GED it is

$$l_t = -\frac{1}{2}\left[N\log\left(\frac{\gamma(v^{-1})^3}{\gamma(3v^{-1})\,\gamma\left(\frac{v}{2}\right)^2}\right) + \sum_{i=1}^{N}\log\sigma_t^2 + (v-1)\sum_{i=1}^{N} log\left(\frac{\gamma(3v^{-1})\epsilon_t^2}{\sigma_t^2(v^{-1})}\right)\right] \tag{13}$$

3. Result

To obtain a stationary series, we use the returns R_t=100(log (Y_t)-log(Y_{t-1})) where Y_t is the closing value of index at month t. The sample statistics for the returns R_t are exhibited in table 1. For NSE index (sample January 2000 to September 2018). The time plots which is the first step to examine hidden characteristic reveals non-stationarity, patterns and clustered volatility.

INDEX	MIN	MEDIAN	MEAN
NSE	1.00	96.50	96.40
MAX	SKEWNESS	KURTOSIS	SHAPIRO-WILK TEST
191.00	-0.00763	-3.2260	0.9538

Descriptive statistics for Returns the skewness is negatively skewed and also exist negative kurtosis which indicate anomalous distribution. Shapiro-Wilk test indicate non normality. Out of the 18 models in consideration, EGARCH-GLBST(1,1) was the best, followed by APARCH-GLBST(1,1) and EGAS models, in terms of the AIC values (7.856,7.988 and 9.984).The forecast evaluation criteria (RMSE, AMAPE), EGARCH-GLBST(1,1) model also ranked best (RMSE =0.281, AMAPE = 0.280), followed by APARCH-GLBST(1,1) model (RMSE = 0.291, AMAPE = 0.290) and EGAS model (RMSE = 0.309, AMAPE = 0.301). The least performing in terms of forecasts was the GARCH(1,1)-Normal model.

4. Discussion and Conclusion

Mixture innovations of GARCH models best explained Nigeria Stock volatilities. The forecasting we obtain are evaluated using Root Mean Square Error (RMSE) and Mean Absolute Percentage Error (MAPE) predicting 24 steps ahead. The forecasting is reported by ranking the different models with respect to RMSE and MAPE for NSE index. The proposed volatility models with mixture error innovations outperformed conventional models in terms of fitness of conditional volatility and forecasts. The proposed models will be good alternatives for volatility modelling of symmetric and asymmetric stock returns.

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Evaluating heterogeneous forecasts for vintages of macroeconomic variables

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Abstract
There are various reasons why professional forecasters may disagree in their quotes for macroeconomic variables. One reason is that they target at different vintages of the data. We propose a novel method to test forecast bias in case of such heterogeneity. The method is based on Symbolic Regression, where the variables of interest become interval variables. We associate the interval containing the vintages of data with the intervals of the forecasts. An illustration to 18 years of forecasts for annual USA real GDP growth, given by the Consensus Economics forecasters, shows the relevance of the method.

Keywords
Forecast bias; Data revisions; Interval data; Symbolic regression
JEL Code: C53

Introduction and motivation

This paper is all about the well-known Mincer Zarnowitz (1969)(MZ) auxiliary regression, which is often used to examine (the absence of) bias in forecasts. This regression, in general terms, reads as

$$Realization = \beta_0 + \beta_1 Forecast + \varepsilon$$

Usually, the statistical test of interest concerns, $\beta_0 = 0$ and $\beta_1 = 1$, jointly. The setting in this paper concerns macroeconomic variables. For many such variables it holds that these experience revisions. For variables like real Gross Domestic Growth (GDP), after the first release, there can be at least five revisions for various OECD countries[1].

The second feature of our setting is that forecasts are often created by a range of professional forecasters. In the present paper for example we will consider the forecasters collected in Consensus Economics[2].

[1] http://www.oecd.org/sdd/na/revisions-of-quarterly-gdp-in-selected-oecd-countries.htm
[2] http://www.consensuseconomics.com/. Other professional forecasters' quotes can be found in the Survey of Professional Forecasters: https://www.philadelphiafed.org/research-and-data/real-time-center/real-time-data/data-files/routput

To evaluate the quality of the forecasts from these forecasters, one often takes the average quote (the consensus) or the median quote, and sometimes also measures of dispersion like the standard deviation or the variance are considered. The latter measures give an indication to what extent the forecasters disagree. Recent relevant studies are Capistran and Timmermann (2009), Dovern, Fritsche, and Slacalek (2012), Lahiri and Sheng (2010), Laster, Bennett, and Geoum (1999), and Legerstee and Franses (2015). Reasons for disagreement could be heterogeneity across forecasters caused by their differing reactions to news or noise, see Patton and Timmermann (2007), Engelberg, Manski and Williams (2009), and Clements (2010).

Recently, Clements (2017) suggested that there might be another reason why forecasters disagree, and that is, that they may target at different vintages of the macroeconomic data. Some may be concerned with the first (flash) quote, while others may have the final (say, after 5 years) value in mind. The problem however is that the analyst does not know who is doing what.

The question then becomes how one should deal with the MZ regression. Of course, one can run the regression for each vintage on the mean of the forecasts. But then still, without knowing who is targeting what, it shall be difficult to interpret the estimated parameters in the MZ regression. At the same time, why should one want to reduce or remove heterogeneity by only looking at the mean?

To alleviate these issues, in this paper we propose to keep intact the heterogeneity of the realized values of the macroeconomic variables as well as the unknown heterogeneity across the quotes of the professional forecasters. Our proposal relies on the notion to move away from scalar measurements to interval measurements. Such data are typically called symbolic data, see for example Bertrand and Goupil (1999) and Billard and Diday (2007). The MZ regression for such symbolic data thus becomes a so-called Symbolic Regression.

The outline of our paper is as follows. In the next section we provide more details about the setting of interest. For ease of reading, we will regularly refer to our illustration for annual USA real growth rates, but the material in this section can be translated to a much wider range of applications. The following section deals with the estimation methodology for the Symbolic Regression. We will also run various simulation experiments to examine the reliability of the methods. Next, we will apply the novel MZ Symbolic Regression to the USA growth rates data and compare the outcomes with what one would have obtained if specific vintages were considered. It appears that the Symbolic MZ Regression is much more informative. The final section deals with a conclusion, limitations, and further research issues.

Setting

Consider the I vintages of data for a macroeconomic variable y_t^i, where $i = 1,2,..,I$ and $t = 1,2,\ldots,T$. In our illustration below we will have $I = 7$ and $t = 1996, 1997, \ldots., 2013$, so $T = 18$.

Professional forecasters, like the ones united in Consensus Economics forecasts, give quotes during the months m, where $m = 1,2,\ldots,M$. For the Consensus Economics forecasters $M = 24$, and the months span January in year t-1, February in year t-1, ..., December in year t-1, January in year t, until and including December in year t. An example of the data appears in Table 1, where the quotes are presented for May 13, 2013, for the years 2013 and 2014. The forecasts can be denoted as

$$\hat{y}_{j,t|m} \text{ with } j = 1,2,\ldots,J_{t,m}$$

The number of forecasters can change per month and per forecast target, hence we write $J_{t,m}$. In Table 1 this number is 29. For 2013, and in our notation, Table 1 considers $J_{2013,5}$ and for 2014 it is $J_{2014,17}$.

A key issue to bear in mind for later, and as indicated in the previous section, is that we do *not* observe

$$\hat{y}_{j,t|m}^i \text{ with } j = 1,2,\ldots,J_{t,m} \ ,$$

that is, we do not know who of the forecasters is targeting which vintages of the data.

To run a Mincer Zarnowitz (MZ) regression, the forecasts per month are usually summarized by taking the median, by using a variance measure, or by the mean ("the consensus"), that is, by considering

$$\hat{y}_{t,m} = \frac{1}{J_{t,m}} \sum_{j=1}^{J_{t,m}} \hat{y}_{j,t|m}$$

The MZ regression then considered in practice is

$$y_t^i = \beta_0 + \beta_1 \hat{y}_{t,m} + \varepsilon_t$$

for $t = 1,2,\ldots,T$, and this regression can be run for each $m = 1,2,\ldots,M$. Under the usual assumptions, parameter estimation can be done by Ordinary Least Squares. Next, one computes the Wald test for the joint null hypothesis $\beta_0 = 0, \beta_1 = 1$.

Now, one can run this MZ test for each vintage of the data, but then still it is unknown what the estimated parameters in the MZ regression actually reflect. Therefore, we propose an alternative approach. We propose to consider, for $t = 1,2,\ldots,T$, the interval

$$(\min_i y_t^i;\ \max_i y_t^i)$$

as the dependent variable, instead of y_t^i, and to consider

$$(\min_j \hat{y}_{j,t|m};\ \max_j \hat{y}_{j,t|m})$$

as the explanatory variable, instead of $\hat{y}_{t,m}$. These two new variables are intervals, and often they are called symbolic variables. The MZ regression thus also becomes a so-called Symbolic Regression, see Bertrand and Goupil (1999), Billard and Diday (2000, 2003, 2007).

Table 2 presents an exemplary dataset for May in year *t*, so *m* = 17. Figure 1 visualizes the same data in a scatter diagram. Clearly, instead of points in the simple regression case, the data can now be represented as rectangles.

How does Symbolic Regression work?

When we denote the dependent variable for short as y and the dependent variable as x, we can compute for the Symbolic MZ Regression

$$\hat{\beta}_1 = \frac{Covariance(y,x)}{Variance(x)}$$

and

$$\hat{\beta}_0 = \bar{y} - \hat{\beta}_1 \bar{x}$$

there by drawing on the familiar OLS formulae.

Under the assumption that the data are uniformly distributed in the intervals, Billard and Diday (2000) derive the following results. At first, the averages are

$$\bar{y} = \frac{1}{2T}\sum_t (\max_i y_t^i + \min_i y_t^i)$$

and

$$\bar{x} = \frac{1}{2T}\sum_t (\max_j \hat{y}_{j,t|m} + \min_j \hat{y}_{j,t|m})$$

The covariance is computed as

$$Covariance(y,x)$$

$$= \frac{1}{4T}\sum_t (\max_i y_t^i + \min_i y_t^i)(\max_j \hat{y}_{j,t|m} + \min_j \hat{y}_{j,t|m})$$

$$- \frac{1}{4T^2}\left[\sum_t (\max_i y_t^i + \min_i y_t^i)\right]\left[\sum_t (\max_j \hat{y}_{j,t|m} + \min_j \hat{y}_{j,t|m})\right]$$

Finally, the variance is computed as

$$Variance(x) = \frac{1}{4T}\sum_t (\max_j \hat{y}_{j,t|m} + \min_j \hat{y}_{j,t|m})^2 - \frac{1}{4T^2}\left[\sum_t (\max_j \hat{y}_{j,t|m} + \min_j \hat{y}_{j,t|m})\right]^2$$

This expression completes the relevant components to estimate the parameters.

Standard errors

To compute standard errors around the thus obtained parameter estimates $\hat{\beta}_0$ and $\hat{\beta}_1$, we resort to the bootstrap. By collecting T random draws of pairs of intervals, with replacement, and by repeating this B times, we compute the bootstrapped standard errors. Together, they are used to compute the joint Wald test for the null hypothesis that $\beta_0 = 0, \beta_1 = 1$.

Simulations

To learn how Symbolic Regression and the bootstrapping of standard errors works, we run some simulation experiments. To save notation, we take as the Data Generating Process (DGP)

$$y_i = \alpha + \beta x_i + \varepsilon_i$$

for $i = 1,2, \ldots, N$. We set $x_i \sim N(0,1)$ and $\varepsilon_i \sim N(0, \sigma_\varepsilon^2)$. Next, we translate the thus generated y_i and x_i to intervals by creating

$$(y_i - |z_{1,i}|;\ y_i + |z_{2,i}|)$$

$$(x_i - |w_{1,i}|;\ x_i + |w_{2,i}|)$$

where

$$z_{j,i} \sim N(0, \sigma_z^2),\ \ j = 1,2$$

$$w_{j,i} \sim N(0, \sigma_w^2),\ \ j = 1,2$$

We set the number of simulation runs at 1000, and the number of bootstrap runs at B = 2000 (as suggested to be a reasonable number in Efron and Tibshirani, 1993). Experimentation with larger values of B did not show markedly different outcomes. The code is written in Python. We set N at 20 and 100, while $\alpha = 0$ or 5, and $\beta = -2$, or 0, or 2.

The results are in Tables 3 to 6. Table 3 shows that when we compare the cases where $\sigma_w^2 = 0.5$ versus $\sigma_w^2 = 2.0$ that a larger interval of the explanatory variable creates more bias than a larger interval for the dependent variable (compare $\sigma_z^2 = 0.5$ versus $\sigma_z^2 = 2.0$). Also, the bootstrapped standard errors get larger when the intervals of the data get wider, as expected.

Table 4 is the same as Table 3, but now $\sigma_\varepsilon^2 = 0.5$ is replaced by $\sigma_\varepsilon^2 = 2.0$. Overall this means that $\hat{\beta}$ deviates more from β when the variance σ_ε^2 increases. The differences across the deviations of $\hat{\alpha}$ versus α are relatively small.

Table 5 is the same as Table 3, but now $N = 20$ is replaced by $N = 100$. Clearly, a larger sample size entails less bias in the estimates, and also much smaller bootstrapped standard errors. But still, we see that $\hat{\alpha}$ is closer to α then is $\hat{\beta}$ to β.

Table 6 is similar to Table 4, but now for $N = 100$. A larger sample can offset the effects of increased variance σ_ε^2, as the standard errors are reasonably small.

Analysis of forecasts

We now turn to an illustration of the Symbolic MZ regression. We choose to consider the forecasts for annual growth rates of real GDP in the USA, for the years 1996 to and including 2013. This makes $T = 18$. Our data source[3] gives annual growth rates per quarter. As there are no vintages of true annual growth data available, we decide to further consider the averages of each time these four quarterly growth rates. The data intervals are presented in Table 2. The right-hand side columns of Table 2 concern the forecasts created in May of year *t*, which means the case where $m = 17$. This implies that we can consider 24 Symbolic MZ regressions, each for each of the 24 months.

Table 7 presents the estimation results, the bootstrapped standard errors and the p value of the Wald test for the null hypothesis that $\beta_0 = 0, \beta_1 = 1$. We see from the last column that a p value > 0.05 appears for the forecasts quoted in May in year *t*-1, and that after that the p value stays in excess of 0.05. However, if we look at the individual parameter estimates, we see that $\beta_1 = 0$ is with the 95% confidence interval until September, year *t*-1. So, Table 7 basically tells us that unbiased forecasts seem to appear from October, year *t*-1 onwards.

Let us now turn to the MZ regression in its standard format, that is, the explanatory variable is the mean of the forecasts and the variable to be explained in one of the vintages of the data. Table 8 presents the results for the first (flash) release real GDP annual growth rates, whereas Table 9 presents the results for the currently available vintage. We also have the results of all vintages in between, but these do not add much to the conclusions that can be drawn from Tables 8 and 9.

First, we see that the standard errors in Table 8 and 9 are much smaller than the bootstrapped standard errors for the Symbolic MZ Regression. This of course does not come as a surprise as we have point data instead of intervals. For the first vintage of data in Table 8, we see from the p values for the Wald test in the last column that only since March, year *t*, the null hypothesis of no bias can be rejected (p value is 0.485). One month earlier, the p value is 0.071, but for that month we see that $\beta_1 = 1$ is not in 95% confidence interval (0.787 with a SE of 0.098). Note by the way that the forecasts created

[3] http://www.oecd.org/sdd/na/revisions-of-quarterly-gdp-in-selected-oecd-countries.htm

in the very last month of the current year (December, year *t*) are biased (p value of 0.012), at least for the first release data.

Table 9 delivers quite intriguing results for the forecasts concerning the most recent vintage of data. The p value of the Wald test becomes > 0.05 (that is, 0.083) for the quotes in May, year *t*, but note that $\beta_1 = 1$ is not in 95% confidence interval for 23 of the 24 months. Only for the forecasts in December, year *t*, the forecasts do not seem biased (p value of 0.115, and $\beta_1 = 1$ is in the 95% confidence interval (0.820 with SE of 0.088).

In sum, it seems that individual MZ regressions for vintages of data deliver confusing outcomes, which seem hard to interpret. Let alone that we effectively do not know who of the forecasters is targeting at which vintage. Moreover, it seems that outcomes of the Symbolic MZ Regression are much more coherent and straightforward to interpret. Of course, due to the very nature of the data, that is, intervals versus points, statistical precision in the Symbolic Regression is smaller, but the results seem to have much more face value and interpretability than the standard MZ regressions.

Conclusion and discussion

Forecasts created by professional forecasters can show substantial dispersion. Such dispersion can change over time, but can also concern the forecast horizon. The relevant literature has suggested various sources for dispersion. A recent contribution to this literature by Clements (2017) adds another potential source of heterogeneity, and this is that forecasters may target different vintages of the macroeconomic data. Naturally, the link between targets and forecasts is unknown to the analyst.

To alleviate this problem, we proposed an alternative version of the Mincer Zarnowitz(MZ) regression to examine forecast bias. This version adopts the notion that the vintages of the macroeconomic data can perhaps best be interpreted as interval data, where at the same time, the forecasts also have upper and lower bounds. Taking the data as intervals makes the standard MZ regression a so-called Symbolic MZ Regression. Simulations showed that reliable inference can be drawn from this auxiliary regression. An illustration for annual USA GDP growth rates showed its merits.

A limitation to the interval-based data analysis is the potential size of the intervals. More dispersion leads to less precision, and statistical inference becomes less reliable. Also, the sample size for a Symbolic Regression should be quite substantial, again for reliability. This might hamper its use for some variables and sample sizes in macroeconomics.

Further applications of the new regression should shine light on its practical usefulness. The method does have conceptual and face validity, but more experience with data and forecasts for more variables related to more countries should provide more credibility.

Figure 1: The intervals of Table 2.

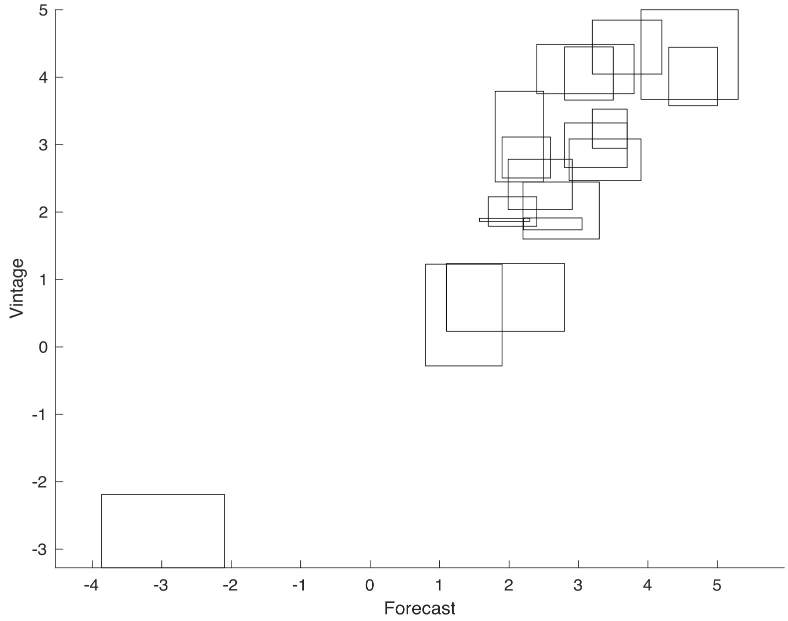

Table 1: An example of the data

Survey Date: May 13, 2013	**Gross Domestic Product** *real, % change* **2013**	**2014**
Consensus (Mean)	1,932	2,702
High	2,300	3,380
Low	1,572	2,007
Standard Deviation	0,159	0,319
Number of Forecasts	29	29
UBS	2,300	3,000
American Int'l Group	2,200	2,600
First Trust Advisors	2,200	3,000
Ford Motor Company	2,172	2,996
Morgan Stanley	2,100	2,500
Eaton Corporation	2,053	2,887
Action Economics	2,000	2,800
RDQ Economics	2,000	2,600
General Motors	1,960	2,968

Goldman Sachs	1,959	2,914
Swiss Re	1,953	3,220
Macroeconomic Advisers	1,941	2,968
Moody's Analytics	1,940	3,380
Northern Trust	1,906	2,722
Citigroup	1,900	2,800
DuPont	1,900	3,000
Fannie Mae	1,900	2,500
Inforum - Univ of Maryland	1,900	2,600
Wells Capital Mgmt	1,900	2,600
Univ of Michigan - RSQE	1,880	2,735
Credit Suisse	1,868	2,300
PNC Financial Services	1,846	2,398
Nat Assn of Home Builders	1,843	2,622
IHS Global Insight	1,841	2,799
Barclays Capital	1,803	2,272
Wells Fargo	1,800	2,100
Bank of America - Merrill	1,756	2,684
The Conference Board	1,643	2,374
Georgia State University	1,572	2,007

Table 2: Forecasts and vintages as symbolic data. For the years 1996 to 2013 there are 7 vintages of quotes. For the month May in year t there are in between 20 to 30 forecasts. The data in this table are the lower and upper bounds of the intervals of these observations. The data are rounded (at two decimal places) for expository purposes.

	Vintages of real GDP growth		Forecasts
	Lower bound	Upper bound	Lower bound
Year			
1996	2.45	3.79	1.80
1997	3.76	4.49	2.40
1998	3.66	4.45	2.80
1999	4.05	4.85	3.20
2000	3.67	5.00	3.90
2001	0.23	1.24	1.10
2002	1.60	2.45	2.20
2003	2.51	3.11	1.90
2004	3.58	4.44	4.30
2005	2.95	3.53	3.20
2006	2.66	3.32	2.80
2007	1.79	2.23	1.70
2008	-0.28	1.23	0.80
2009	-3.28	-2.19	-3.87
2010	2.47	3.08	2.86
2011	1.74	1.91	2.21
2012	2.04	2.78	1.99
2013	1.86	1.91	1.57

Table 3: Simulation experiments for the case where $N = 20$ and $\sigma_\varepsilon^2 = 0.5$. The cells are average estimates of the parameters and associated standard errors (SE) across 1000 replications.

α	β	σ_z^2	σ_w^2	$\hat{\alpha}$ (SE)	$\hat{\beta}$ (SE)

0	-2	0.5	0.5	-0.008	(0.269)	-1.843	(0.168)
0	-2	0.5	2.0	-0.006	(0.317)	-1.581	(0.206)
0	-2	2.0	0.5	-0.011	(0.295)	-1.912	(0.207)
0	-2	2.0	2.0	-0.008	(0.350)	-1.631	(0.248)
0	0	0.5	0.5	-0.010	(0.210)	-0.014	(0.133)
0	0	0.5	2.0	-0.009	(0.216)	0.029	(0.126)
0	0	2.0	0.5	-0.012	(0.256)	-0.083	(0.179)
0	0	2.0	2.0	-0.012	(0.246)	-0.022	(0.171)
0	2	0.5	0.5	-0.011	(0.191)	1.814	(0.128)
0	2	0.5	2.0	-0.013	(0.199)	1.639	(0.137)
0	2	2.0	0.5	-0.014	(0.223)	1.745	(0.159)
0	2	2.0	2.0	-0.015	(0.227)	1.588	(0.164)
5	-2	0.5	0.5	4.992	(0.269)	-1.843	(0.178)
5	-2	0.5	2.0	4.994	(0.318)	-1.581	(0.198)
5	-2	2.0	0.5	4.989	(0.299)	-1.912	(0.210)
5	-2	2.0	2.0	4.991	(0.358)	-1.631	(0.250)
5	0	0.5	0.5	4.990	(0.261)	-0.014	(0.132)
5	0	0.5	2.0	4.991	(0.213)	0.029	(0.122)
5	0	2.0	0.5	4.988	(0.250)	-0.083	(0.171)
5	0	2.0	2.0	4.988	(0.253)	-0.022	(0.167)
5	2	0.5	0.5	4.989	(0.199)	1.814	(0.127)
5	2	0.5	2.0	4.987	(0.208)	1.639	(0.135)
5	2	2.0	0.5	4.986	(0.226)	1.745	(0.166)
5	2	2.0	2.0	4.985	(0.221)	1.588	(0.156)

Table 4: Simulation experiments for the case where $N = 20$ and $\sigma_\varepsilon^2 = 2.0$. The cells are average estimates of the parameters and associated standard errors (SE) across 1000 replications.

α	β	σ_z^2	σ_w^2	$\hat{\alpha}$ (SE)		$\hat{\beta}$ (SE)	
0	-2	0.5	0.5	-0.015	(0.464)	-1.788	(0.260)
0	-2	0.5	2.0	-0.013	(0.494)	-1.502	(0.288)
0	-2	2.0	0.5	-0.017	(0.463)	-1.857	(0.291)
0	-2	2.0	2.0	-0.015	(0.516)	-1.552	(0.326)
0	0	0.5	0.5	-0.016	(0.407)	0.040	(0.244)
0	0	0.5	2.0	-0.016	(0.407)	0.108	(0.208)
0	0	2.0	0.5	-0.019	(0.426)	-0.029	(0.273)
0	0	2.0	2.0	-0.019	(0.427)	0.058	(0.254)
0	2	0.5	0.5	-0.018	(0.382)	1.868	(0.224)
0	2	0.5	2.0	-0.020	(0.375)	1.718	(0.208)
0	2	2.0	0.5	-0.021	(0.406)	1.800	(0.257)
0	2	2.0	2.0	-0.022	(0.395)	1.667	(0.232)
5	-2	0.5	0.5	4.985	(0.462)	-1.788	(0.265)
5	-2	0.5	2.0	4.988	(0.490)	-1.502	(0.287)
5	-2	2.0	0.5	4.983	(0.468)	-1.857	(0.287)
5	-2	2.0	2.0	4.985	(0.500)	-1.552	(0.319)
5	0	0.5	0.5	4.984	(0.411)	0.040	(0.234)
5	0	0.5	2.0	4.984	(0.408)	0.108	(0.226)
5	0	2.0	0.5	4.981	(0.448)	-0.029	(0.272)
5	0	2.0	2.0	4.982	(0.420)	0.058	(0.243)
5	2	0.5	0.5	4.982	(0.393)	1.868	(0.225)

5	2	0.5	2.0	4.980	(0.378)	1.718	(0.210)
5	2	2.0	0.5	4.979	(0.385)	1.800	(0.250)
5	2	2.0	2.0	4.978	(0.387)	1.667	(0.229)

Table 5: Simulation experiments for the case where $N = 100$ and $\sigma_\varepsilon^2 = 0.5$. The cells are average estimates of the parameters and associated standard errors (SE) across 1000 replications.

α	β	σ_z^2	σ_w^2	$\hat{\alpha}$ (SE)		$\hat{\beta}$ (SE)	
0	-2	0.5	0.5	0.000	(0.093)	-1.878	(0.080)
0	-2	0.5	2.0	-0.000	(0.120)	-1.589	(0.095)
0	-2	2.0	0.5	-0.000	(0.114)	-1.866	(0.110)
0	-2	2.0	2.0	-0.001	(0.132)	-1.580	(0.115)
0	0	0.5	0.5	0.001	(0.088)	-0.036	(0.075)
0	0	0.5	2.0	0.001	(0.086)	-0.048	(0.068)
0	0	2.0	0.5	0.001	(0.109)	-0.024	(0.106)
0	0	2.0	2.0	0.001	(0.105)	-0.040	(0.097)
0	2	0.5	0.5	0.002	(0.110)	1.806	(0.094)
0	2	0.5	2.0	0.003	(0.138)	1.493	(0.117)
0	2	2.0	0.5	0.002	(0.128)	1.818	(0.118)
0	2	2.0	2.0	0.002	(0.149)	1.501	(0.140)
5	-2	0.5	0.5	5.000	(0.095)	-1.878	(0.082)
5	-2	0.5	2.0	5.000	(0.120)	-1.589	(0.097)
5	-2	2.0	0.5	5.000	(0.114)	-1.866	(0.111)
5	-2	2.0	2.0	5.000	(0.139)	-1.580	(0.112)
5	0	0.5	0.5	5.001	(0.086)	-0.036	(0.077)
5	0	0.5	2.0	5.001	(0.088)	-0.048	(0.070)
5	0	2.0	0.5	5.001	(0.107)	-0.024	(0.105)
5	0	2.0	2.0	5.001	(0.107)	-0.040	(0.094)
5	2	0.5	0.5	5.002	(0.108)	1.806	(0.093)
5	2	0.5	2.0	5.003	(0.138)	1.493	(0.120)
5	2	2.0	0.5	5.002	(0.127)	1.818	(0.116)
5	2	2.0	2.0	5.002	(0.149)	1.501	(0.143)

Table 6: Simulation experiments for the case where $N = 100$ and $\sigma_\varepsilon^2 = 2.0$. The cells are average estimates of the parameters and associated standard errors (SE) across 1000 replications.

α	β	σ_z^2	σ_w^2	$\hat{\alpha}$ (SE)		$\hat{\beta}$ (SE)	
0	-2	0.5	0.5	0.002	(0.161)	-1.926	(0.129)
0	-2	0.5	2.0	0.001	(0.176)	-1.645	(0.131)
0	-2	2.0	0.5	0.001	(0.174)	-1.914	(0.146)
0	-2	2.0	2.0	0.001	(0.183)	-1.637	(0.139)
0	0	0.5	0.5	0.003	(0.158)	-0.084	(0.131)
0	0	0.5	2.0	0.003	(0.156)	-0.104	(0.119)
0	0	2.0	0.5	0.002	(0.177)	-0.072	(0.146)
0	0	2.0	2.0	0.002	(0.174)	-0.096	(0.137)
0	2	0.5	0.5	0.004	(0.180)	1.758	(0.146)
0	2	0.5	2.0	0.004	(0.200)	1.436	(0.158)

0	2	2.0	0.5	0.003	(0.190)	1.770	(0.164)
0	2	2.0	2.0	0.004	(0.210)	1.444	(0.174)
5	-2	0.5	0.5	5.002	(0.158)	-1.926	(0.126)
5	-2	0.5	2.0	5.001	(0.175)	-1.914	(0.128)
5	-2	2.0	0.5	5.001	(0.175)	-1.914	(0.148)
5	-2	2.0	2.0	5.001	(0.190)	-1.637	(0.141)
5	0	0.5	0.5	5.003	(0.161)	-0.084	(0.129)
5	0	0.5	2.0	5.003	(0.162)	-0.104	(0.122)
5	0	2.0	0.5	5.002	(0.175)	-0.072	(0.153)
5	0	2.0	2.0	5.002	(0.175)	-0.096	(0.141)
5	2	0.5	0.5	5.004	(0.176)	1.758	(0.148)
5	2	0.5	2.0	5.004	(0.197)	1.436	(0.161)
5	2	2.0	0.5	5.003	(0.191)	1.770	(0.165)
5	2	2.0	2.0	5.004	(0.211)	1.444	(0.185)

Table 7: Symbolic regression results. Bootstrapped standard errors are in parentheses.

Forecast origin	**ß$_0$**		**ß$_1$**		**p value Wald test**
January, year *t*-1	2.879	(2.448)	-0.141	(0.762)	0.032
February, year *t*-1	3.041	(2.014)	-0.206	(0.648)	0.028
March, year *t*-1	2.689	(2.122)	-0.080	(0.658)	0.021
April, year *t*-1	2.683	(2.090)	-0.076	(0.659)	0.033
May, year *t*-1	2.147	(2.231)	0.118	(0.734)	0.055
June, year *t*-1	1.773	(2.485)	0.250	(0.786)	0.108
July, year *t*-1	0.649	(2.927)	0.655	(0.956)	0.394
August, year *t*-1	-0.104	(2.640)	0.941	(0.893)	0.703
September, year *t*-1	0.554	(2.682)	0.703	(0.959)	0.749
October, year *t*-1	-0.459	(1.417)	1.148	(0.502)	0.944
November, year *t*-1	-0.412	(1.395)	1.156	(0.501)	0.951
December, year *t*-1	-0.324	(0.889)	1.131	(0.318)	0.915
January, year *t*	-0.000	(0.812)	0.999	(0.269)	1.000
February, year *t*	-0.167	(0.559)	1.043	(0.188)	0.951
March, year *t*	0.052	(0.429)	0.987	(0.146)	0.992
April, year *t*	-0.087	(0.420)	1.016	(0.141)	0.966
May, year *t*	-0.009	(0.403)	0.976	(0.130)	0.880
June, year *t*	-0.075	(0.386)	0.990	(0.127)	0.789
July, year *t*	-0.142	(0.331)	1.025	(0.106)	0.856
August, year *t*	-0.068	(0.332)	1.011	(0.118)	0.956
September, year *t*	-0.077	(0.317)	1.000	(0.107)	0.855
October, year *t*	-0.057	(0.291)	1.011	(0.109)	0.965
November, year *t*	-0.095	(0.276)	1.024	(0.105)	0.923
December, year *t*	-0.087	(0.219)	1.006	(0.081)	0.760

Table 8: MZ results, based on the consensus forecasts, first release data. Standard errors are in parentheses.

Forecast origin	**ß$_0$**		**ß$_1$**		**p value Wald test**
January, year *t*-1	2.969	(0.258)	-0.028	(0.085)	0.000
February, year *t*-1	2.898	(0.276)	-0.024	(0.092)	0.000
March, year *t*-1	2.809	(0.293)	0.002	(0.097)	0.000

April, year *t*-1	2.708	(0.288)	0.028	(0.096)	0.000
May, year *t*-1	2.625	(0.283)	0.058	(0.094)	0.000
June, year *t*-1	2.533	(0.276)	0.090	(0.092)	0.000
July, year *t*-1	2.389	(0.266)	0.141	(0.088)	0.000
August, year *t*-1	2.271	(0.244)	0.163	(0.081)	0.000
September, year *t*-1	2.178	(0.258)	0.187	(0.086)	0.000
October, year *t*-1	1.558	(0.331)	0.363	(0.110)	0.000
November, year *t*-1	1.229	(0.361)	0.466	(0.120)	0.000
December, year *t*-1	0.900	(0.350)	0.592	(0.116)	0.014
January, year *t*	0.729	(0.361)	0.675	(0.120)	0.021
February, year *t*	0.441	(0.295)	0.787	(0.098)	0.071
March, year *t*	0.101	(0.284)	0.916	(0.094)	0.485
April, year *t*	0.101	(0.247)	0.937	(0.082)	0.661
May, year *t*	0.009	(0.212)	0.997	(0.070)	0.999
June, year *t*	0.009	(0.182)	1.002	(0.061)	0.986
July, year *t*	0.034	(0.162)	0.988	(0.054)	0.974
August, year *t*	-0.114	(0.141)	1.013	(0.047)	0.519
September, year *t*	-0.082	(0.124)	1.008	(0.041)	0.621
October, year *t*	-0.175	(0.085)	1.035	(0.028)	0.073
November, year *t*	-0.141	(0.067)	1.033	(0.022)	0.089
December, year *t*	-0.160	(0.055)	1.051	(0.018)	0.012

Table 9: MZ results, based on the consensus forecasts, most recent released data (computed: September 2018). Standard errors are in parentheses.

Forecast origin	**β_0**		**β_1**		**p value Wald test**
January, year *t*-1	3.046	(0.219)	-0.059	(0.071)	0.000
February, year *t*-1	2.983	(0.236)	-0.060	(0.076)	0.000
March, year *t*-1	2.910	(0.253)	-0.039	(0.082)	0.000
April, year *t*-1	2.811	(0.251)	-0.012	(0.081)	0.000
May, year *t*-1	2.737	(0.248)	0.015	(0.080)	0.000
June, year *t*-1	2.674	(0.245)	0.036	(0.079)	0.000
July, year *t*-1	2.566	(0.241)	0.075	(0.078)	0.000
August, year *t*-1	2.470	(0.227)	0.089	(0.074)	0.000
September, year *t*-1	2.390	(0.241)	0.109	(0.078)	0.000
October, year *t*-1	1.858	(0.316)	0.256	(0.102)	0.000
November, year *t*-1	1.587	(0.349)	0.341	(0.113)	0.000
December, year *t*-1	1.331	(0.355)	0.442	(0.115)	0.000
January, year *t*	1.208	(0.373)	0.509	(0.121)	0.000
February, year *t*	1.007	(0.351)	0.590	(0.114)	0.002
March, year *t*	0.760	(0.372)	0.687	(0.121)	0.035
April, year *t*	0.766	(0.353)	0.707	(0.114)	0.037
May, year *t*	0.684	(0.333)	0.765	(0.108)	0.083
June, year *t*	0.691	(0.323)	0.768	(0.105)	0.072
July, year *t*	0.700	(0.307)	0.759	(0.098)	0.046
August, year *t*	0.576	(0.310)	0.776	(0.101)	0.083
September, year *t*	0.602	(0.302)	0.773	(0.098)	0.066
October, year *t*	0.516	(0.291)	0.799	(0.094)	0.102
November, year *t*	0.535	(0.278)	0.802	(0.090)	0.087
December, year *t*	0.516	(0.272)	0.820	(0.088)	0.115

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General Class of Ratio-cum-Product Estimators in Two-Phase Sampling using Multi-Auxiliary Variables

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Abstract
The generalised mixed ratio-cum-product estimators in Two-phase sampling has been developed and recommended using multi-auxiliary variables for Full Information Case (FIC), Partial Information Case I (PICI) and No Information Case (NIC) estimators. The PIC-I did not consider all the necessary conditions for using multi-auxiliary variables available in the population. Hence, this study has developed two PIC (PIC-II and PICIII) estimators which satisfied other conditions for any PIC estimator in the considered mixed estimator. Theoretical comparison established that the proposed PIC-II and PIC-III estimators are asymptotically efficient than PIC-I estimator. Similarly, the empirical analysis and comparison for thirty three simulated populations, following normal distribution, confirmed the asymptotic efficiency of the proposed estimators. The proposed estimators were recommended not as substitute to the reviewed PIC-I estimator but as compliment, subject to the confirmation of the conditions of usage. The special case estimators were developed based on the settings of the unknown constants in the proposed estimators.

Keywords
Ratio-cum-product estimators; Multi-auxiliary variables; Two-phase sampling; Partial information case

1. Introduction

The incorporation of auxiliary variables in the estimation of the population parameter has, over the years, proved to be efficient and reliable. Graunt (1662) seems to be the first author to implement auxiliary information in the estimation of English population (human population estimation). High correlation coefficient between the study variable and the auxiliary variable is a significant factor that is necessary in maximizing the advantages of auxiliary variables. Different estimation methods have been developed by samplers that use auxiliary variables for efficient estimator. Cochran (1940) developed ratio estimator in single phase sampling. The presence of positive and high correlation coefficient between the study and auxiliary variables is a primary requirement for the use of ratio estimator. Robson (1957) proposed the product estimator in single phase sampling. Product estimator requires the presence of negative and high correlation coefficient between the study variable and the auxiliary variables. Regression and difference estimators are other estimators that have been developed alongside with ratio and product estimators. The use of more than one auxiliary variable in the estimation of the study variable has been implemented by Raj (1965). This method is called multi-auxiliary variable in estimation. Mohanty (1967) was the first to combine two estimators (ratio and product) in single phase sampling. This method is tagged mixed estimation method. Mixed estimation method has been confirmed to improve the efficiency of any estimator. Ratio-cum-product estimator is an instance of mixed estimator. Singh (1967a) and Singh (1967b) developed ratio-cum-product estimator which proved efficient than either of ratio and product estimator. Other literatures that have discussed about ratio-cum-product estimator include Shah and Shah (1978) and Taylor and Sharma (2009).

The use of regression, ratio, product and difference estimators in single phase sampling requires that the population mean of the auxiliary variables should be known prior to the estimation of the study variable. However, when the population total of the auxiliary variable is not known in advance, Neyman (1938) has introduced two-phase sampling or double sampling to be used instead of the single phase sampling. Among samplers, the term two phase sampling has been preferred over double sampling because double sampling is a common and known term among the quality control statisticians (Keen, 2005). Two phase sampling is a sampling scheme and estimation method when it is combined with any of ratio, regression, product or difference estimator. Two phase sampling also uses mixed estimator. Choudhury and Singh (2011) has developed ratio-cum-product estimator in two phase sampling while Chanu and Singh (2014) has developed mixed ratio-cumproduct estimators considering the two cases where second-phase sampling is a dependent sample of the firstphase and the second phase sample is an independent sample of the first phase.

Kung'u and Nderitu (2016) developed improved estimators using ratio-cum-product estimation method with multi-auxiliary variables in two phase sampling. These estimators satisfied the full, no and partial information case methods of utilizing auxiliary variables (Samiuddin and Hanif, 2007). These estimators were confirmed to be efficient than either of ratio or product estimators in both single and two phase sampling with one auxiliary variable. However, the partial information case of this family estimator is subjected to the conclusion that there exists partial information about the multi-auxiliary variables, simultaneously, in both the ratio and product estimation components. This partial information case estimator has been identified to be incompatible if the data do not, simultaneously, hold partial information case for both ratio and product estimation components in the mixed estimator. This challenge has been identified by Ogunyinka and Sodipo (2017) in other estimators.

Hence, this study has improved on the partial information case by proposing two additional partial information cases (PIC-II and PIC-III) in addendum to the existing partial information case (PIC-I) in generalised ratio-cumproduct estimator in two-phase sampling as proposed by Kung'u and Nderitu (2016). Similarly, the mean square errors (MSEs) of the proposed estimators for partial information cases have been established theoretical in the subsequent sections.

2. Methodology

2.1. Notation and Assumption

Considering N as the population size and n_1 and n_2 as the first and second phase sample sizes (using simple random sampling without replacement), respectively. Where $n_1 > n_2$. Hence, presenting

$$\theta_1 = \left(\frac{1}{n_1} - \frac{1}{N}\right);\ \theta_2 = \left(\frac{1}{n_2} - \frac{1}{N}\right) \quad ;\text{for } \theta_1 < \theta_2 \qquad (1)$$

Let $x_{(1)i}$ and $x_{(2)i}$ be the *ith* auxiliary variable at the first and second phase sampling, respectively and y_2 be the study variable at the second phase sampling.

2.2. Ratio-cum-Product Estimator in Two-phase Sampling

Kung'u and Nderitu (2016) has developed the ratio-cum-product estimator in Full Information Case (FIC) estimator as

$$Q_1 = \bar{y}_2 * \prod_{i=1}^{k}\left(\frac{\bar{X}_i}{\bar{x}_{(2)_i}}\right)^{\alpha_i} \prod_{j=k+1}^{p}\left(\frac{\bar{x}_{(2)_j}}{\bar{X}_j}\right)^{\beta_j}$$

The corresponding Mean Square Error (MSE) is presented as

$$MSE(Q_1)_{min} \cong \theta_2 \bar{Y}^2 C_y^2 \left(1 - \rho_{y\underset{\smile}{x}_p}^2\right)$$

The No Information Case (NIC) estimator was presented as:

$$Q_2 = \bar{y}_2 * \prod_{i=1}^{k}\left(\frac{\bar{x}_{(1)_i}}{\bar{x}_{(2)_i}}\right)^{\alpha_i} \prod_{j=k+1}^{p}\left(\frac{\bar{x}_{(2)_j}}{\bar{x}_{(1)_i}}\right)^{\beta_j}$$

The corresponding Mean Square Error (MSE) was given as

$$MSE(Q_2)_{min} \cong \bar{Y}^2 C_y^2 \left[\theta_2\left(1 - \rho_{y\underset{\smile}{x}_p}^2\right) + \theta_1 \rho_{y\underset{\smile}{x}_p}^2\right]$$

The Partial Information Case I (PIC-I) estimator was, also presented as:

$$Q_3 = \bar{y}_2 \left[\prod_{i=1}^{r} \left(\frac{\bar{x}_{(1)_i}}{\bar{x}_{(2)_i}}\right)^{\alpha_i} \left(\frac{\bar{X}_i}{\bar{x}_{(1)_i}}\right)^{\beta_i}\right] \left[\prod_{j=r+1}^{k} \left(\frac{\bar{x}_{(1)_j}}{\bar{x}_{(2)_j}}\right)^{\alpha_j}\right] \left[\prod_{m=k+1}^{h} \left(\frac{\bar{x}_{(2)_m}}{\bar{x}_{(1)_m}}\right)^{\gamma_m} \left(\frac{\bar{x}_{(1)_m}}{\bar{X}_i}\right)^{\lambda_m}\right] * \left[\prod_{n=h+1}^{p} \left(\frac{\bar{x}_{(2)_n}}{\bar{x}_{(1)_n}}\right)^{\sigma_n}\right]$$

The corresponding Mean Square Error (MSE) is further simplified as thus:

$$MSE(Q_3)_{min} \cong \bar{Y}^2 C_y^2 \left[\theta_2 \left(1 - \rho^2_{y.\underset{\smile}{x}_p}\right) + \theta_1 \left(\rho^2_{y.\underset{\smile}{x}_p} - \rho^2_{y.\underset{\smile}{x}_{r,h}}\right)\right]$$

This study has termed this estimator as Partial Information Case I (PIC-I). This is necessary in order to relate this existing estimator to the proposed estimators. However, these reviewed estimators have been confirmed to be asymptotically efficient.

2.3. Proposed Generalized Ratio-cum-Product Estimator in Two-Phase Sampling for Partial Information Case II (PIC-II):

This study proposes a partial information case for a generalized ratio-cum-product estimator using multiauxiliary variables in two phase sampling. The ratio estimation component is in full information case while the product estimation component is in partial information case. This partial information case is tagged Partial Information Case II (PIC-II) and presented as:

$$Q_4 = \bar{y}_2 \left[\prod_{i=1}^{k} \left(\frac{\bar{x}_{(1)_i}}{\bar{x}_{(2)_i}}\right)^{\alpha_i} \left(\frac{\bar{X}_i}{\bar{x}_{(1)_i}}\right)^{\beta_i}\right] \left[\prod_{m=k+1}^{h} \left(\frac{\bar{x}_{(2)_m}}{\bar{x}_{(1)_m}}\right)^{\gamma_m} \left(\frac{\bar{x}_{(1)_m}}{\bar{X}_m}\right)^{\lambda_m}\right] \left[\prod_{n=h+1}^{p} \left(\frac{\bar{x}_{(2)_n}}{\bar{x}_{(1)_n}}\right)^{\sigma_n}\right] \quad (2)$$

According to Ogunyinka and Sodipo (2017), the schema for estimator Q_4 is presented as:

$$Q_4^* = \left\{ \overbrace{\bar{y}_2 * \underbrace{\alpha_i^{+k} * \beta_{1.i}^{+k}}_{\substack{Ratio\ (FIC) \\ AV}} * \underbrace{\gamma_m^{-h} * \lambda_{1.m}^{-h} * \sigma_n^{-p}}_{\substack{Product\ (PIC) \\ AV}}}^{Ratio-cum-Product\ (PIC-II)} \right\} \quad (3)$$

Substitute the equation (1) into equation (2) yields

$$MSE(Q_4) = E_1 E_{2/1} \left[\begin{array}{c} \bar{e}_{y2} + \bar{Y} \sum_{i=1}^{k} \alpha_i \frac{\left(\bar{e}_{x(1)_i} - \bar{e}_{x(2)_i}\right)}{\bar{X}_i} - \bar{Y} \sum_{i=1}^{k} \beta_i \frac{\bar{e}_{x(1)_i}}{\bar{X}_i} - \bar{Y} \sum_{m=k+1}^{h} \gamma_m \frac{\left(\bar{e}_{x(1)_m} - \bar{e}_{x(2)_m}\right)}{\bar{X}_m} \\ + \bar{Y} \sum_{m=k+1}^{h} \lambda_m \frac{\bar{e}_{x(1)_m}}{\bar{X}_m} - \bar{Y} \sum_{n=h+1}^{p} \sigma_n \frac{\left(\bar{e}_{x(1)_n} - \bar{e}_{x(2)_n}\right)}{\bar{X}_n} \end{array} \right]^2$$

Apply Taylors series of expansion, simplification and partial differentiation to obtain the optimum value of the unknown constants

$$\alpha_i = \frac{C_y(-1)^{i+1}|R_{yx_i}|_{y\underset{\sim}{x}_k}}{C_{x_i}|R|_{\underset{\sim}{x}_k}} \quad for\ i = 1,2,\dots,k \qquad \gamma_m = \frac{-C_y(-1)^{m+1}|R_{yx_m}|_{y\underset{\sim}{x}_h}}{C_{x_m}|R|_{\underset{\sim}{x}_h}} \quad for\ m = k+1, k+2, \dots, h$$

$$\beta_i = \frac{C_y(-1)^{i+1}|R_{yx_i}|_{y\underset{\sim}{x}_k}}{C_{x_i}|R|_{\underset{\sim}{x}_k}} \quad for\ i = 1,2,\dots,k \qquad \sigma_n = \frac{-C_y(-1)^{n+1}|R_{yx_n}|_{y\underset{\sim}{x}_p}}{C_{x_n}|R|_{\underset{\sim}{x}_p}} \quad for\ n = h+1, h+2, \dots, p$$

$$\lambda_m = \frac{-C_y(-1)^{m+1}|R_{yx_m}|_{y\underset{\sim}{x}_h}}{C_{x_m}|R|_{\underset{\sim}{x}_h}} \quad for\ m = k+1, k+2, \dots, h$$

Hence, substitute the constants to obtain the minimized MSE as:

$$MSE(Q_4)_{min} \cong \overline{Y}^2 C_y^2 \left[\theta_2\left(1 - \rho^2_{y.\underset{\sim}{x}_p}\right) + \theta_1\left(\rho^2_{y.\underset{\sim}{x}_p} - \rho^2_{y.\underset{\sim}{x}_{k,h}}\right)\right] \tag{4}$$

2.4. Proposed Generalized Ratio-cum-Product Estimator in Two-Phase Sampling for Partial Information Case III (PIC-III):

This study proposes a partial information case for a generalized ratio-cum-product estimator using multiauxiliary variables in two phase sampling. The ratio estimation component is in partial information case while the product estimation component is in full information case. This partial information case is tagged Partial Information Case III (PIC-III). It is presented as:

$$Q_5 = \overline{y}_2 * \left[\prod_{i=1}^{r}\left(\frac{\bar{x}_{(1)_i}}{\bar{x}_{(2)_i}}\right)^{\alpha_i}\left(\frac{\bar{X}_i}{\bar{x}_{(1)_i}}\right)^{\beta_i}\right]\left[\prod_{j=r+1}^{k}\left(\frac{\bar{x}_{(1)_j}}{\bar{x}_{(2)_j}}\right)^{\alpha_j}\right]\left[\prod_{m=k+1}^{p}\left(\frac{\bar{x}_{(2)_m}}{\bar{x}_{(1)_m}}\right)^{\gamma_m}\left(\frac{\bar{x}_{(1)_m}}{\bar{X}_m}\right)^{\lambda_m}\right] \tag{5}$$

The schema for estimator Q_5 is presented as:

$$Q_5^* = \left\{ \overline{y}_2 * \overbrace{\underbrace{\alpha_i^{+r} * \beta_{1.i}^{+r} * \alpha_j^{+k}}_{\substack{Ratio\ (PIC)\\ AV}} * \underbrace{\gamma_m^{-p} * \lambda_{1.m}^{-p}}_{\substack{Product\ (FIC)\\ AV}}}^{Ratio-cum-Product\ (PIC-III)} \right\} \tag{6}$$

Apply Taylors series of expansion, simplification and partial differentiation to obtain the optimum value of the unknown constants. The corresponding MSE is presented as:

$$MSE(Q_5)_{min} \cong \overline{Y}^2 C_y^2 \left[\theta_2\left(1 - \rho^2_{y.\underset{\sim}{x}_p}\right) + \theta_1\left(\rho^2_{y.\underset{\sim}{x}_p} - \rho^2_{y.\underset{\sim}{x}_{r,p}}\right)\right] \tag{7}$$

3. Result

3.1. Theoretical Comparison of the Estimators in PIC-I, PIC-II, PIC-III and NIC:

Theoretical and empirical comparison of the proposed estimators with the reviewed estimators has been conducted in this section.

3.1.1. Theoretical Comparison of PIC-I and PIC-II:

$$MSE(Q_3)_{min} - MSE(Q_4)_{min} = \theta_1\overline{Y}^2 C_y^2\left(-\rho^2_{y.\underset{\sim}{x}_{r,h}} + \rho^2_{y.\underset{\sim}{x}_{k,h}}\right)$$

It is expected that $(r < k)$ or $\left(\rho^2_{y.\underset{\sim}{x}_{r,h}} < \rho^2_{y.\underset{\sim}{x}_{k,h}}\right)$, hence, $\theta_1\overline{Y}^2 C_y^2\left(-\rho^2_{y.\underset{\sim}{x}_{r,h}} + \rho^2_{y.\underset{\sim}{x}_{k,h}}\right) > 0$.

Therefore, Q_4 will be efficient than Q_3.

3.1.2. Theoretical Comparison of PIC-I and PIC-III:

$$MSE(Q_3)_{min} - MSE(Q_5)_{min} = \theta_1\overline{Y}^2 C_y^2\left(-\rho^2_{y.\underset{\sim}{x}_{r,h}} + \rho^2_{y.\underset{\sim}{x}_{r,p}}\right)$$

It is expected that $(h < p)$ or $\left(\rho^2_{y.\underset{\sim}{x}_{r,h}} < \rho^2_{y.\underset{\sim}{x}_{r,p}}\right)$, hence, $\theta_1\overline{Y}^2 C_y^2\left(-\rho^2_{y.\underset{\sim}{x}_{r,h}} + \rho^2_{y.\underset{\sim}{x}_{r,p}}\right) > 0$.

Therefore, Q_5 is efficient than Q_3.

3.1.3. Theoretical Comparison of PIC-II and PIC-III:

$$MSE(Q_4)_{min} - MSE(Q_5)_{min} = \theta_1\overline{Y}^2 C_y^2\left(-\rho^2_{y.\underset{\sim}{x}_{k,h}} + \rho^2_{y.\underset{\sim}{x}_{r,p}}\right)$$

Q_4 will be efficient than Q_5 if and only if $[(k > r)\ and\ (h > p)]\ or$ $\left(\rho^2_{y.\underset{\sim}{x}_{k,h}} < \rho^2_{y.\underset{\sim}{x}_{r,p}}\right)$. However, it is expected that $(k > r)$ but $(h < p)$.Hence, the efficiency between PIC-II and PIC-III will be confirmed from the empirical analysis.

3.1.4. Theoretical Comparison of PIC-II and NIC:

$$MSE(Q_4)_{min} - MSE(Q_2)_{min} = -\theta_1\overline{Y}^2 C_y^2\rho^2_{y.\underset{\sim}{x}_{k,h}} < 0$$

Since $\left(-\theta_1\overline{Y}^2 C_y^2\rho^2_{y.\underset{\sim}{x}_{k,h}} < 0\right)$ then Q_4 is unconditionally efficient than Q_2.

3.1.5. Theoretical Comparison of PIC-III and NIC:

$$MSE(Q_5)_{min} - MSE(Q_2)_{min} = -\theta_1\overline{Y}^2 C_y^2\rho^2_{y.\underset{\sim}{x}_{r,p}} < 0$$

Since $\left(-\theta_1\overline{Y}^2 C_y^2\rho^2_{y.\underset{\sim}{x}_{r,p}} < 0\right)$ then Q_5 is unconditionally efficient than Q_2.

3.2. Empirical Comparison of all Estimators

Tables 1.0 through 5.0 display the results of the numerical analysis for thirty three simulated populations.

Table 1.0: The Mean Square Errors (MSEs) for the thirty-three simulated populations.

Estimator	1	2	3	4	5	6	7	8	9	10	11
FIC	0.0130	0.0132	0.0145	0.0149	0.0142	0.0137	0.0151	0.0159	0.0179	0.0169	0.0172
PIC-I	0.0885	0.0918	0.0963	0.0947	0.0943	0.0997	0.0902	0.1414	0.1434	0.1298	0.1389
PIC-II	0.0720	0.0784	0.0753	0.0767	0.0791	0.0817	0.0770	0.1183	0.1169	0.1085	0.1137
PIC-III	0.0288	0.0285	0.0320	0.0301	0.0291	0.0303	0.0317	0.0383	0.0438	0.0427	0.0416
NIC	0.1681	0.1786	0.1675	0.1742	0.1728	0.1936	0.1728	0.2578	0.2615	0.2575	0.2851

Table 2.0: The Mean Square Errors (MSEs) for the thirty-three simulated populations (continuation).

Estimator	12	13	14	15	16	17	18	19	20	21	22
FIC	0.0182	0.0210	0.0209	0.0225	0.0233	0.0230	0.0255	0.0296	0.0283	0.0292	0.0311
PIC-I	0.1397	0.1398	0.1480	0.1473	0.1876	0.1698	0.1723	0.1826	0.2106	0.2179	0.2115
PIC-II	0.1112	0.1120	0.1213	0.1225	0.1476	0.1393	0.1470	0.1544	0.1913	0.1870	0.1725
PIC-III	0.0432	0.0468	0.0443	0.0429	0.0588	0.0513	0.0558	0.0586	0.0623	0.0720	0.0727
NIC	0.2510	0.2504	0.2785	0.2827	0.3606	0.3572	0.3440	0.3815	0.3840	0.4164	0.4356

Table 3.0: The Mean Square Errors (MSEs) for the thirty-three simulated populations (continuation)

Estimator	23	24	25	26	27	28	29	30	31	32	33
FIC	0.0372	0.0428	0.0470	0.0480	0.0521	0.0604	0.0836	0.0782	0.1435	0.1392	0.1963
PIC-I	0.2779	0.2520	0.3322	0.3677	0.4850	0.4920	0.6181	0.7271	0.9796	1.3718	1.4872
PIC-II	0.2207	0.2142	0.2785	0.3116	0.3465	0.3856	0.5375	0.6425	0.8427	1.1297	1.3037
PIC-III	0.0876	0.0888	0.1094	0.1014	0.1246	0.1495	0.1854	0.1878	0.3050	0.3341	0.4618
NIC	0.5719	0.4927	0.5682	0.7764	0.8381	0.8903	1.2303	1.8439	2.1695	2.9585	3.0566

Table 4.0: Ranking of the Mean Square Errors (MSEs).

Info. Case	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
FIC	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
PIC-I	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
PIC-II	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
PIC-III	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
NIC	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*

Table 5.0: Ranking of the Mean Square Errors (MSEs) (continuation).

Info. Case	22	23	24	25	26	27	28	29	30	31	32	33	Rank Average	Ave. Rank
FIC	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1.00*	*1*
PIC-I	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4.00*	*4*
PIC-II	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3.00*	*3*
PIC-III	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2.00*	*2*
NIC	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5.00*	*5*

3.3. Special Cases of the proposed Estimators

This section shows some special cases for the proposed estimators subject to the setting of the unknown constants in each estimator.

Table 6.0: Some of the special case estimators.

SN	α_i	β_i	γ_m	λ_m	σ_n	Partial Information Case II (PIC-II)	Description
01	0	0	1	1	1	$Q_4 = \bar{y}_2 \left[\prod_{m=k+1}^{h} \left(\frac{\bar{x}_{(2)m}}{\bar{x}_{(1)m}} \right)^{\gamma_m} \left(\frac{\bar{x}_{(1)m}}{\bar{X}_m} \right)^{\lambda_m} \right] \left[\prod_{n=h+1}^{p} \left(\frac{\bar{x}_{(2)n}}{\bar{x}_{(1)n}} \right)^{\sigma_n} \right]$	General Product Estimators using Multi-Auxiliary Variables in Two-Phase Sampling in PIC-II

SN	α_i	β_i	α_j	γ_m	λ_m	Partial Information Case III (PIC-III)	Description
01	0	0	1	1	1	$Q_5 = \bar{y}_2\left[\prod_{j=r+1}^{k}\left(\frac{\bar{x}_{(1)j}}{\bar{x}_{(2)j}}\right)^{\alpha_j}\right]\left[\prod_{m=k+1}^{p}\left(\frac{\bar{x}_{(2)m}}{\bar{x}_{(1)m}}\right)^{\gamma_m}\left(\frac{\bar{x}_{(1)m}}{\bar{X}_m}\right)^{\lambda_m}\right]$	General Product Estimators using Multi-Auxiliary Variables in Two-Phase Sampling in PIC-III.

4. Discussion and Conclusion

This study uses R statistical software for the empirical simulation and analysis in the comparison of the five estimators (FIC, NIC, PIC-I, PIC-II and Pic-III). Simulation, following normal distribution, was conducted for thirty three populations at the population sizes, first-phase sample sizes, second-phase sample sizes and seed values for the thirty three simulated populations. Tables 4.0 through 5.0 show the computed Mean Square Errors (MSEs) obtained for the thirty three populations and the five proposed estimators. Finally, tables 6.0 and 7.0 show the ranking of the computed MSEs for the thirty three populations, the average of the ranked values were computed and the ranking of the average values were obtained to decide on the ranking of the proposed estimators. Github repository hosts the source code used for this empirical analysis with the bitly Uniform Resource Locator (URL) https://bit.ly/2JxDb33.

Tables 1.0 through 3.0 reveal that increment in the population and sample sizes leads to decrement in the MSEs for the thirty three populations and the five estimators. This analysis establishes the estimators to be asymptotically efficient. It is, also, observed that the proposed estimators (PIC-II and PIC-III) have smaller MSEs compared to the reviewed PIC-I estimator. This confirms that PIC-II and PIC-III estimators are asymptotically efficient than PIC-I estimator in the family of the PIC estimators.

Tables 4.0 and 5.0 show the ranking of the computed MSEs, the average of the ranked values and the rank of the average values for the thirty three simulated populations and the five estimators. It is observed that the rank of the estimator remains one (1) throughout for the thirty three populations. Similarly, the ranks of the NIC, PIC-I, PIC-II and PIC-III estimators remain fixed throughout the thirty three populations. Finally, the rank of the average ranks establishes that FIC and NIC estimators are best and least ranked estimators, respectively. It, also, shows that the proposed estimators (PIC-II and PIC-III) prove efficient than the reviewed PIC-I estimator. This is, also, confirmed in the theoretical comparison. This argument will remain true based on the correlation coefficient obtained in the empirical analysis. Finally, table 6.0 shows some of the special case estimators that were extracted from PIC-II and PIC-III estimators based on the setting of the unknown constants in each estimator.

In conclusion, the proposed PIC-II and PIC-III estimators are asymptotically efficient than the reviewed PIC-I estimator. These proposed estimators have created alternative PIC estimator based on the confirmation of the conditions of usage. The proposed PIC-II and PIC-III estimators do not serve as replacement to the reviewed PIC-I estimator because there are different conditions of usage. Hence, each one of the three PIC estimators should be used based on the stated conditions of usage. Therefore, the proposed estimators are recommended subject to the confirmation of the conditions of usage.

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Bayesian decision fusion of palm and finger prints for personal identification

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Abstract
The ever increasing demand of security has resulted in a wide use of Biometrics systems. Despite overcoming the traditional verification problems, the unimodal systems suffer from various challenges like intra class variation, noise in the sensor data etc, affecting the system performance. These problems are effectively handled by the multimodal systems. In this paper, we present a multimodal approach for palm and finger prints by decision level fusion. The proposed multi-modal system is tested on a developed database consisting of 440 palm and finger prints each of 55 individuals. In methodology of decision level fusion, Directional energy based feature vectors of palm and finger print identifiers are compared with their respective databases to generate scores based upon which final decisions are made by the individual matcher which are combined through Bayesian decision fusion. Receiver Operating Characteristics curves are formed for the unimodal and multimodal systems. Equal Error Rate (EER) of 0.7321% for decision level fusion shows that the multimodal systems significantly outperforms unimodal palm and finger prints identifiers with EER of 2.822% and 2.553% respectively.

Keywords
Decision fusion, multimodal system, palm-print identification, fingerprint identification

1. Introduction

Modern networked society needs more reliability in providing high level security to access and transaction systems. Traditional personal identity verification systems i.e. token and password based, can be easily breached when the password is disclosed or the card is stolen. The traditional systems are not sufficiently reliable to satisfy modern security requirements as they lack the capability to identify the fraudulent user who illegally acquires the access privilege. The world's attention is diverting towards the field of biometrics for establishing secured identity verification systems which utilizes unique behavioural or physiological traits of individuals for authentication purposes and, therefore, inherently possesses the capability of differentiating genuine users from imposters [1], [2].

These traits include palm-print, palm-geometry, finger-knuckle-print, fingerprint, palm-vein, face, retina, voice, gait, iris, signature and ear etc. Unimodal systems that use single biometric modality for recognition purposes suffer several practical problems like non-universality, intra-class variation, noisy sensor data, restricted degree of freedom, failure-to-enroll, unacceptable error rate and spoof attacks [3]. Several studies have shown that multiple sources of information can be consolidated together to form multi-biometrics systems in order to address some of the problems faced by unimodal systems and improved recognition performance [4], [5], [6].

Multi-biometrics system can be developed by utilizing different approaches: (a) multi-algorithm systems process single biometric modality using multiple algorithms, (b) multi-sensor systems combine evidences of different sensors using a single trait, (c) multi-sample systems use multiple samples of same biometric modality using a single sensor, (d) multi-instance systems consolidate multiple instances of the same body trait, (e) multimodal systems are developed by fusing the information of different biometric traits of the individual to establish identity [3].

Multimodal system can be developed by fusing information of different biometric modalities at preclassification and post-classification levels. Pre-classification fusion possesses feature extraction level Page 2 of 5 and post-classification fusion includes fusion at matching score level and decision level [3], [7]. At feature level fusion, the feature vectors extracted from different biometric modalities are combined together and subsequently used for classification [8]. Fusion at score level is accomplished by combining the matching scores originating from different classifiers pertaining to various modalities, and depending upon the combined score threshold a classification decision is made. For decision level fusion, final outputs of individual classifiers are combined together for final decision [6].

In this paper, we present a multimodal system at decision level fusion using our already reported unimodal palm-print and finger print identifiers [9], [10]. The unimodal finger and palm print identification systems utilize directional energies of texture as features, extracted using contourlet transform. The rest of paper is organized as follows: section 2 briefly describes the unimodal palmprint and finger print systems, followed by the decision level fusion of palm-print and finger print identifiers for multimodal system in section 3. The details of experiments and results are given in section 4, and the paper is concluded in Section 5.

2. Unimodal Biometric Identifiers

2(a) Palmprint Identification System: The present work is continuation of our research on unimodal palm-print and finger-print systems [9], [10]. Palm-prints are captured with the help of the palm-print acquisition platform, Fig 1. It is an enclosed black box, simple in construction and is provided with two flat plates for image acquisition. The camera and the light source are fixed on the upper plate while the bottom plate is provided with fixed pegs to place the hand for image acquisition. To ensure uniform illumination inside the box, ring shaped lighting tube is used. To minimize any mismatch due to scale variance the distance between upper and lower plates is kept constant. After empirical testing the distance between the plates is kept at 14 inches. After acquiring the palm image Distance Transform is used to find the center of the palm and parameters for the best fitting ellipse that help to find the alignment of hand by calculating the slant angle 'θ'. A square region of size 256 x 256 pixels around the center of palm aligned at 'θ' degrees is cropped to achieve rotational invariance. After extraction of the region of interest (ROI), iterated directional filter banks split the two dimensional (2-D) spectrums into fine slices. With the help of contourlet transform, textural information available on the palm is extracted. Contourlet, a new discrete transform, can efficiently handle the intrinsic geometrical structure containing contours. It is proposed by Minh Do and Martin Vetterli [11], and provides sparse representation at both spatial and directional resolutions. It also offers a flexible multi-resolution and directional decomposition by allowing different number of directions at each scale with flexible aspect ratio.

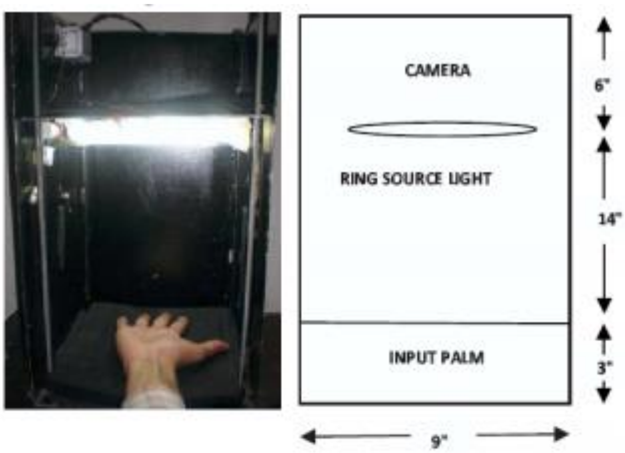

Fig. 1 Palm-print Image Acquisition Platform

Directional energy components for each block are computed from the decomposed sub-band outputs. Both local and global details in a palm-print are extracted as a fixed length palm code known as feature vector and stored to form database. Normalized Euclidian Distance classifier is then used for palm-print matching of input image with the already stored database.

2(b) Finger Print Identification System: Our work on fingerprint identification system is reported in the literature [10]. Fingerprint scanner of digital persona is used for acquiring fingerprints of individuals. Region of interest (ROI) of 128 x 128 pixels size is extracted from input image and Contourlet transform is used for its textural analysis. 2-D spectrum is fragmented into fine slices with the help of Directional Filter Banks (DFBs). Directional energy values are calculated for each sub block from the decomposed sub-band outputs at different resolutions to make feature vectors of input fingerprints and stored to form database. Fingerprint feature vector comprises of core and delta points along with the ridge and valley orientations which have strong directionality. Euclidian distance classifier is employed for matching of input fingerprint with stored database. To further improve the matching criteria, adaptive majority vote algorithm is employed.

3. Decision Level Fusion

Least amount of information is required for fusion at decision level, as only final output is available for fusion purposes. Bayesian Decision Fusion [3], [12] is used to fuse final decisions of palm-print and finger-print identification systems. Bayesian Decision Fusion involves the transformation of discrete output labels of unimodal systems into continuous probability values. To achieve this objective, a confusion matrix is formed for individual palm-print and finger-print systems by applying the systems to a trained data. Rows of confusion matrix show the actual individuals data that are input to the system and columns show the one which are identified by the system. The values from confusion matrix are used to calculate the apriori probability values according to the formula in (1):

$$p(c|\omega_k) = \prod_{j=1}^{2} p(c_j|\omega_k) \qquad (1)$$

where p(c|ωk) = priori probability, c = predicted class of the matcher, ω= actual class, k=number of users or classes, j = number of matchers i.e., palmprint and fingerprint systems. According to the Bayes Rule in (2):

$$p(\omega_k|c) = \frac{p(c|\omega_k)P(\omega_k)}{P(x)} \qquad (2)$$

As the denominator is independent of class ω so for decision making purposes it can be ignored. Thus the discriminant function is shown in (3):

$$g_k = p(\omega_k)p(c|\omega_k) \qquad (3)$$

where gk is the discriminant function and p(ωk) is total probability of each class occurring in the system. For making the final decision, Bayesian Decision Fusion technique selects the class having largest value of discriminant function. Fig. 2 shows the block diagram of proposed multimodal system using decision level fusion. Fig. 2 Block diagram of proposed multimodal system. Finger ROI Extraction Finger Feature Extraction Decision making module Decision fusion Finger database Palm database Matching module Palm ROI

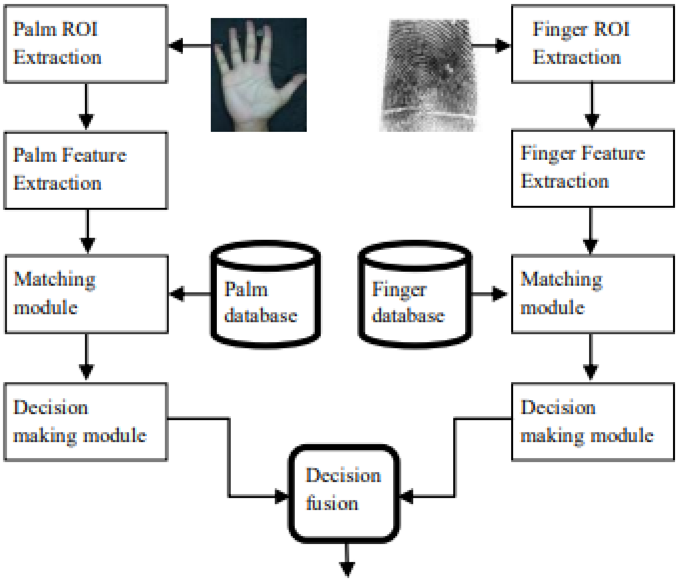

Fig. 2 Block diagram of proposed multimodal system

4. Experiments and Results

Fingerprint images were captured using Digital Persona Fingerprint scanner 4000B, while palm-prints with the help of developed palm-print acquisition platform. A database containing palm and finger images of 55 individuals has been constructed. 16 prints are collected from each individual with 8 records per biometric modality. Thus multimodal database consists of 16 x 55 = 880 records, having 440 palmprint and 440 fingerprint records. The database is developed in two sessions with an average interval of three months to focus on performance of developed multimodal system. User training is conducted before data acquisition phase for both palm and finger prints. In our experiments, the developed database is divided into two non overlapping sets: training and validation datasets of 440 images each (220 for each modality).

Palmprint and fingerprint based multi-modal system is implemented in Matlab on a 3.0 GB RAM, 2.0 GHz Intel Core2Duo processor PC. Training set is first used to train the system and to determine threshold. Validation dataset is then used to evaluate the performance of trained system. The performance of the system is recorded in terms of statistical measures like False Rejection Rate (FRR), False Acceptance Rate (FAR), Equal Error Rate (EER) and results are plotted in terms of Receiver Operating Characteristics (ROC) curves. Fig. 3 shows the ROC curve of proposed multimodal system using decision level fusion in comparison with unimodal palmprint and fingerprint systems respectively. ROC curves depict that multimodal system shows improved performance compared to individual unimodal systems.

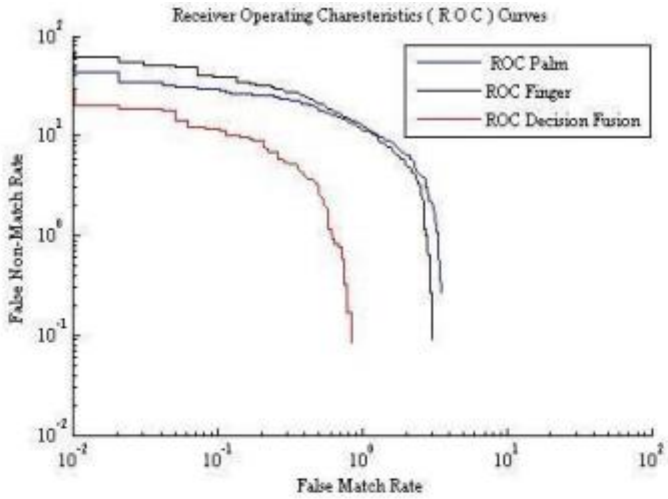

Fig. 3 ROC curve for Multimodal system using decision level fusion in comparison with unimodal fingerprint and palmprint identifier

Table 1 gives the comparison of Equal Error Rates of Multimodal systems using decision level fusion with the unimodal systems. Equal Error Rate (EER) of decision level fused system is 0.5380%. EER for multimodal systems is far less than EER values of individual palmprint (2.8224%) and fingerprint (2.5533%) identifiers. The results depict obvious improvement in performance of multimodal system as compared to unimodal systems.

Table I

Biometric System	**Equal Error Rate (%)**
Palmprint	2.8224
Fingerprint	2.5533
Palm and fingerprints (Decision level Fusion)	0.7321

5. Discussion and Conclusion

The paper presents multimodal personal identification system utilizing palmprint and fingerprint systems using decision level fusion. The unimodal identifiers utilize directional energies for matching purpose with the help of distance based (Euclidean distance) classifier. The decision level fused multimodal system uses discrete decision labels of individual biometric identifiers for fusion purposes. ROC curves and EER values demonstrate considerable improvement in recognition results for multimodal system as compared to individual unimodal identifiers.

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Measurement the effect of black campaign to Indonesia's crude palm oil export: Analysis time series error correction mechanism

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Abstract

Palm oil is one of the main commodities being developed by the government to increase non-oil and gas exports. The palm oil industry is a main foreign exchange that is very important for millions of Indonesians. But, Indonesia's palm oil product still haunted by non-tariff barriers by countries. The issue state that increasing production of crude palm oil (CPO) in Indonesia has caused negative variations on the environment. This study aims to measure the impact of Black Campaigns on Indonesia CPO exports and economic factors that effected. Error Correction Mechanism analysis showed the results that the CPO export prices, Gross Domestic Product, and Exchange Rate effected CPO export value significantly, while the black campaign did not effect. But in the long run, the Black Campaign has a negative direction on CPO export value. In other words, the order of Black Campaign reduced the performance of Indonesia's CPO export even though it was not significant.

Keywords

main commodity, non tariff barrier, supply-demand

1. Introduction

Palm oil is one of the ten main commodities being developed by the government to increase nonoil and gas exports. World palm oil production is dominated by Indonesia and Malaysia (Syaukat, 2010). The United States Department of Agriculture recorded the production of Indonesian Crude Palm Oil (CPO) in 2017 reached 38.5 million tons or increase about 6.94 percent from the previous year. It makes Indonesia as the largest producer of CPO in the world. In addition, CPO commodities contributed 18.51 billion USD or around 250.96 trillion rupiah to the economy as one of the main export foreign exchange in the non-oil and gas sector (GAPKI, 2018). The oil palm plantation and processing industry is a key industry for the Indonesian economy where this industry provides employment opportunities for millions of Indonesians (Ewaldo, 2015).

Lately the palm oil exports is haunted by non-tariff barriers by various countries. The issue that arises is palm oil production that continues to increase in Indonesia and Malaysia has caused various negative impacts on the environment, including forest conversion, habitat loss, endanger species, greenhouse effect and climate change (Syaukat, 2010). The campaign to reject palm oil is very prevalent especially in Europe. This makes the government anxious because the contribution of the palm oil industry to the economy is very significant (Sally, 2016).

Research to see the impact caused by the black campaign on Indonesia's export demand, as the world's largest supplier of palm oil is interesting to be appointed because the position of the world's palm oil producers in the coming years will be increasingly challenged. Thus it is necessary to conduct research on the impact of changes in several variables macro so that the dominant and significant variables that influence CPO export demand can be finded.

2. Methodology

Factors Effecting Demand

Gross Domestic Product (GDP) is monetary measure of the market value of all the final goods and services produced in a period of time. According to the law of demand, the price is inversely proportional to the number of items requested. The opposite applies, in most commodities, prices have a positive relationship with the quantity offered (Pindyck and Rubinfield, 2009). According to N. Gregory Mankiw (2010) the nominal exchange rate is the relative price of the two countries currencies. According to Salvatore (1995), in conducting trade transactions between countries, they use foreign currencies instead of their country's currency. If the currency of the importer country depreciates against the currency of the exporting country, the goods price of the exporter is relatively more expensive. So, demand for goods from exporting countries will decrease. The opposite applies, if the currency of the importing country appreciates against the currency of the exporting country, then the goods price of the exporter is relatively cheaper, so the demand for goods for exporters will increase.

Black Campaign Against Crude Palm Oil

In November 2007, Greenpeace launched an 82 pages report titled "How the Palm Oil Industry Is Cooking the Climate" which presented the results of a two-year investigation into how the food, cosmetics, and biodiesel industries have been driving massive destruction of Indonesia's rainforests and peatlands through the continued trade of palm oil (Greenpeace, 2008). Since then, the campaigns that reject Indonesia and Malaysia CPO become rampant, especially in Europe.

Data

The data in this research sourced from Badan Pusat Statistik (www.bps.go.id), World Bank (www.datacatalog.worldbank.org) and Bank Indonesia (www.bi.go.id) with the series from 2000-2017. The time period used is quarterly data, starting from 2000-Q1 to 2017-Q4. The dependent variable used is the export value according to the 4 digit Harmonized System (HS2017) code 1511 (Palm oil, and its fractions, whether or not refined, but not chemically modified), then the independent variable used are the real Gross Domestic Product (GDP) base year 2010 (billion USD), exchange rate, CPO export prices (USD/ton), CPO world prices (USD/MT) and Black Campaign (BC) as dummy variables. Software used for processing data in this research was Eviews 8.1.

Error Correction Mechanism (ECM) Analysis

According to Gujarati (2004), time series data is data of a sample unit collected in a certain period of time. The inferential analysis was used to see the effect of CPO export prices, GDP in the base year 2010, exchange rate, CPO world prices, and Black Campaign (BC) as dummy variables. This research used time series analysis method to answer the aim of this research. The procedures of the ECM are:

1. Stationarity Test

   Stationary data is the data that stochastically shows a constant pattern from time to time. One of the requirements of the ECM method is that all variables must be stationary on the same difference so cointegration tests can be do.

2. Cointegration Test

   Cointegration is a long run relationship between stationary variables at the same degree. The method used in this test is the Engel-Granger Cointegration Test.

3. Establishment of Error Correction Mechanism model (ECM)

   After performing the stationary test and cointegration test, all variabel stationed on the same difference. In addition, residual from regression X and Y has cointegration, then the ECM model can be formed. In this research, ECM is used as method to analize variables that effect the CPO export value in Indonesia both in the long run and short run. The aim of the test is to produce the right estimation for describe the relation between independent and dependent variables.

Short-term model equations (ECM) is formed by entering the residual first lag from the long run equation regression when the variables is stationary in the same difference. So the model can be written as follows:

$$dln\_valuex = \beta0 + \beta1dln\_dprice + \beta2dln\_gdp + \beta3dln\_kurs + \beta4dln\_wprice + \beta5BC - \beta6ECT(-1)$$

Note:

dln_valuex: Natural Logarithm of indonesia CPO value change in quater-t
dln_dprice: Natural Logarithm of CPO export price change in quarter-t
dln_gdpriil: Natural logarithm of Indonesian real GDP change in quarter-t
dln_kurs : Natural logarithm of exchange rate change in quarter-t
dln_wprice : Natural logarithm of CPO world price change in quartal-t

BC : dummy variable, after Black Campaign (BC = 1) and before Black Campaign (BC = 0)

ECT (-1) : Residuals of long-run equation period t-1

3. Result

Stationarity Test

In this research, stationary test was used the Augmented Dickey-Fuller (ADF) method. The test results from Eviews 8.1 are shown in the following table.

Table 1. Summary of ADF test Output at the Series Level and First Difference

Variables	Level		First difference	
	t-Statistic	Prob	t-Statistic	Prob
(1)	*(2)*	*(3)*	*(4)*	*(5)*
ln_valuex	-2,143422	0,2287	-9,650570*	0,0000
ln_gdpriil	0,395840	0,9814	-3,727988*	0,0057
ln_wprice	-2,059822	0,2614	-6,307063*	0,0000
ln_dprice	-1,416846	0,5693	-6,340802*	0,0000
ln_kurs	-0,928739	0,7735	-8,368511*	0,0000

Source: Output Eviews 8.1

Note: *) significant at $\alpha = 5$ percent

The results of stationary test at the series level showed that at the significance level (5%), all variables contained unit root. Then, the stationarity test at first difference needed to be done because the assumption of stationarity at the level is not fulfilled. Stationarity test using the ADF shows that all variables that are not stationary at the level series have been stationary in first difference (I).

Cointegration Test

Before doing cointegration test, it is necessary to do long run regression model. After the long run model is formed, the residual of that will be used to cointegration test. The following of long run models formed:

ln_valuex = 20,74815 + 2,209297ln_dprice* + 0,468677ln_gdp – 2,272718ln_kurs* - 0,684121ln_wprice – 0,429491BC

Adj-R^2 = 67,20 percent d = 0,754834

Note: *) significant at $\alpha = 5$ percent

The results of stationarity test of residuals from long run regression are as follows:

Table 2. Results of ADF Stationer Test of Residuals From The Long Run Model

Variable	Probability	AD-F test-statistic	Sig. 5 %
(1)	(2)	(3)	(4)
ECT	0,0028	-3,9512	-2,9029

Source : Output Eviews 8.1

Note : *) significant at α = 5 percent

Based on the Table 2, it can be concluded that the residual has been stationary at the level. so that, it can be interpreted that the regression model can be used as a model of the long run model or can be called a cointegrated regression model and the parameters are called cointegration parameters.

The variable CPO exports price growth has a positive effected on the growth of Indonesia's CPO export value. This is not accordance with economic theory which states that the demand for an item is inversely to the price of the item. The import dependence on Indonesia’s CPO as the largest producer in the world caused the relationship between prices and CPO exports to be close and positive but not elastic, meaning that the fluctuating CPO export prices are not immediately followed by the fluctuating CPO export value. GDP growth has a positive effect on the CPO export value. This is in accordance with the theory which states that the increase in people's income in this case GDP will cause an increase in consumption so that export demand can increase.

The exchange rate growth had a negative effect to the growth of Indonesia's CPO export value. This is in accordance with the theory, if rupiah depreciated to dollar, the demand for CPO increased because of Indonesia’s CPO export price becomes cheaper than prices on the international market. Beside that, CPO world price growth had a negative effect on the growth of Indonesia's CPO export value. Necessarily, increasing of world prices provide greater opportunities for Indonesia’s CPO exports. But this study showed the opposite, if world prices fall, the demand for Indonesian CPO remains high. This phenomenon can occur because world CPO prices have tended to be more expensive than the prices of Indonesia’s CPO exports. So that the ups and downs of world CPO prices did not effect Indonesia's CPO demand.

The Black Campaign variable has the opposite relationship with the value of Indonesian CPO exports. This shows that the existence of a black campaign against CPO products, especially the countries in Europe, caused a decline in the value of Indonesian CPO exports.

Error Correction Mechanism Model (ECM)

The formation of this model aims to determine which change of variable between CPO price exports, real GDP, exchange rate, CPO world prices, and Black Campaign that give effect significantly in the short run to changes of Indonesia's CPO export value. The following of ECM model formed:

dln_valuex = 0,0912 + 1,2426dln_dprice* - 4,3043dln_gdp* - 2,4279dln_kurs* - 0,5291dln_wprice – 0,1861BC – 0,3559ECT(-1)

Adj-R^2 = 21,65 percent d = 1,9603

Note : *) significant at α = 5 percent

Based on the model above, it can be seen that cointegration coefficient (ECT) that functions as speed of adjustment is negative and significant at the test level of 5 % which the value is -0.3559. This ECT showed how quickly the imbalance in the previous quarter was corrected in the current quarter. ECT values that are negative and significant indicate that the export value is out of balance, so to go to balance it will be corrected by an adjustment of 35.59 %. Thus, it can be concluded that the speed of error correction to correct the behavior of each variable in the short run towards equilibrium the long run is quitely fast. In other words, the short run effect of the CPO export price, real GDP, the exchange rate, CPO world prices and Black Campaign to CPO export value in Indonesia is quite large.

Based on the ECM equation model above, it can be seen that at the 5 percent significance level, the variable that significantly effect the change in CPO export value in the short run is the changing of CPO export prices, real GDP, and exchange rate, while changes in CPO world price growth and Black Campaign did not significantly effect in short run.

Statistics test

- Overall the F-test

Overall test aim to find out whether the independent variables simultaneously effect the dependent variable. Based on the test, the statistical value of the F-test is 4.2229 with a probability value of 0.0012 at the significance level of 5 percent. This showed that the independent variable simultaneously has a significant effect to Indonesia's export value.

- Partition t-test

This test aims to determine whether the independent variable has a significant effect to dependent variables partially. The results of the partial t-test:

Table 3. Partial T-Test Result

Independent Variable	t-Statistic	Probability
(1)	(2)	(3)
dln_dprice	2,1607	0,0345*
dln_gdp	-2,4992	0,0150*
dln_kurs	-2,3787	0,0204*
dln_wpri	-1,0106	0,3160
ce BC	-0,5647	0,5743

Source: Output Eviews 8.1

Table 3 shows that at significance level 5 percent, the independent variable that is able to explain the dependent variable significantly is CPO exports price, real GDP, and exchange rate.

Classic assumption test

- Normality Test

This test is conducted to determine whether the residuals formed from a model are normally distributed or not. The results of using the Augmented Dickey-Fuller test are as follows:

Table 4. Normality test

Variable	Probability	AD-F test-statistic	Sig. 5%
(1)	(2)	(3)	(4)
ECT	0,0000	-8,153731*	-2,903566

Source: Ouput Eviews 8.1

Based on the test results above, the residuals are stationary. Beside that, at 5 percent significance level, we have enough evidence that the residuals in the model followed the normal distribution. In this study, normal assumptions have been fulfilled.

- Non-Autocorrelation Assumptions

To detect autocorrelation in this research, the Breusch-Godfrey Serial Correlation LM test was used. Based on the short run model obtained residuals that will be regressed with independent variables and lag values of residual estimators (ECT). Non-autocorrelation test results can be seen in the following table

Table 5. The Results of Non-Autorrelation Test

Obs*R-squared	Prob.Chi-Square(2)
(1)	(2)
1,901163	0,3865

Source: Output Eviews 8.1

Based on the table 5, it can be seen that the probability Obs * R-Squared value is 0.3865 or greater than significance level (5%). Thus it means, failed to reject H_0. In this research, non-autocorrelation assumptions have been fulfilled.

- Homoscedatisity Test

This research was used the Breusch-Pagan-Godfrey Heteroskedasticity statistical test to detect heteroscedasticity. The following are the results of the Breusch-Pagan-Godfrey Heteroskedasticity test:

Table 6. Breusch-Pagan-Godfrey Heteroskedasticity Test

F-statistic Obs*R-squared	0,217882 1,421246	Prob. F(6,64) Prob. Chi Squared(6)	0,9697 0,9646

Scale explained SS	1,644596		0,9493

Source: Output Eviews 8.1

Based on the test results above, the probability value (p-value) of Obs * R-squared is 0.9646 that is greater than the significance level (5%). So, it can be concluded at 5 percent significance level, the ECM model formed has fulfilled the assumption of homoskedasticity.

- Non-multicollinearity Test

Tests to detect multicollinearity by showing the value of Variance Inflation Factors (VIF). The following table is the VIF value:

Table 7. Non-multicolinearity test

Variable	VIF
(1)	(2)
dln_dprice	2,5101
dln_gdp	1,0796
dln_kurs	2,0511
dln_wprice	3,1681
dBC	1,0398

Source: Output Eviews 8.1

Based on the test above, it can be concluded that there is no multicollinearity between the independent variables in the ECM model because the VIF values of all variables is smaller than 10.

Export Elasticity

The calculation of elasticity aims to determine how much the percentage change in the value of Indonesia's CPO exports is due to changes in the percentage of independent variables. In the process of forming an ECM model, short run model was obtained. In the short run, the amount of elasticity of the CPO export price is 1.2426, which means that a one percent increase in the change of CPO export price growth will result in an increase in the change of export value growth of 1.2426 percent. In the short run or long run, the CPO export price is elastic.

Elasticity of GDP in the short run is -4.3043, which means that one percent increasing in changes of Indonesia's GDP growth will result the growth of Indonesia's CPO export value decreasing by 4.3043 percent. Based on the result of test, increasing GDP or people's income will be followed by decreasing in the value of exports. This variable is elastic in the short run. In the short run, the amount of the elasticity of the rupiah-to-dollar exchange rate is -2.4279, which means that a one percent increasing in the change of exchange rate will decrease the growth of CPO export value of 2.4279 percent. In the short run, exchange rate is elastic. In the short run, the elasticity of CPO world price is -0,1861, which means that one percent increasing in the change of CPO world price growth will decreasing changes of CPO export value of 0.1861 percent. In the short run, the CPO world price is inelastic.

Supposedly, if there is an increasing in CPO world prices, Indonesia's export volume will increase but because CPO world prices are almost the same even tend to be more expensive compared to Indonesian export prices, a one percent increasing in CPO world prices does not significantly effect to the export value or inelastic. The elasticity of the black campaign as dummy variable (d = 1) in the short run is -0,1861. Because this research used linear log, the interpretation of the dummy variable becomes, the average value of Indonesian CPO exports after the black campaign against CPO products is lower by around 0.1861 percent compared before there was a black campaign.

4. Discussion and Conclusion

The export price of CPO, real GDP, exchange rate, CPO world prices, and the Black Campaign Dummy effected CPO export value in Indonesia. The CPO export price and exchange rate have a significant effected on CPO export value both in the short run and long run.

In the long run, CPO domestic price and Indonesian real GDP has a positive relationship to the CPO export value, while exchange rate, CPO world price, and Black Campaign as dummy variables have a negative effect to CPO export value. Meanwhile, in the short run, CPO export prices, GDP, and exchange rates have a statistically significant effect to Indonesia's CPO export value, while the Black Campaign variable has no effect on the level of testing used. Even though Black Campaign against CPO products does not significantly effect Indonesia's CPO export value, the government should still protect palm oil farmers from the Black Campaign. For further analysis, the comparison of the black campaign effect towards the world's palm oil supplier countries such as Indonesia and Malaysia is a challenging future study.

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Evaluating agreement between ratings on The Patient Global Impression of Improvement (PGI-I) scale and the Clinical Global Impressions – Improvement (CGI-I): Random effects linear models for estimating intraclass correlation coefficients for reliability research

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Abstract
Intraclass correlation coefficient (ICC) is a widely used reliability index in between-raters reliability analysis. This study aims to estimate the agreements between clinician and patient ratings using ICC and its 95% confidence interval by implementing random-effects linear models. Data were derived from three double-blind, placebo-controlled, multicentre studies conducted among adult individuals diagnosed with bipolar or major depressive disorders (N = 472). Clinicians were asked to rate participants symptoms using the Clinical Global Impressions – Improvement (CGI-I) and participants were asked to assess their symptom improvement with the Patient Global Impression of Improvement (PGI-I) scale. Two-way random effects ANOVA model was used to estimate ICCs. The two-way random-effects model were chosen in order to generalize reliability results to any raters (i.e. patients and clinicians) who possess the same characteristics as the selected raters in the reliability study.
There was high agreement between the PGI-I and CGI-I ratings across studies follow-up time points. Similar results were observed in male only and female only data and after adjustment for age and gender. ICC is a reliability index that reflects both degree of correlation and agreement between measurements. Because the ICC estimate obtained from a reliability study is only an expected value of the true ICC, it is more appropriate to evaluate the level of reliability based on the 95% confident interval of the ICC estimate, not the ICC estimate itself. In our case study, the findings support the utility of the PGI-I as a participant rated measure of global improvement among patients with bipolar or major depressive disorders.

Keywords
Intraclass Correlation Coefficient; Random-Effects Model; Absolute Agreement; Reliability Analysis; Randomized Control Trials

1. Introduction

ICC is widely used in mental health research to examine between-rater reliability. If raters randomly selected from a large population of raters with similar characteristics, two-way random-effects model can be used to model the ICC. Suppose that each of N subjects yields K observations. A set of K raters is randomly selected from the population of raters. These raters are then used to judge all subjects. The ANOVA model is:

$$Y_{ij} = \mu + \alpha_i + \beta_j + \alpha\beta_{ij} + \varepsilon_{ij}$$

where

$$\alpha_i \sim N(0, \sigma_\alpha^2), \beta j \sim N(0, \sigma_\beta^2), \alpha\beta_{ij} \sim N(0, \sigma_{\alpha\beta}^2), \text{and } \varepsilon_{ij} \sim N(0, \sigma_\varepsilon^2).$$

The ICC is estimated from the mean squares of the ANOVA table as follows

$$r = \frac{MS_B - MS_E}{MS_B + (K-1)MS_E}$$

where MS_B is the between-subject mean square, MS_E is the residual mean square. ICC values lower than 0.40 can be interpreted as poor, between 0.41 and 0.75 as fair, and above 0.75 as excellent agreement.

2. Methodology

Study design.

This was a secondary analysis of data from 3 clinical trials. Details of the study designs and populations have previously been published [1], [2], and [3]. Demographics and other important participants characteristics is illustrated in Table 1.

Instruments

Patient global impression of improvement scale (PGI-I) is a single-item global rating of change scale that ask an individual patient to rate the severity of a specific condition at baseline and or to rate at endpoints the perceived change in his/her condition in response to therapy. There are seven possible responses (scored 1–7): very much better, much better, a little better, no change, a little worse, much worse, and very much worse. The clinical global impression of improvement scale (CGI-I) is the clinician rated single-item scale that uses the same seven-point response criteria as the PGI-I. The agreements between clinician and patient ratings were assessed using ICC and its 95% confidence interval CI by using two-way random-effects models [4]. The Bland-Altman plot [5] was used to visually inspect agreement. This analysis involved plotting the difference between CGI-I and PGI-I measurements against the average of the two measurements ± 1.96 times its SD known as the 95% limits of agreement.

3. Result

A total of 472 individuals, (female 307) were analysed. A total of 200 had major depressive disorder and 148 had bipolar depression. Mean ± SD of PGI-I and CGI-I values at follow-up assessment time points are presented in Table 2. There was a decline in both PGI-I and CGI-I values through follow-ups, reflecting clinical improvement with treatment. However, PGI-I and CGI-I mean values and SD were very similar at each time point. The unadjusted and adjusted (adjusted for age and/ or gender) ICC of all time points were excellent.

Variable	Test statistics	Value		
		Study 1[1]	**Study 2**[2]	**Study 3**[3]
Age at entry to study	M (SD)	45.8 (11.4)	50.2 (12.7)	48.8 (14.7)
Gender % Female	% (n)	67.8 (101)	63.1 (159)	66.2 (47)
Diagnosis	% (n)			
Bipolar I disorder		69.6 (103)	-	
Bipolar II disorder		29.7 (44)	-	
Bipolar NOS		0.7 (1)	-	
Major depressive disorder		-	100 (252)	100 (71)
Age of clinical diagnosis	M (SD)	35.9 (11.6)	35.7 (13.3)	36.2 (13.5)

1.Study 1: The efficacy of N-acetylcysteine as an adjunctive treatment in bipolar depression: An open label trial, ACTRN12607000074493; 2. Study 2: The Efficacy of Adjunctive N-Acetylcysteine in Major Depressive Disorder: A Double-Blind, Randomized, Placebo-Controlled Trial, ACTRN12607000134426; 3. Study 3: Adjunctive minocycline treatment for major depressive disorder: A proof of concept trial; ACTRN12612000283875. 4. Pooled DSM-IV anxiety disorders.

Table 2 – Agreement between PGI and CGI in all, female and male participants

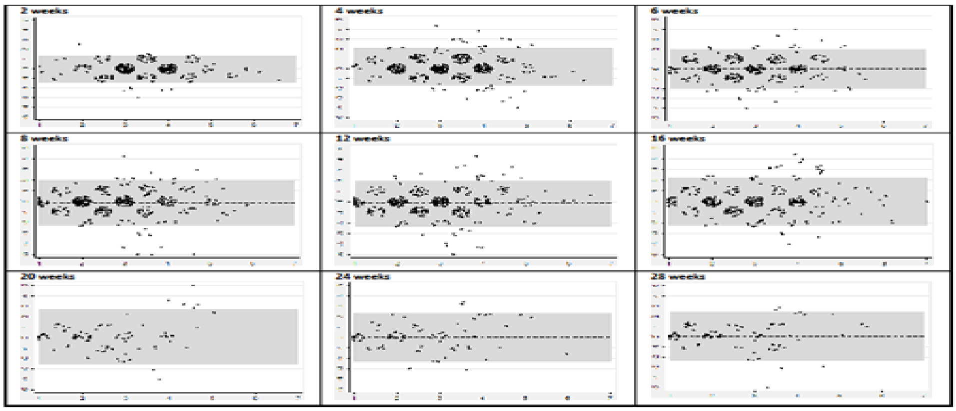
Time point of follow-up	Participants	Number of pairs	Mean ± SD CGI	Mean ± SD PGI	ICC unadjusted ICC (95%CI)	ICC Adjusted ICC (95%CI)
2 weeks	All	308	3.40 ± 0.90	3.46 ± 0.92	0.93 (0.83, 0.98)	0.92 (0.81, 0.97)
	Female	197	3.36 ± 0.94	3.46 ± 0.99	0.94 (0.83, 0.98)	0.94 (0.84, 0.98)
	Male	111	3.46 ± 0.82	3.48 ± 0.80	0.94 (0.82, 0.98)	0.93 (0.79, 0.98)
4 weeks	All	437	3.24 ± 1.00	3.10 ± 1.05	0.89 (0.73, 0.96)	0.87 (0.69, 0.95)
	Female	278	3.19 ± 1.01	3.02 ± 1.07	0.87 (0.70, 0.95)	0.87 (0.70, 0.95)
	Male	159	3.33 ± 0.97	3.24 ± 0.99	0.92 (0.77, 0.98)	0.91 (0.74, 0.97)
6 weeks	All	347	2.90 ± 1.12	2.88 ± 1.09	0.87 (0.64, 0.96)	0.88 (0.65, 0.97)
	Female	220	2.81 ± 1.11	2.77 ± 1.08	0.86 (0.63, 0.96)	0.89 (0.67, 0.97)
	Male	127	3.04 ± 1.13	3.07 ± 1.08	0.88 (0.66, 0.97)	0.87 (0.63, 0.96)
8 weeks	All	391	2.72 ± 1.16	2.88 ± 1.15	0.85 (0.68, 0.93)	0.80 (0.61, 0.91)
	Female	256	2.68 ± 1.15	2.85 ± 1.19	0.82 (0.65, 0.92)	0.83 (0.66, 0.93)

	Male	135	2.81 ± 1.17	2.96 ± 1.06	0.89	(0.71, 0.97)	0.87	(0.68, 0.96)
12 weeks	All	365	2.74 ± 1.27	2.87 ± 1.22	0.85	(0.69, 0.93)	0.82	(0.65, 0.92)
	Female	235	2.71 ± 1.30	2.85 ± 1.32	0.84	(0.70, 0.92)	0.84	(0.69, 0.93)
	Male	130	2.80 ± 1.22	2.90 ± 1.04	0.87	(0.66, 0.96)	0.87	(0.64, 0.96)
16 weeks	All	353	2.93 ± 1.31	2.93 ± 1.24	0.83	(0.66, 0.92)	0.77	(0.60, 0.89)
	Female	126	3.00 ± 1.22	3.10 ± 1.21	0.87	(0.70, 0.96)	0.85	(0.63, 0.95)
	Male	126	3.00 ± 1.22	3.10 ± 1.21	0.87	(0.70, 0.96)	0.85	(0.63, 0.95)
20 weeks	All	89	2.62 ± 1.34	2.55 ± 1.14	0.81	(0.52, 0.95)	0.79	(0.47, 0.94)
	Female	30	2.87 ± 1.46	2.83 ± 1.32	0.84	(0.53, 0.96)	0.79	(0.44, 0.95)
	Male	30	2.87 ± 1.46	2.83 ± 1.32	0.84	(0.53, 0.96)	0.79	(0.44, 0.95)
24 weeks	All	83	2.53 ± 1.29	2.49 ± 1.20	0.87	(0.63, 0.96)	0.86	(0.60, 0.96)
	Female	28	2.89 ± 1.40	2.96 ± 1.26	0.88	(0.63, 0.97)	0.88	(0.61, 0.97)
	Male	28	2.89 ± 1.40	2.96 ± 1.26	0.88	(0.63, 0.97)	0.88	(0.61, 0.97)
28 weeks	All	88	2.43 ± 1.33	2.41 ± 1.32	0.85	(0.54, 0.96)	0.81	(0.48, 0.95)
	Female	31	2.71 ± 1.44	2.84 ± 1.34	0.75	(0.31, 0.95)	0.30	(0.10, 0.62)
	Male	31	2.71 ± 1.44	2.84 ± 1.34	0.75	(0.31, 0.95)	0.30	(0.10, 0.62)

Note: PGI: Patient global impression. CGI: Clinician global impression. SD: Standard deviation. ICC: Intra-class correlation, CI: Confident interval.

Figure 1 shows CGI-I and PGI-I agreement measuring through plots across follow-up time points. The mean difference between CGI-I and PGI-I were close to zero across all follow-up time points showing negligible measurement bias between CGI-I and PGI-I. The direction of mean differences (CGI-I – PGI-I) were randomly changed across time points showing no time trend bias. The number of pairs outside 95% limits of agreement were also acceptable. Figure 1 also revealed acceptable homogeneity in CGI-I and PGI-I agreement across low, middle and high values of mean CGI-I and PGI-I values.

Figure 1. Bland and Altman plots at all post-baseline assessment time points to describe agreement between PGI-I and CGI-I.



Note. The y axes indicate difference between CGI-I and PGI-I. The x axes indicate the average of CGI-I and PGI-I. Shaded areas present agreement limits.

4. Discussion and Conclusion

This study examined reliability through estimating absolute agreement between patient's global impressions of improvement and clinicians' global impressions of improvement in bipolar and major depressive disorder. PGI-I is an outcome measure commonly used in clinical trials for the treatment of medical and psychiatric disorders with subjective endpoints. Overall, our findings support the utility of the PGI-I ratings among patients with major depressive disorder and bipolar disorder.

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Bayesian analysis of REER-SAARC Series using C-AR model with spherically symmetric error

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Abstract

Present work has investigated the inferences in covariate autoregressive (C-AR) model when error term is non-Gaussian. Spherically symmetric behaviour is one of the non-Gaussian characteristic and may be seen in agricultural, economics and biological field etc. Therefore, present paper is modelling the Indian real effective exchange rates (I_{REER}) considering REER of South Asian Association for Regional Cooperation (SAARC) countries as covariate. Under Bayesian methodology, unit root hypothesis is tested by Bayes factor and recorded that series are stationary on all cases. However, minimum AIC and BIC is recorded when Bangladesh real exchange rates (BREER) is considered as covariate. As all series are stationary so the estimation of parameters is carried out.

Keywords

AR Process; Covariate; Spherical symmetric distribution; Prior and posterior distribution

1. Introduction

In present scenario, time series analysis is challenging and demanding new research area because of it's versatile applicability in different fields. In reference to modelling of time series, generally errors are assumed normally distributed but sometimes it not happened so far, instead of this non-gaussian distribution is more useful. Spherical symmetric form is one of the non-gaussian distribution and it is becoming popular in last few decades. A wide literature is available in reference of regression modelling when errors are belonging to a class of spherical symmetric distribution, Ullah and ZindeWalsh (1985) studied the estimation and testing in a regression model. Jammalamadaka *et al*. (1987) discussed Bayes predictive inference in regression models. For inferential assumption of parameters, several authors have studied the behaver of a random variable from spherically symmetric distribution please refer to Berger (1975), Judge *et al*. (1985) etc. In Bayesian approach, Panday (2015) developed the state space model with non-normal disturbances and estimated the parameters using Gibbs sample technique and derived the marginal posterior densities. De Kock and Eggers (2017) proposed Bayesian variable selection for linear parametrizations with normal *iid* observations based on spherically symmetric distribution. Rather than error distribution, observed series is also affect by other associates variables. These associated variables may be partially or continuously influence the series depend upon the circumstances. Therefore, these associate series is appropriate for the study to increase the efficiency of the model.

There is variety of literature exist to deal covariate in time series model. Hensen (1995) proposed covariate augmented Dickey-Fuller (CADF) unit root test and obtained the asymptotic local power function of CADF statistic. Recently Chang *et al.* (2017) developed bootstrap unit root tests with covariate method to the CADF test to deal the time series with the nuisance parameter dependency and provided a valid basis for inference based on the CADF test. Also, Kumar *et al.* (2017, 2018) explored an autoregressive model with consideration of covariate variables and extended to panel data time series model. In this paper, we studied C-AR time series model when error terms are spherically distributed under Bayesian approach. To carrying out the Bayesian approach, model involving various parameters which is difficult to obtain the conditional posterior densities, in that case Markov Chain Monte Carlo (MCMC) technique as Gibbs sampler is used. For unit root test, Bayes factor is derived from posterior probability. The applicability of the model is verified by REER-SAARC series.

2. Model Description

Let us assume that $\{y_t \; ; t = 1,2, \ldots, T\}$ be a time series with intercept term Φ.

$$y_t = \emptyset + u_t \tag{1}$$

The error term u_t follows AR (1) process associated with stationary covariate $\{w_t\}$. Then, times series may be serially correlated to the covariate series and u_t follows the model

$$u_t = \rho u_{t-1} + \sum_{j=-r+1}^{p} \lambda_j w_{t-j} + \varepsilon_t \tag{2}$$

Where ρ is autoregressive coefficient and λ_j is covariate coefficient. Utilizing equation (2) in (1), model can be written as

$$y_t = \phi(1-\rho) + \rho y_{t-1} + \sum_{j=-r+1}^{p} \lambda_j w_{t-j} + \varepsilon_t \tag{3}$$

Generally, researcher considers the error term as normally distributed but in real life situation, structure of the series having some skewed nature. So, in this paper, we assume that errors $\{\varepsilon_t \; ; t = 1,2, \ldots T\}$ are distributed according to probability law which belongs to the class of spherically symmetric distribution. Considering limitation of study, we have considered the following probability density function of ε_t.

$$f(\varepsilon_t)=\int_0^\infty \frac{\tau^{1/2}}{(2\pi)^{1/2}\psi(\zeta)}\exp\left[-\frac{\tau}{2\psi^2(\zeta)}\varepsilon_t^{\ 2}\right]dG(\zeta) \tag{4}$$

Where $\psi(\zeta)$ is a positive measurable function and $dG(\zeta)$ is cumulative distribution function of ζ.

The main motive behind the present study is to test the unit root hypothesis and estimated the model parameters under consideration of spherically symmetric error. Under the unit root hypothesis model (3) becomes

$$\Delta y = \sum_{j=-r+1}^{p}\lambda_j w_{t-j} + \varepsilon_t \tag{5}$$

Model (3) and (5) can be written in matrix notation as follows

$$Y = \rho Y_{-1} + (1-\rho)l_T\emptyset + w\Lambda + \varepsilon \tag{6}$$

$$\Delta Y = W\Lambda + \varepsilon \tag{7}$$

where

$$Y=(y_1\ y_2 \dots y_T)';\ Y_{-1}=(y_0\ y_1 \dots y_{T-1})';\ \Delta Y=(\Delta y_1\ \Delta y_2 \dots \Delta y_T)';\ l_T=(1\ 1 \dots 1)'$$

$$W=\begin{pmatrix} w_r & w_{r-1} & \cdots & w_{1-p} \\ w_{r+1} & w_r & \cdots & w_{2-p} \\ \vdots & \vdots & \ddots & \vdots \\ w_{T+r-1} & w_{T+r-2} & \cdots & w_{T-p} \end{pmatrix};\Lambda=(\lambda_{-r+1}\ \lambda_{-r+2}\dots\lambda_0\ \lambda_1\dots\lambda_p)'$$

3. Bayesian Framework

Bayesian approach contains not only recorded observations but also have an additional information regarding the parameters known as prior. There is independent area of researcher about the form and nature of prior. Present study is for the study of C-AR model with spherically symmetric error. So, we have assumed that intercept and error variance follow conjugate normal and chi square distribution, respectively. A uniform distribution is considered for autoregressive coefficient (ρ) and covariate coefficient, the joint prior distribution of model parameters is obtained under assumed prior

$$P(\Theta)=\frac{\tau^{\frac{v+1}{2}-1}}{(1-a)(2\pi)^{\frac{1}{2}}2^{\frac{v}{2}}\Gamma\left(\frac{v}{2}\right)}\exp\left[-\frac{\tau}{2}\{(\phi-\phi_0)^2+1\}\right] \tag{8}$$

Likelihood function for model (6) and (7) denoted by L_1 and L_0 are respectively

$$L_1(\varepsilon)=\int_0^\infty \frac{\tau^{\frac{T}{2}}}{(2\pi)^{\frac{T}{2}}\psi^T(\xi)}\exp\left[-\frac{\tau}{2\psi^2(\xi)}(Y-\rho Y_{-1}-l_T(1-\rho)\phi-\Lambda W)^{'}(Y-\rho Y_{-1}-l_T(1-\rho)\phi-\Lambda W)\right]dG(\xi) \tag{9}$$

$$L_0(\varepsilon)=\int_0^\infty \frac{\tau^{\frac{T}{2}}}{(2\pi)^{\frac{T}{2}}\psi^T(\xi)}\exp\left[-\frac{\tau}{2\psi^2(\xi)}(\Delta Y-\Lambda W)^{'}(\Delta Y-\Lambda W)\right]dG(\xi) \tag{10}$$

First, we are interested to test the unit root hypothesis $H_0 : \rho = 1$ against the alternative $H_1 : \rho \in s; s = \{\rho : 1 > \rho > a; a > -1\}$. The unit root test is very important before drawing the inference in ARIMA methodology see Box and Jenkins (1976), Phillips and Ploberger (1994), Lubrano (1995) etc. For testing unit root hypothesis, we used posterior probability of H_1 and H_0 to obtain the Bayes factor. The posterior probability under H_1 and H_0 obtained as

$$P(Y|H_1)=\int_a^1\int_0^\infty \frac{\Gamma\left(\frac{T+v-r-p}{2}\right)\left[\psi^2(\xi)\right]^{\frac{r+p+1}{2}}\left|W^{'}W\right|^{-\frac{1}{2}}\left|A(\rho,\psi(\xi))\right|^{-\frac{1}{2}}}{(1-a)(2\pi)^{\frac{T-r-p}{2}}2^{\frac{v}{2}}\Gamma\left(\frac{v}{2}\right)\left[C(\rho,\psi(\zeta))\right]^{\frac{T+v-r-p}{2}}\psi^T(\zeta)}d\rho dG(\xi) \tag{11}$$

$$P(Y|H_0)=\int_0^\infty \frac{\Gamma\left(\frac{T+v-r-p}{2}\right)\left[\psi^2(\xi)\right]^{\frac{r+p}{2}}\left|W^{'}W\right|^{-\frac{1}{2}}}{(2\pi)^{\frac{T-r-p}{2}}2^{\frac{v}{2}}\Gamma\left(\frac{v}{2}\right)\left[D(\psi(\zeta))\right]^{\frac{T+v-r-p}{2}}\psi^T(\zeta)}dG(\xi) \tag{12}$$

where

$$\Sigma = I - W(W^{'}W)^{-1}W^{'}$$
$$A(\rho,\psi(\zeta)) = (1-\rho)^2 l_T^{'}\Sigma l_T + \psi^2(\zeta)$$
$$B(\rho,\psi(\zeta)) = (1-\rho)\; l_T^{'}\Sigma(Y-\rho Y_{-1}) + \phi_0\psi^2(\zeta)$$
$$C(\rho,\psi(\zeta)) = \frac{1}{2\psi^2(\xi)}\left[(Y-\rho Y_{-1})^{'}\Sigma(Y-\rho Y_{-1}) - B(\rho,\psi(\zeta))^{'}A^{-1}(\rho,\psi(\zeta))B(\rho,\psi(\zeta))\right]+\frac{1}{2}(1+\phi_0{}^2)$$
$$D(\rho,\psi(\zeta)) = \frac{1}{2\psi^2(\xi)}\left[(\Delta Y^{'}\Sigma\Delta Y)(Y-\rho Y_{-1})\right]+\frac{1}{2}$$

In Bayesian testing procedure, the linking of respective model is obtained through Bayes factor (B_{10}) which is the ratio of posterior probability for respective hypothesis. We used the Kass and Raftery (1995) Bayes factor for rejection or acceptance of hypothesis. For estimation of parameters of model, derived the conditional posterior distribution of ϕ, Λ, ρ and τ with the help of Gibbs sampler procedure as follows.

$$\hat{\phi} \sim N\left(Z_1 H_1^{-1}, \frac{1}{\tau\psi^2(\zeta)} H_1^{-1}\right) \tag{13}$$

$$\hat{\Lambda} \sim N\left(Z_2 H_2^{-1}, \frac{1}{\tau\psi^2(\zeta)} H_2^{-1}\right) \tag{14}$$

$$\hat{\rho} \sim TN\left(Z_3 H_3^{-1}, \frac{1}{\tau\psi^2(\zeta)} H_3^{-1}, l, 1\right) \tag{15}$$

$$\hat{\tau} \sim Gamma\left(\frac{v+T+1}{2}, V\right) \tag{16}$$

Where,

$$H_1 = l_T' l_T (1-\rho)^2 + \psi^2(\zeta)$$

$$H_2 = W'W$$

$$H_3 = (Y_{-1} - l_T\phi)'(Y_{-1} - l_T\phi)$$

$$Z_1 = l_T'(1-\rho)(Y - \rho Y_{-1} - \Lambda W) + \frac{1}{\psi^2(\zeta)}\phi_0$$

$$Z_2 = (Y - \rho Y_{-1} - l_T(1-\rho)\phi)$$

$$Z_3 = (Y_{-1} - l_T\phi)'(Y - l_T\phi - \Lambda W)$$

$$V = \frac{1}{\psi^2(\zeta)}(Y - \rho Y_{-1} - l_T(1-\rho)\phi - \Lambda W)'(Y - \rho Y_{-1} - l_T(1-\rho)\phi - \Lambda W) + \psi^2(\zeta)\{(\phi-\phi_0)^2 + 1\}$$

The conditional posterior distribution of all parameters is conditionally in standard distribution form. Hence, we can use Gibbs algorithm to simulate the posterior sample from equation (13) to (16). For better interpretation, different loss functions (Asymmetric Loss Functions (ALF), Squared Error Loss Functions (SELF) and Precautionary Loss Function (PLF)) are considered under Bayesian approach (for details please refer Norstrom (1996), Schroeder and Zieliński (2011)).

4. Empirical Study

In current trend, economy of a country is majorly measured by import and export of good and commodities. This may be influencing the currency of any nation, mainly developing countries. India is one of the developing country which also affects the portfolio currency issues. Hence, in this paper, we have used real effective exchange rate (REER) for South Asian Association for Regional Cooperation (SAARC) countries. Because REER contains the information about the country currency which compare with others trading country. SAARC is regional organization of South Asia countries Afghanistan, Bangladesh, Bhutan, India, Nepal, Maldives, Pakistan and Sri Lanka. The series is recorded monthly from January 2009 to May 2017.

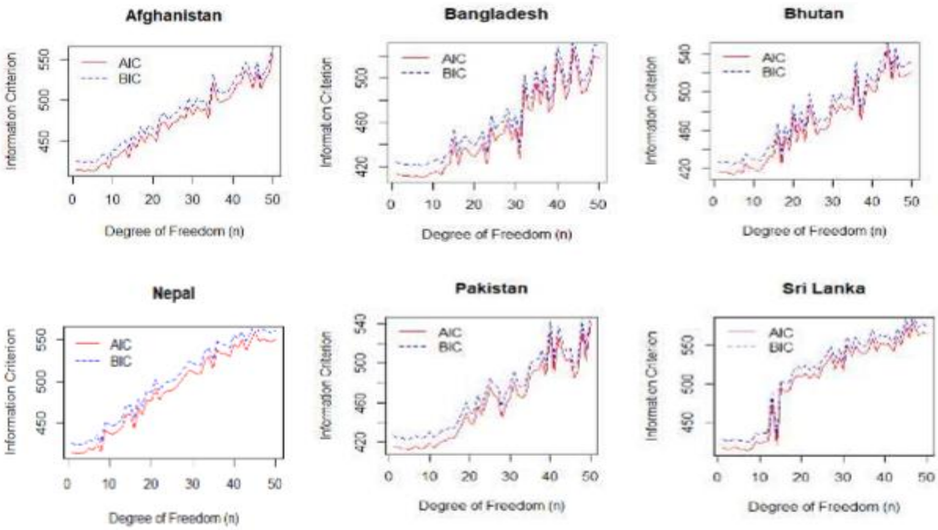

Figure 1: Information Criterion plot of SEERC countries

For this analysis, we considered all SAARC countries of REER series except Maldives due to unavailability of series. Here, REER of India as an observed time series and considered other SAARC countries as a covariate. First, we find out the appropriate degree of freedom for a particular covariate using information criterion. Figure 1 represents the AIC and BIC plot of SAARC countries with different degree of freedom. Observing the Figure 1, study recorded the minimum AIC and BIC of each assumed countries in Table 1. Table 1 also observed that Bayes factor (B_{10}) is greater than 40 in each case when including covariate in the series. Therefore, B_{10} strongly favours that series reject the null hypothesis i.e. series is stationary. After obtaining the best suitable degree of freedom (DF) with each covariate, estimation of parameters is carried out for India series. The estimated value of MLE and Bayesian setup are reported in Table 2 and confidence interval for Bayesian estimator are also recorded in Table 2.

DF	**Table 1**: Selection of Best Suitable Model			
	Countries	Min. AIC	Min. BIC	B_{10}
5	Afghanistan	413.2639	423.8029	135.536
8	Bangladesh	410.2569	420.7958	213.2329
5	Bhutan	413.4703	424.0092	117.0011
3	Nepal	413.6300	424.1689	47.6660
5	Pakistan	412.5019	423.0408	143.0281
7	Sri Lanka	413.8527	424.3916	194.2551

Table 2: Estimates and Confidence Interval for Selected Models

DF	Countries	Parameters	MLE	SELF	ALF	PLF	CI
5	Afghanistan	ρ	0.9510	0.9557	0.9588	0.9558	(0.9484, 0.9595)
		ϕ	48.5886	69.0581	73.5515	69.7209	(48.5886, 73.5515)
		Λ	0.0282	0.0179	0.0150	0.0186	(0.0148, 0.0283)
		τ	0.3466	0.8892	1.0224	0.9725	(0.0762, 1.2999)
8	Bangladesh	ρ	0.9212	0.9296	0.9301	0.9296	(0.9163, 0.9372)
		ϕ	64.6240	79.1317	79.1281	79.1609	(76.2851, 81.5435)
		Λ	0.0290	0.0183	0.0182	0.0184	(0.0156, 0.0222)
		τ	0.3573	0.1780	0.1769	0.1797	(0.1342, 0.2303)
5	Bhutan	ρ	0.9768	0.9753	0.9754	0.9753	(0.9744, 0.9766)
		ϕ	60.0033	80.8361	79.6659	80.9239	(79.6659, 90.4162)
		Λ	0.0169	0.0115	0.0119	0.0116	(0.0087, 0.0119)
		τ	0.3439	0.2457	0.2458	0.2488	(0.1678, 0.3219)
3	Nepal	ρ	0.8543	0.8584	0.8593	0.8585	(0.8414, 0.8765)
		ϕ	30.5513	46.7379	44.6911	46.8590	(44.6911, 53.0181)
		Λ	0.1051	0.0816	0.0830	0.0821	(0.0634, 0.0939)
		τ	0.3564	0.0640	0.0614	0.0659	(0.0413, 0.0901)
5	Pakistan	ρ	0.9388	0.9545	0.9566	0.9546	(0.9415, 0.9608)
		ϕ	58.5080	83.2600	84.0935	83.3036	(81.5354, 84.0935)
		Λ	0.0298	0.0127	0.0119	0.0130	(0.0118, 0.0157)
		τ	0.3478	0.1744	0.1743	0.1766	(0.1238, 0.2283)
7	Sri Lanka	ρ	0.9451	0.9484	0.9491	0.9484	(0.9416, 0.9503)
		ϕ	62.6289	82.8046	83.1799	82.8225	(82.5800, 83.8421)
		Λ	0.0225	0.0124	0.0123	0.0125	(0.0117, 0.0137)
		τ	0.3297	0.1569	0.1563	0.1586	(0.1124, 0.1992)

5. Conclusion

Present work investigated the inferences in covariate autoregressive (C-AR) model when error term is non-Gaussian. Under Bayesian methodology, estimators of the model parameters are obtained by conditional posterior distribution and posterior probability is used for unit root hypothesis. In real application, we recorded that series are stationary on all SAARC countries. However, minimum AIC and BIC is recorded when degree of freedom of multivariate t-distribution is less than 10. This model is further may be extend for panel and vector autoregressive model.

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Green development and green development index under the background of ecological civilization pilot zone

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Abstract
This paper introduces the era background of the development of green, the national ecological experimental zone of civilization (Jiangxi) implementation plan, index system of green development and situation of green development index in China in 2016, this paper expounds the significance of green development index, and parts of our country public satisfaction with the green development index ranking problem such as matching, annual evaluation results put forward the exploratory thinking.

Keywords
Green development; Ecological civilization; Index

1. Introduction

Green development is the trend of the world. It is a sustainable development strategy that coordinates environmental protection with economic growth. The sustainable development of economy and society needs a set of perfect laws and regulations to guarantee. Green development index is produced under such background.

2. Methodology

The green development index is evaluated according to the green development index system to ensure that the evaluation method is scientific, objective, open and operable. The green development index is calculated using the comprehensive index method. Firstly, some green development indicators are transformed into green development statistical indicators that can be directly calculated for individual indexes, and the indicators that are missing from the data are processed. Then, the statistical index of green development was standardized and the individual index was calculated by the efficiency coefficient method. Then, six sub-indexes, including resource utilization, environmental governance, environmental quality, ecological protection, growth quality and green living, were calculated by weighting individual indexes. Finally, the green development index is calculated by weighting the classification index.

Public satisfaction with ecological civilization is a subjective index. To this end, the national bureau of statistics formulated the "public ecological environment satisfaction survey program. "The public satisfaction survey on ecological environment aims to find out how satisfied the public are with various aspects of the ecological environment. Survey content reflects all aspects of the living environment health, focus on the public reflects a strong and is closely related to the life field, including the social public the satisfaction degree of the region ecological environment as a whole, the ecological environment to improve the status of the judge, and the regional natural environment, and pollution and management of municipal environmental sanitation in three aspects, such as satisfaction. The survey was conducted by computer-aided telephone survey and was carried out by the provincial (district, city) statistics bureau. The whole visit process of each province is recorded, and the access data is recorded in real time. The whole investigation process can be traced back. In order to prevent interference, data collection adopts the method of investigation in different places, that is, each investigation unit conducts investigation in other provinces, does not carry out investigation in its own province, and ensures that there is no interactive investigation between the two provinces to ensure the independence of the investigation.

3. Results

1. There is a small gap between the total index of green development and most sub-indexes, especially fujian. Overall green development index: jiangxi 79.28, ranked 15th, with a difference of 4.43 points from the highest. Highest Beijing 83.71; Fujian 83.58, 2nd; Guizhou, 79.15, ranked 17th.Ten provinces are over 80.Resource utilization index: jiangxi 82.95, ranked 20th, with a difference of 7.37 points from the highest. Highest fujian 90.32; Guizhou 80.64, ranked 26th.Environmental protection index: jiangxi 74.51, ranked 24th, with a difference of 23.85 points from the highest. Highest Beijing 98.36; Fujian 80.12 ranked 14th; Guizhou 77.10, ranked 19th.Environmental quality index: jiangxi 88.09, ranked 11th, with a maximum difference of 6.3 points. Highest Tibet 94.39; Fujian 92.84, 3rd; Guizhou was 90.96, ranking 7th.Ecological protection index: jiangxi 74.61, ranked 6th, 3.07 points from the highest. Highest chongqing 77.68; Fujian 74.78, third; Guizhou 74.57, ranked 7th.Growth quality index: jiangxi 72.93, ranked 15th, with a difference of 20.98 points from the highest. Highest Beijing 93.91; Fujian 74.55, ranked 11th; Guizhou 71.67, ranked 19th.Green living index: jiangxi 72.43, ranked 14th, with a difference of 10.72 points from the highest. Highest Beijing 83.15;Fujian 73.65, ranked 9th;Guizhou, 69.05, ranked 26th.

2. Public satisfaction with ecological environment, mainly to understand the subjective satisfaction of the public with the ecological environment, and highlight the "sense of gain" of the public in the construction of ecological civilization. Jiangxi ranked 81.96% in terms of public satisfaction with ecological environment, ranking 13th in the country and 7.08 percentage

points lower than the highest. The highest was 88.14% in Tibet and the lowest was 62.50% in hebei. Fujian ranked fourth with 87.14%.Guizhou ranked second with 87.82%.The difference between the lowest and highest provinces was 25.64 percentage points.

4. Conclusion

The green development index is a comprehensive evaluation index, which not only emphasizes the connotation of combining green and development, but also emphasizes the resources, ecology, environment, production and life, etc., and highlights the evaluation and comparison of green development in various regions. Six sub-indexes and 56 indicators should be further used to compare and analyze the achievements and existing problems in various key fields of ecological civilization construction in various regions. To consolidate and maintain the advantages of the field, for the need to improve and improve the field of in-depth analysis and research, put forward targeted measures and implementation, so as to complement the weak links of green development, from resources, environment, ecology, quality of growth, lifestyle and other comprehensive joint efforts to achieve comprehensive and coordinated development.

The development concept of "green water and green mountains are mountains of gold and silver" has been refined into specific arrangements in various aspects. Recently held national conference on ecological protection, and further puts forward the construction of ecological civilization in our country is in the critical period, GongJianQi, window period of the new judgment, under this background, as the first national pilot provinces, ecological civilization according to xi jinping, general secretary of the important requirements for working in jiangxi, play the largest green ecological brand, completes the afforestation and water, obvious as articles, out of the economic development and ecological civilization level supplement each other, bring out the best in each other's way, create beautiful "model" in jiangxi province, China.

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The determinants of remittances: Evidence from Oman*

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Abstract
Over the past years, remittances have become increasingly important as a source of income for many developing countries. In this paper, we examine determinants of remittances by scrutinizing the outflow of funds from Oman to home countries of the majority of foreign workers in Oman. To investigate the relationship between foreign workers remittances and some macroeconomic indicators in Oman and major recipient countries, we use Philip and Hansen (1990) FM-OLS method. According to FMOLS estimation, we found that non-oil GDP, real GDP per capita in home countries and new employment of foreign workers in Oman have significant and positive effect on remittance sent from Oman by foreign workers. However, both exchange rate of home countries' currencies against USD and prices level in Oman negatively affect the level of remittances.

Keywords
Workers; Wages; Growth; Current Account; Least Square

1. Introduction

Workers' remittances are among the topics that have received much attention both locally and internationally see Shaun and Gradzka (2007), Sayan (2010), Frankel (2010), Adams, R. H. Jr. (2006) and others. Economic literature differed in the definition of workers 'remittances, but it remained unified in terms of its general concept, its significance and the role it plays in the development of peoples' lives.

The term "remittances" generally refers to remittances sent by an immigrant to their families either cash or in-kind outside his or her country of employment.

The IMF (2010) defines them as current remittances from those who work in an economy other than their own economy and reside in it. Workers usually send these funds to their relatives. In addition, the remittances of workers are

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included in current account transfers in the current account of the balance of payments.

Over the past years, these remittances have become increasingly important as a source of income for many developing countries such as Kyrgyzstan, Tajikistan and Nepal (35%, 31% and 29% respectively). As a result of the steady increase in the number of migrants from their countries, light should be shed to extensively study and clarify the role that these transfers play for all concerned parties from recipient countries and exporting countries of such transfers. In this paper, we examine determinants of remittances by scrutinizing the outflow of funds from Oman to home countries of the majority of foreign workers in Oman.

The remainder of this paper is organized as follow: section 2 gives a glance on worker remittances in Oman. Section 3 outlines a review of the literature relating to the determinants of remittances. Section 4 covers the methodology that examined the methods that will be used to achieve the objective of this study followed by section 5 that shows the empirical results. Section 6 comprises a discussion on the findings and lastly, section 7 comprises of the conclusions and recommendations of this study.

2. Worker Remittances’ Magnitude and Trend in Oman

There are seventeen commercial banks and sixteen exchange houses licensed to send remittances abroad and issuance of draft operations by end of September 2017. This resulted in decreasing administrative users’ fees. The demand for foreign workers in Oman has been increasing despite the unfavourable economic environment. Graph 1 shows the development of foreign workers. Growth also was fuelled by the need for foreign workers participation in developing Oman major projects, which includes main road works, many new regional airports and the development of Muscat Airport etc. However, as of December 2016, 91 percent of foreign labour in Oman are in labour intensive sectors and they are to make money and sent them back when they are paid.

Remittances in Oman has been on the rise as shown by CBO statistics. Graph 2 shows the development of remittances in Oman over up to end of 2016. Growth of worker remittances in recent years slowed since disposable income in Oman declined because of the decline in energy prices.

3. Literature Review

Abdel-Rahman (2003) studies the trend and cause of per worker remittances in Saudi Arabia. He includes some determinants that are important in Saudi case as one of the major remittances sending-country. These determinants include, GDP of Saudi Arabia, wages per worker as a measure of income, returns on capital and a number of risk indicators and socio-economic factors affecting the Saudi economy. Results from this study are generally in line with major studies in regards to causes of workers remittances. The study finds a significant and positive relationship between GDP per capita and the level of remittances per worker. The remittances level moves pro-cyclically with the level of economic activity. Wages have significant and positive impact on the level of remittances. However, the study finds an inverse relationship between the return on capital in Saudi Arabia and the amount of money workers remit. According to this study, expats remit more money when political risk is perceived to be higher.

According to Lucas & Stark (1985) migrants have three motivations to remit money. The first motivation is the altruistic characteristic of the migrant. Where the worker derives his or her utility from the utility of his or her family, which depends on consumption per capita of the family. A second motivation is self-interest. The worker remits money for his own benefit. The migrant worker remits more to increase his chances of inheriting some wealth from his or her parents. In addition, the migrant worker could enhance his or her political influence. Thirdly, the authors argue that migrants usually enter into implicit arrangements with their families. These arrangements are based on two main components, investment and risk. By allowing a member of the family to emigrate, families try to diversify the risk and insure themselves against bad states of the world such as drought or fluctuating prices.

Overall, causes of remittances have been well documented in the literature. Yet, workers tend to remit more with adverse business cycles in home country and these remittances usually used for consumption rather than investment.

4. Methodology

One single equation approach is most suitable in our aim at explaining the remittances changes in Oman. We estimate the following specification of the regression equation:

$$Rem_t = \alpha + \Sigma_i \beta_i X_{it} + \varepsilon_t \quad , \varepsilon_t \approx N(0, \sigma^2), t = 1,2, \ldots, T$$

Our dependent variable measured in Rial Omani. In this model, we regress remittances on a set of independent explanatory variables to explain the changes in level of remittances sent. The description of the explanatory variables are present and their relation to remittances is presented in section 4.2 of this study.

Data

This study examines the remittances of foreign workers in Oman and the determinants of these remittances. These remittances have been pressuring Oman Current Account balance. The data consist of yearly remittances from Oman over the period 1980-2016 which are reported by Central Bank of

Oman. Moreover, macroeconomic indicators, which we use as explanatory variables are available from the International Monetary Fund's World Economic Outlook database.

Dependent Variable

Rem: according to the IMF (2009), International Transactions in Remittances Compilation Guide, remittances represent income received in foreign economies that arises from movement of workers to those foreign economies, which includes cash or in kind and flow through official and nonofficial channels.

Explanatory Variables

Among the determinants of remittances is the business cycle in Oman, which defines the level of economic activities and the demand for foreign labour in which Business cycle is measured by both oil activities and non-oil activities in Oman. Also, we consider adding the demand for foreign labour in Oman which is measured by the number of foreign labour in both public and private sector in Oman. Another determinant of remittances is income in both Oman and the home country, which is a proxy- measure of the level of altruism the foreign worker has. A fourth determinant is the level of prices in Oman, and as well as the home country. In addition, the exchange rate movement plays a greater role in determining the level of remittances. However, because Oman has a fixed exchange rate we only consider the movement of foreign worker home countries' currencies against USD. Table 1 below shows a summary of variables used in this study. The table provides list of all variables included in this study and their description, followed by a brief description of each variable measures and the expected effect on level of remittances.

Econometric Techniques

Unit Root Tests

To define the causal relationship between time series data, one need to make sure that these series have solid relationship and not spurious association. Therefore, we employ two test to check for the stationary of the series. These tests allow us to determine the level of integration of the series employed in this study. This study is using Augmented DickeyFuller test (ADF) for testing the series of having unit roots and Kwiatkowski-Philips-Schmidt-shin (KPSS).

Cointegration Test

We use the Johansen (1988) test for cointegration between the non-stationary variables. The optimal lag length is determined using the Akaike Information Criterion (AIC). In addition, the estimated VAR consists of the series discussed in this study that we are testing for long-run equilibrium. Lutkepohl (1991) and Hamilton (1994) both show if all roots of the estimated VAR lie inside the unit circle then it is proven that the VAR meets the stability condition. The trace statistics test and the max-eigenvalue test indicate if there exist cointegration among variables of interest, we would proceed to estimate Vector Error Correction Model (VECM).

Fully Modified Ordinary Least Square Method (FM-OLS)

To investigate the relationship between foreign workers remittances and some macroeconomic indicators in Oman and major recipient countries, we use Philip and Hansen (1990) FM-OLS method. FM-OLS is good for a small sample size regression. This method modifies the least squares to tackle the problem of serial correlation in single equation and by this; FMOLS achieves asymptotic efficiency (Rukhsana and M Shahbaz, 2008).

5. Results

Unit Root Result

Tables 2 & 3 reports the results of ADF unit root test for unit root and the KPSS for stationary. Both tests confirm that all variables are integrated of order 1 or I(1) at the 5 percent significance level. Schwarz Information Criterion (SIC) determines the optimal lag length for ADF test.

Cointegration Result

Since all the variables in this study are I(1), we therefore estimate the appropriate lag-length of VAR at levels suggested by Log likelihood, AIC, SIC and HIQIC in VAR estimation. Table 4 reports the VAR lags order selection criteria. The stability condition of VAR along with appropriate autocorrelation test are reported in the appendices.

Tables 5 and 6 show the result of Johansen and Juselius cointegration test done for examining the long-run relationship between series under study. Trace statistics and Maximum Eigen values show there are number of cointegration relationships with trace test indicates there are only two. Meanwhile, Maximum Eigenvalues indicates that there are at most 3 long-term relationships at 5 % significant level.

We showed that there exist some long-run relationship between remittances and some macroeconomic variables in Oman. Our next step is to estimate the long-run elasticities using FM-OLS. Table 7 below reports the results from single cointegration equation.

The FMOLS results reveals a significant positive effect of nonoil GDP on remittances, where a 10% increase in nonoil GDP increases remittances by almost 9 percent. In addition, remittances are positively affected by real GDP per capita in home countries, where a 10 percent increase in real GDP per capita in home countries increases remittances from Oman by 4 percent. Another significant and positive relationship is found between employment in Oman and amount sent abroad as remittances. A 10 percent rise in employment of foreign labour would lead to 5 percent increase in remittances.

However, a rise of prices level in Oman by 10 percent reduces remittances sent by 4 percent. In addition, our FMOLS estimator reveals that rising exchange rate of home-country currencies against USD negatively affect remittances. The dummy variable Dummy2001 significance level explains that war on terrorism back in 2001 affected the amount sent by foreign workers to their respected countries due to political instability.

6. Discussion and Conclusion

The paper investigated the determinants of workers remittances in Oman by utilizing FMOLS for the series in this paper. All the series in the study was found to be integrated of order 1 i.e. I (1). Johansen 1988 cointegration test was perfumed and we found that there are many long-term relationships among the variables. According to FMOLS estimation, we found that non-oil GDP, real GDP per capita in home countries and new employment of foreign workers in Oman have significant and positive effect on remittance sent from Oman by foreign workers. However, both exchange rate of home countries' currencies against USD and prices level in Oman negatively affect the level of remittances.

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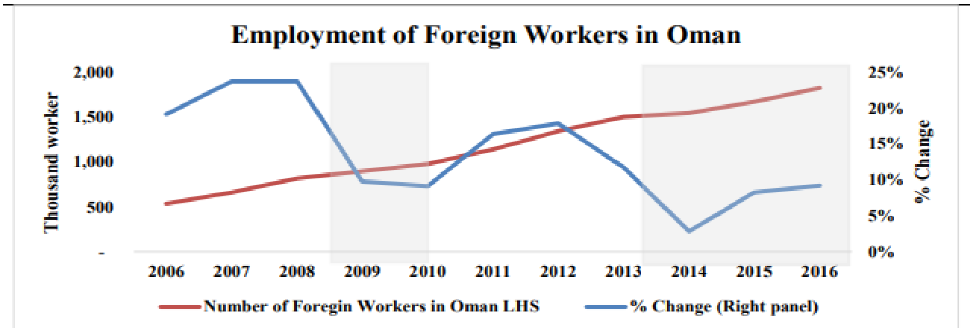
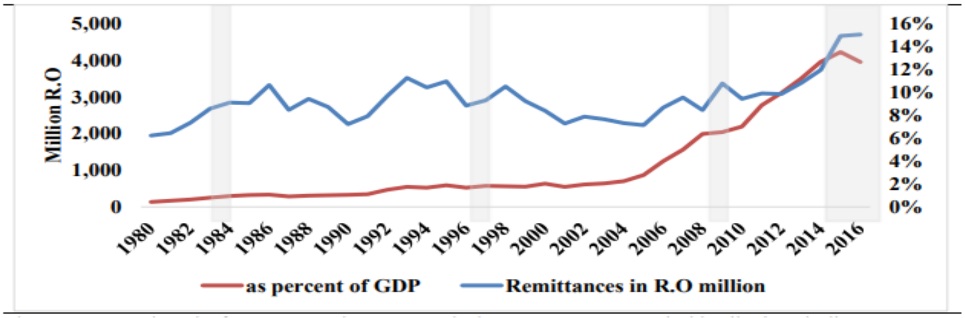
Appendix

Graph 1: Employment of Foreign Workers in Oman



* Source: NCSI annual reports. # Shadow years represent noticable oil prices declines.

Graph 2: Annual Remittances from Oman



* Source: Central Bank of Oman Annual Reports. # Shadow years represent noticable oil prices declines

Table 1: Variable Definitions, Measures and Expected Effect of Explanatory Variables

Variable	Description of the variable	Measure	Expected Effect
Dependent variable			
Rem	Total remittances in USD	Natural logarithm of total remittances through formal channels from Oman	n.a
Explanatory variables			
1. NON_GDP	Yearly non-oil GDP in USD	Natural logarithm of nominal non-oil GDP in R.O million	Positive
2. rGDPpc_o	Real GDP per capita in Oman in USD	Natural logarithm of real GDP per capita in Oman	Positive
3. rGDPpc_home	Weighted average real GDP per capita of home countries	Natural logarithm of Weighted average of real GDP per capita in home countries	?
4. CPI_om	Consumer Price Index in Oman	Natural Logarithm of chained Oman CPI. Base year = 2010	?
5. Emp	Employment of foreign labour	Natural logarithm of total foreign labour workforce in public and private sector in Oman	Positive
6. EXCH	Weighted average exchange rate of three home countries	Natural Logarithm of weighted average exchange rate against USD	Positive

Table 2: ADF Unit root Test

Variable	Level t-stat	C.V	Result	First differenced t-stat	C.V	Level of Integration
Rem	-0.18	-2.95	Series has unit root	-4.40	-2.95	I(1)
Non_gdp	-1.83	-3.54	Series has unit root	--4.14	-2.95	I(1)
emp	-1.97	-3.54	Series has unit root	-4.26	--2.95	I(1)
rGDPpc_om	-2.66	-2.95	Series has unit root	-5.25	-2.95	I(1)
rGDPpc_hom	-1.64	-3.54	Series has unit root	-4.91	-3.54	I(1)
cpi_om	-2.62	-3.54	Series has unit root	-3.68	-2.95	I(1)
exch	-1.66	-3.54	Series has unit root	-4.58	-3.54	I(1)

Table 3: KPSS Stationary Test

Variable	Level LM -stat	C.V	Result	First differenced LM -stat	C.V	Level of Integration
Rem	0.18	0.15	Series has unit root	0.11	0.15	I(1)
Non_gdp	0.18	0.15	Series has unit root	0.13	0.15	I(1)
emp	0.16	0.15	Series has unit root	0.15	0.15	I(1)
rGDPpc_om	0.19	0.15	Series has unit root	0.09	0.15	I(1)
rGDPpc_hom	0.19	0.15	Series has unit root	0.07	0.15	I(1)
cpi_om	0.17	0.15	Series has unit root	0.08	0.15	I(1)
exch	0.06	0.15	Series has unit root	0.12	0.46	I(1)

Table 4: Lag Length Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	202.0007	NA	3.42E-14	-11.1429	-10.8318	-11.0355
1	473.2214	418.4549*	1.11E-19	-23.8412	-21.35267*	-22.98218*
2	529.079	63.83716	1.07e-19*	-24.23308*	-19.567	-22.6224

Table 5: Trace Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5% C. V.	Prob.**
None	0.831833	168.5271	125.6154	0.000
At most 1	0.711138	106.1292	95.75366	0.008
At most 2	0.635774	62.66598	69.81889	0.1628

**MacKinnon-Haug-Michelis (1999) p-values

Table 6: Maximum Eigenvalues Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5% C. V.	Prob.**
None	0.831833	62.39786	46.23142	0.0005
At most 1	0.711138	43.46323	40.07757	0.02
At most 2	0.635774	35.34936	33.87687	0.0331
At most 3	0.310869	13.03132	27.58434	0.8832

**MacKinnon-Haug-Michelis (1999) p-values

Table 7: FMOLS result (Dependent variable: *Rem*)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
NON_GDP	0.878	0.115	7.658	0.000
RGDPPC_O	-0.022	0.149	-0.145	0.886
RGDPPC_H	0.406	0.198	2.054	0.050
CPI_OM	-0.433	0.161	-2.686	0.012
EMP	0.548	0.059	9.223	0.000
EXCH	-0.445	0.073	-6.065	0.000
DUMMY2001	-0.140	0.048	-2.933	0.007
C	-3.032	1.864	-1.627	0.115
R^2	0.996824	Adjusted R^2	0.996031	

Statistics' importance to assess food security in the 2030 Agenda

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High Commission for Planning Morocoo

Abstract

Agricultural statistics have a key role in monitoring progress in food security. They cover a large part of the indicators providing information on the level of food security. However, the record for specific surveys is an option not to ignore for better identification of the nutritional status of populations. The objective of this paper is to study food and nutrition security in the framework of the 2030 Agenda through the analysis of the links between SDG2 and the other SDGs on the one hand and the 4 axes of food security and the SDGs on the other hand. It's based on individual consultation to build a global vision on the contribution of the SDGs to the 4 dimensions of food security. Finally, it makes a comparison between countries in the achievement of the SDGs, through the analysis of homogeneous groups (PCA).The 2030 Agenda recognizes that achieving many of the targets of the various SDGs will depend on progress made in food security. However, progress on SDG 2 will depend on the results achieved for several targets from the other targets. Therefore, there is a need to consider the mutual relations within SDG 2 as well as the interactions between the SDGs. Objective 2, which has eight targets related primarily to outcomes on hunger and nutrition and covers the four dimensions of food security, is most closely linked to the other 16 goals of the 2030 Agenda. The results of the cross-fertilization of the 17 SDGs and 4 axes of food security, resulting from the consultation, make it possible to clarify the importance of the SDG targets in the construction of its axes. Three homogeneous groups are identified: Mediterranean-type group (SDG 13, SDG 6), is, especially for the northern subgroup of the Mediterranean. However, this group is negatively impacting on the availability of natural resources (SDGs 2, 15) and the high unemployment rate in the Southern and Eastern Mediterranean Dream. Between these two sub-groups lies the Latin-Asian zone. On the opposite side, there is the Sub-Saharan Africa group. Despite the availability of fisheries and water resources (SDGs 6, 14), the Latin America group suffers from poor nutrition, and therefore members of this group miss out on SDG2.By way of conclusion, countries are classified according to the level of their food security, by moving from rich countries that meet their food needs to countries that cover part of their food needs by resorting to imports from hungry countries. With the exception of SDGs 1 and 12, the other SDGs are on the side of countries with a level of nutrition from the Good State to the Modest level. SDGs 16 and 17 are at the center of the cloud of other SDGs.

Keywords
SDG; Food Security; Statistics

1. Introduction

Agricultural statistics have an important role in monitoring progress in food security and population nutrition. In fact, the usual national statistics cover a large part of the indicators providing information on the level of food security at the country level. However, for a better knowledge of the nutritional status of populations, the record of statistics from specific surveys remains a choice not to ignore. And with global sustainable development initiatives, the record for such statistics becomes an indispensable and necessary tool. The United Nations 2030 Agenda provides a framework from which agricultural and environmental statistics will need to be enriched and diversified to meet food security indicators in the 17 SDGs.

This paper zooms in on the statistics used to clarify the level of food security and the nutritional status of populations on the one hand and how these statistics are introduced into the indicators of the 17 SDGs on the other hand.

This paper addresses the level of food and nutrition security in Agenda 2030 through:

- a double reading: the links between SDG2 and the other SDGs on the one hand and the 4 axes of food security and the SDGs on the other hand.
- the paper is based on an individual consultation with the source persons chosen beforehand. It allows to build a global vision and share on the contribution of the SDGs to the 4 dimensions of food security (crossing of the SDGs and 4 axes).
- the analysis makes a comparison between the African countries in particular in the achievement of the SDGs in 2030, through an analysis of homogeneous groups (ACP)

2. Food Security and The SDGs

Food Security in Global Orientations

The United Nations through its various agencies as well as the various global organizations have integrated the issue of food security into their priority initiatives and programs. Several global, regional and local institutions are specialized in the issue of food security and therefore, specific and local approaches are developed.

The 2030 Agenda, the global framework for sustainable development of nations, puts food security and nutrition in its top concern more than the MDGs. Goal 2 on eradicating hunger and malnutrition and promoting sustainable agriculture as the second largest of the 17 SDGs is largely justified.

In addition, Africa's Agenda 2063 places food security among its strategic priorities (Goal 6) to address the geostrategic challenges of African countries.

Food Security is at The Center of SDG 2

SDG 2 is a global goal with eight linked targets mainly related to outcomes related to hunger and nutrition, smallholder income and sustainable agriculture. They cover the four dimensions of food security proposed by FAO (availability, access, use and stability).

By sustainably managing available natural resources, the 17 SDGs that address the three dimensions (economic, social and environmental) of sustainable development, contribute differently (direct and indirect) to eradicating poverty and hunger, and and have indissociable targets.

Indeed, the 2030 Agenda recognizes that achieving many of the targets of the various SDGs will depend on progress made in food security and sustainable agriculture. However, progress on SDG 2 will depend on the results achieved for several targets from the other targets. Therefore, there is a need to consider the mutual relations within SDG 2 as well as the interactions between SDG 2 and the others in order to achieve SDG 2 targets.

Links Between SDG 2 and The Other SDGs

Objective 2 is most closely linked to the other 16 objectives of the 2030 Agenda according to the four dimensions of food security:

- **Access to food**

SDG 1 on poverty eradication: Inadequate income is the main problem for many people affected by food insecurity. Many food producers are unable to provide adequate nutrition for themselves and often have limited access to land, water and other means of production, as well as financial resources.

It is essential that people's incomes are sufficient for everyone to have access to nutritious food and thus to lead a healthy life.

SDG 8 (promoting sustained, shared and sustainable economic growth) and SDG 10 (reducing inequality) are goals that should not be overlooked from the point of view of access to food.

- **Food availability**

SDG 6 (Ensuring access for all to water and sanitation services), especially aspects related to drinking water supply. By 2030, global demand for water is set to increase by 50%. Agriculture uses more than 70% of the water consumed in human activities. Increasing agricultural production with less water is a huge challenge (Target 2.3).

SDG 12 (establishing sustainable consumption and production patterns) is closely linked to the promotion of sustainable agriculture and food availability. Knowing that every year, about a third of food production is lost or wasted. This SDG stresses the importance of reducing food losses and waste along production and supply chains, including post-harvest losses (Target 12.3).

SDG 13 (taking action to combat climate change): recognizing that climate risks mainly affect the most vulnerable people, who are exposed to natural disasters, who are at risk of aggravating hunger, because they have major impacts on agricultural production, destroy land, livestock, crops, food reserves, ...

SDG 14 (conserve and sustainably use marine resources) and SDG 15 (conserve and sustainably use land and halt biodiversity loss) refer to the term sustainability and are therefore essential to long-term availability of food resources.

Soil is a non-renewable medium-term resource that is essential for food production. Sustainable farming practices would increase the productivity of small farmers and create off-farm employment, which would limit land degradation, deforestation and desertification and restore terrestrial ecosystems.

- **Food use**

SDG 6 (ensuring access for all to water and sanitation services) and SDG 3 (enabling healthy living and promoting well-being) are relevant from the point of view of improving nutrition. Indeed, access to clean water and adequate sanitation prevents the spread of a number of diseases, and prevents the proper assimilation of food, which leads to malnutrition.

SDG 4 (ensuring quality education): Appropriate education enables people to improve their behavior, including nutrition, hygiene, sanitation and health.

- **Food stability**

Food stability implies the stability of the three dimensions previously mentioned in time in space (throughout the year). Apart from SDG 2 and more specifically Target 2.4, the SDGs do not directly address food stability, but allude to it. All objectives and targets dealing with infrastructure strengthening (9.a and 11.a), tackling the effects of climate change (SDG 13), sustainability of natural resources (SDGs 14 and 15), promoting peace around the world (SDG 16) and improving finance and trade (SDG 17), contribute directly and indirectly to ensuring food stability around the world.

3. Importance of The Links Between The SDGs And Food Security Methodology

In order to build a broad vision on the role of the SDGs in achieving food security and nutrition among potential stakeholders at the national level, consultations with source persons were conducted via an individual questionnaire. This questionnaire is based on the opinion of those who are in contact with either the SDGs or with food security and / or both. 18 people were interviewed representing 12 departments and organizations.

The cross-fertilization results of the 17 SDGs and 4 axes of food security, resulting from the consultations, make it possible to analyze at two different levels and to raise the following observations:

- The contribution of each SDG through specific targets to the achievement of the different axes of food security.

● The SDGs contribute an average of 6% for each of them to the formation of the 4 axes of food security with an average difference of 4.62. However, the five SDGs (2, 6, 12, 14, 16) which constitute the core of the food security of the 17 SDGs, together contribute 61% to the formation of the 4 dimensions of food security with an average of 12 points and a gap of 2.8, with SDG 2 coming in first with 16% followed by SDG 6 and SDG 13 with 13% and 12% respectively. In addition, SDG 2 contributes 4 times more to the formation of food security axes than SDG 4.

● Global Cooperation and Solidarity (SDG 16) is the strategic pillar of food security in developing countries with a 12% contribution similar to the efforts in SDG 12 on food loss and waste. Similarly, development finance is in great demand for strengthening the quality of nutrition and improving the level of food security especially in underdeveloped countries.

The Importance of The Axes in The Targets of The SDGs

The vertical reading of the intersection of the axes and the SDGs makes it possible to raise the following conclusions:

● The 4 dimensions together accumulated 85 points in absolute value in terms of the contribution of all the SDGs together with an average of 21 points per axis. However, the SDGs together contribute more to ensure the availability of food products with 35%, therefore they put it first, followed by access with 32% and 29% for the axis of stability. The quality of nutrition and the use of food products attracted only 15% of the SDGs. This observation is justified for those countries suffering from hunger.

4. The Determinants of Food Security in The Context of The SDGs Methodology

Principal Component Analysis (PCA) provides a harmonized and comprehensive reading of several cross-variables that affect the levels of food security and nutrition in different countries (21) representing different regions of the globe. The four continents are represented by a number of countries namely:

Bibliographic research has identified several variables determining the level of food security crossed with the SDGs. Given the large number of variables identified (49), some variables were considered additional (30) and do not act on country situations.

5. Importants' Results

Reading the results above identifies three major homogeneous groups:

- Mediterranean-type group, threatened by climate change (SDG 13) and scarcity of water resources (SDG 6), is characterized by a high level of R&D and IFP, especially for the Northern subgroup of Mediterranean (Spain, France, Italy) whose SDGs 3, 7, 8 and 9 have a greater role in the level of food security of the countries. Their roles in global cooperation to improve the level of nutrition in the world is crucial (SDGs 16 and 17). However, this group is negatively affected by the availability of natural resources, particularly the agricultural land boundary (SDGs 2 and 15) and the high unemployment rate in the Southern and Eastern Mediterranean Dream (AMU and Near East countries).

Between these two sub-groups is the Latin-Asian zone with a modest per capita GDP between those of the subgroups.

- On the opposite side, we find the Sub-Saharan Africa group of countries with a high agricultural GDP each time we move from coastal areas to the East. A noted threat to fisheries resources (SDG 14) in the countries on the Atlantic coast (Côte d'Ivoire and Senegal) and a lack of food, unlike the first group in the area of food waste (SDG 12) for the mainland countries Mali, Benin).
- Despite the availability of fisheries and water resources (SDGs 6 and 14), the Latin American group suffers from poor nutrition, and therefore members of this group are missing out on SDG2 without reaching it. The achievement of the SDGs especially for their level of food security.

The analysis of the first axis considered the axis of food safety makes it possible to raise the following conclusions:

- Countries are classified according to the level of their food security, by moving from rich countries (EU) that have met their food needs (right of the axis) to countries that partly cover their food needs by resorting to imports (South Africa). north and near-east) to countries suffering from hunger and based on aid and gifts in kind (Sub-Saharan African countries).
- With the exception of SDGs 1 and 12, the other SDGs are on the side of countries with a level of nutrition from the Good State to the Modest level. SDGs 16 and 17 are at the center of the cloud of other SDGs.
- Governance, the reduction of waste of food products and the treatment of household waste have a positive effect on the quality of nutrition in less developed countries.

6. Conclusion

Agricultural statistics play a key role in monitoring progress in food security and nutrition. They cover a large part of the indicators providing information on the level of food security. However, the record for specific surveys is an option not to ignore for better identification of the nutritional status of populations. The United Nations 2030 Agenda provides a framework from which agricultural and environmental statistics will need to be enriched, diversified and standardized in order to respond in the same way to food security related indicators in the 17 SDGs.

The analysis has shed light on the importance of the SDGs to eradicate hunger and ensure a level of food security under optimum exploitation of natural resources.

According to FAO publications, the 2030 Agenda recognizes that achieving many of the targets of the various SDGs will depend on progress made in food security. However, progress on SDG 2 will depend on the results achieved for several targets from the other targets. Therefore, there is a need to consider the mutual relations within SDG 2 as well as the interactions between the SDGs.

- Access to food includes SDGs 1, 8 and 10;
- Food availability, we find SDGs 6, 12, 13, 14 and 15;
- Food utilization: the main SDGs that can contribute are 6, 3 and 4;
- The SDGs do not directly address food stability, but allude to it (9, 11, 13, 14, 15, 16, 17).

The crossing of the 17 SDGs and the 4 axes of food security, resulting from the consultation, make it possible to clarify the importance of the targets of the SDGs in the construction of its axes. SDGs 2, 6, 12, 14 and 16 constitute the core of food security, 61% contribute to the formation of the 4 dimensions, and SDG 2 ranks first (16%) followed by SDG 6 (13%). %) and 13 (12%).

Global solidarity and reduced waste of food products are among the strategic pillars of food security in developing countries, accompanied by enhanced development funding.

The 4 dimensions accumulated 85 points in absolute value in terms of the contribution of the SDGs with an average of 21 points per axis. The SDGs contribute more to ensure food availability (35%), followed by access (32%) and stability (29%). The quality of nutrition and the use of food products ranked last (15%).

The analysis of determinants of food security in the context of the SDGs through principal component analysis, a, allows us to study cross-variables from different regions of the globe (21 countries). Some variables were considered additional (25/49). Three homogeneous groups are identified: Mediterranean-type group, threatened by climate change (SDG 13) and scarcity of water resources (SDG 6), is characterized by a high level of R & D, especially for the North subgroup of the Mediterranean. Their roles in global cooperation to improve the level of nutrition in the world is crucial (SDGs 16 and 17). However, this group is negatively impacting on the availability of natural resources (SDGs 2 and 15) and the high unemployment rate in the Southern and Eastern Mediterranean Dream. Between these two sub-groups lies the Latin-Asian zone with a modest GDP per capita. On the opposite side, there is the Sub-Saharan Africa group of countries (% of high agricultural GDP) and a threat of fisheries resources (SDG 14) and a lack of food (SDG 12).

Despite the availability of fisheries and water resources (SDGs 6 and 14), the Latin America group suffers from poor nutrition, and therefore members of this group miss out on SDG2.

By way of conclusion, countries are classified according to the level of their food security, by moving from rich countries that meet their food needs to countries that cover part of their food needs by resorting to imports from hungry countries. based on aid and in-kind donations. With the exception of SDGs 1 and 12, the other SDGs are on the side of countries with a level of nutrition from the Good State to the Modest level. SDGs 16 and 17 are at the center of the cloud of other SDGs. Governance, the reduction of food waste and the treatment of waste have a positive effect on the quality of nutrition.

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Global coral species diversity and its relationship with environmental factors

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Abstract
In this study, the global pattern of species richness in corals was examined. I mapped hotpots of coral species richness by extracting more than 540,000 coral records (Class Anthozoa) and binned them to 2,592 cells in a 5 × 5 latitude-longitude grid. I then analyzed the relationships between global patterns of coral-species richness and environmental factors, such as sea-surface temperature, sea-surface salinity, partial pressure of CO_2, and sea-surface current. The highest levels of coral biodiversity were found to occur in tropical environments (ranging between ~25°N and ~25°S) characterized by relatively high water temperatures (25–27°C), and salinity levels of 34–35 PSU and 360–380 μ atm of partial pressure of CO_2. These environments were largely restricted to the Caribbean Sea, the Indian Ocean and the western Pacific Ocean, regions where warm oceanic currents flow at moderate speeds (< 0.2 ms^{-1}).

Keywords
Biodiversity; climatic change; global distribution; species richness

1. Introduction

Coral reefs are one of the most productive ecosystems on earth. They are estimated to cover more than 280,000 km^2 of the surface area in oceans and fringed one-sixth of the world's coastlines, thus provide varied marine habitats that support a large variety of other organisms (Barnes & Mann 1991; Birkeland 1997). The ecosystems of coral reefs are biologically rich and may be home to about 4,000 coral reefassociated fish species and 25% of all known marine animal and plant species, including seabirds, sponges, cnidarians, mollusks, worms, crustaceans, echinoderms, sponges, tunicates, sea squirts, sea turtles and sea snakes (McAllister 1995; Birkeland 1997; Spalding & Grenfell 1997; Spalding et al. 2001). Although corals can exist at greater depths and colder temperatures at a wide range of latitudes, shallow-water reefs form only in a zone extending in tropical and subtropical waters (from 30°N to 30°S latitudes of the equator) and only 800 species of reef-building corals have been described (Paulay 1997).

For humans, coral reefs deliver ecosystem services to tourism, fisheries and shoreline protection. However, more than 60 percent of the world's coral reefs are under direct threat from one or more local sources from anthropogic activities, such as overfishing and destructive fishing, coastal development, watershed-based pollution, marine-based pollution and damage, forest clearing, farming and crop cultivation (Burke et al. 2004). It is clear that coral reefs are suffering from massive declines of their diversities in response to anthropogic activities (Bellwood et al. 2004; Wilkinson 2008) and their status is declining rapidly all over the world (Bryant et al. 1998; Hoegh-Guldberg 1999).

Besides the damage from local-scale impacts, coral reefs are increasingly at risk from the global threats. Coral reefs are fragile ecosystems and are under threat from climate change and oceanic acidification (Danovaro et al. 2008). Twenty-five percent of the coral reefs in the world have already been destroyed or degraded through problems arising from global warming, because they are very sensitive to water temperature (Goreau et al. 2000). Warming sea temperatures can induce either widespread coral bleaching or death.

In this study, the aim is to investigate the global pattern of species richness in corals. I mapped species-rich hotspots areas showing the highest biodiversity. I analyzed the relationships between global patterns of coral species richness and environmental factors, i.e., sea surface temperature, sea surface salinity, partial pressure of CO_2 and sea surface current.

2. Methodology

The data of global coral distribution were retrieved from the Ocean Biogeographical Information System (OBIS 2016) database (available online from http://iobis.org/). I extracted more than 540,000 coral records (Anthozoa class) from OBIS and binned them to 2,592 cells in 5×5 latitude-longitude grid. I then calculated the number of species recorded in each of the 2,592 cell. In total, there are 1,084 cells which was recorded at least one species.

The data of sea surface temperature were obtained from "IGOSS nmc Reyn_SmithOIv2 monthly SST datasets" downloaded from the website of IRI/LDEO Climate Data Library (available online from http://iridl.ldeo.columbia.edu/SOURCES/.IGOSS/.nmc/). Data were retrieved on 22 January 2015. We obtained data for each month during 2005–2014, and calculated the 10-year average temperature (°C) at the central point for each 5×5 latitude-longitude grid cell. The data of sea surface salinity were downloaded from the website of the National Aeronautics and Space Administration (NASA 2016) Earth Observations. I obtained data for each month in 2014, and calculated the yearly average salinity (practical salinity units) at the central point for each 5×5 latitude-longitude cell.

The data of sea surface partial pressure of CO_2 were downloaded from the Global Surface pCO_2 (LDEO) Database V2014 (Takahashi et al. 2015) in the website of Carbon Dioxide Information Analysis Center. I obtained data for each month, and calculated the yearly average partial pressure of CO_2 (micro-atmosphere) at sea surface temperature and transformed the data of 4×5 latitude-longitude cells into the data of 5×5 latitude-longitude cells by using the value which closest to the central point of each 5×5 latitude-longitude cell.

The data of sea surface current were downloaded from the website of the Operational Surface Current Processing and Data Center of National Oceanic and Atmospheric Administration (NOAA) (available online from http://www.oscar.noaa.gov/). Data were retrieved on 12 January 2016. I obtained data for each month in 2014, and calculated the yearly average speed (m s-1) at the central point for each 5×5 latitude-longitude cell.

The smooth curve fitted to the data point was obtained by using the locally weighted scatterplot smoothing curve. At each point in the data set a low-degree polynomial is fitted to a subset of the data, with explanatory variable values near the point whose response is being estimated. The polynomial is fitted using weighted least squares, giving more weight to points near the point whose response is being estimated and less weight to points further away. The value of the regression function for the point is then obtained by evaluating the local polynomial using the explanatory variable values for that data point. All calculation and statistical analyses were performed using the statistical software R 3.2.3 (R Core Team 2015).

3. Results

The species richness of corals worldwide ranged from 1 to 688 (mean±standard deviation=40±84) in the 1,084 cells of 5×5 latitude-longitude grid recorded at least one species (Fig. 1). Globally, the highest species richness of coral reefs was found in tropics, especially in Indian Ocean, i.e., the region off eastern Africa, southern Asia and western Australia, western Pacific Ocean, i.e., eastern Australia, Indonesia, Philippines, Taiwan, Japan, islands of the tropical Pacific Ocean and Golf of Mexico and Caribbean Sea in the north tropical Atlantic Ocean. Among the 55 hotspots cells showing the highest species richness (top 5% of all recorded cells; number of species>200) worldwide, I found 47% (26/55) of them were in Indian Ocean, 33% (18/55) were in Pacific Ocean and 20% (11/55) were in Atlantic Ocean. Coral species richness was highest at the seas in intermediate latitudes (10–20°N and 10–20°S) and eastern hemisphere (40–170°E; Fig. 2).

The relationships between species richness and sea surface temperature (SST) sea surface salinity (SSS), partial pressure of CO2 (pCO_2), and sea surface current (SSC) worldwide were analyzed (Fig. 3). 1) Corals distribute at wide ranges of SST ranging from <0 to 30°C (Fig. 3a). The correlation of species richness with SST becomes higher in the cells showing >10 species ($r=0.36$; p-value<0.01). Among the cells having>100 species, species richness increased with increase of SST and the inclination of the line increased more sharp over 22°C, but decreased sharply over 27°C. 2) Corals distribute at wide ranges of SSS ranging from 31 to 38 PSU (Fig. 3b). Species richness was weakly correlated with SSS in all cells (r=–0.03; p-value=0.26). The cells with the highest species richness were located in the area showing median salinity (34–36 practical salinity unit; PSU). Among the cells showing>100 species, species richness increased gradually from 32 PSU until 35 PSU, but decreased slightly over 35 PSU. 3) Corals distribute at wide ranges of pCO_2 ranging from 300 to 450 μ atm (Fig. 3c). Species richness was weakly correlated with pCO_2 in all cells (r=0.09; p-value=0.02). The cells showing the highest species richness were located in the area with median pCO2 (340–390 micro-atmosphere; μ atm). Among the cells showing>100 species, species richness increased from 340 μ atm until 380 μ atm, but decreased suddenly over 390 μ atm. 4) Corals distribute at wide ranges of the speed of sea surface current (SSC) ranging from<0.0 to 0.7 m s–1 (Fig. 3d). Species richness was weakly correlated with the speed of SSC in all cells (r=0.11; p-value<0.01). The cells showing the highest species richness were located in the areas with the speed of SSC<0.2 ms^{-1}. Species richness in the cells with speed of SSC>0.4 ms^{-1} (mean=74.8) was found higher than average species richness in all cells (z test; p-value<0.01).

4. Discussion and Conclusion

The global patterns of marine species richness has been widely studied, including in a cross section of organisms ranging from phytoplankton (Irigoien et al. 2004; Barton et al. 2010; Boyce et al. 2010), zooplankton (Irigoien et al. 2004; Tittensor et al. 2010), marine mammals (Tittensor et al. 2010), tuna and billfish (Worm et al. 2005; Boyce et al. 2008; Trebilco et al. 2011), and sharks (Lucifora et al. 2011; Chen & Kishino 2015). Being one of the biologically richest ecosystems in the oceans, the global decline of coral reefs highlights the need to understand the global patterns of diversity of coral species (Hughes et al. 2003; Bellwood et al. 2004) and their conservation priorities (Roberts et al. 2002; Veron et al. 2009a). Local richness and the size of regional species pools were reported to decline significantly across 15 islands spanning the gradient in the central Indo-Pacific, the most diverse coral reefs in the world (Karlson & Cornell 2002). I analyzed the environmental factors which influence the species diversity of corals using global datasets, and found out the optimum environmental conditions which allow the highest diversity. The optimum environments obtained relatively high diversity for corals was found in the shallow waters with 25–27°C of water temperature, 34–35 PSU of salinity and 360–380 uatm of pCO_2, and with the speed of sea surface current <0.2 m s–1 (Fig. 3). These environments were mostly limited in the tropics (from ~25°N to ~25°S of the equator). The optimum temperature to obtain good growths and maintain healthy ecosystems in most coral reefs is 26–27°C

(Achituv & Dubinsky 1990), and it is well corresponded to our result (Fig. 3a). On the other hand, some corals were identified in harsh environment with a wide range of water temperature, e.g., 37 species of scleractinian corals which were found around Larak Island (Vajed Samiei et al. 2013), and corals in the Persian Gulf have adapted to temperatures of 13°C in winter and 38°C in summer (Wells & Hanna 1992).

The salinity of open water is generally between 34 and 37 PSU and is lower in coasts and estuaries (Kirst 1989). Globally, corals can thrive in exceptionally high and low salinity conditions and occur in a wide salinity range between 31 and 38 PSU (Fig. 3b). However, compared with average salinity concentrations, sudden decreases in salinity due to high freshwater input from rivers or torrential rains is seen as a main factor for the disappearance of massive coral reefs (Muthiga & Szmant 1987; Moberget al. 1997 Hoegh-Guldberg et al. 2007). When CO_2 levels reached around 340 ppm (mixing ratio of CO_2 in dry air; that is, the number for uatm of CO_2 in 1 atm air will be equivalent to ppm of CO_2, so depends on temperature and relative humidity the number for uatm of CO_2 is somewhat lower than that for ppm of CO_2), sporadic but highly destructive mass bleaching occurred in most reefs around the world (Veron et al. 2009b). However, CO_2 levels was predicted to reach 450 ppm by 2030–2040 at the current increasing rates, which could cause corals to be in rapid and terminal decline worldwide from multiple synergies (Veron et al. 2009b).

The regions with high species richness of corals are mostly located in the western coasts in the oceans which the warm sea currents travel though (Fig.1), e.g., Kuroshio Current and East Australian Current in the west Pacific Ocean, Agulhas Current and Mozambique Current in the west Indian Ocean and Gulf Stream in the west Atlantic Ocean. In tropical and subtropical waters, the species diversity was found low along the west coasts of the North and South Americas and west coasts of Africa, and (Fig. 1), which is due to upwelling and strong cold coastal currents that reduce water temperatures in these areas (California, Peru, Benguela and Canary currents, respectively; Nybakken 1997). The freshwater released from the rivers can also due to the low species richness at the coastal areas (Spalding et al. 2001), e.g., along the coasts of northeastern South America (Amazon River; Fig. 1) and the coastline of South Asia (Ganges River; Fig. 1).

The two hotspots, where more than 700 species distribute, were found at the coastal area of Myanmar in the Bay of Bengal (with a number of large rivers flow into the bay, such as Ganga River, Padma River, Hooghly River and Brahmaputra River) and the famous Great Barrier Reef, the world's largest coral reef system (UNEP World Conservation Monitoring Centre 1980), at the coastal area of northeast Australia. This hotspot is located in the Coral Triangle, an area extending from the Philippines to the Solomon Islands, has 76% of the world's total species complement including 15 regional endemics (Veron et al. 2009a).

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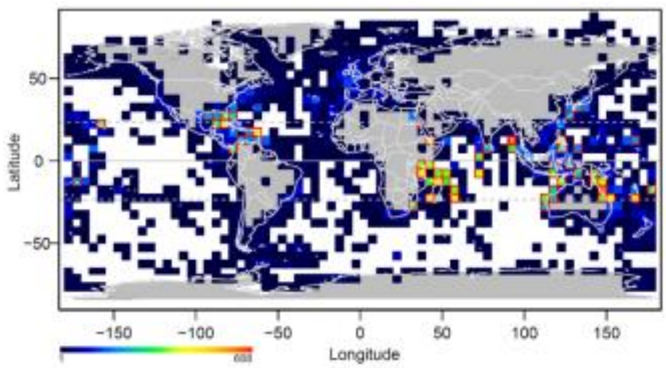

Figure 1. Global patterns of species richness of corals. Colors refer to the number of species in each 5×5 latitude-longitude cell. The 55 cells with the highest species richness (top 5% of all recorded cells) are indicated with red outlines. Negative numbers indicate southern latitudes and western longitudes.

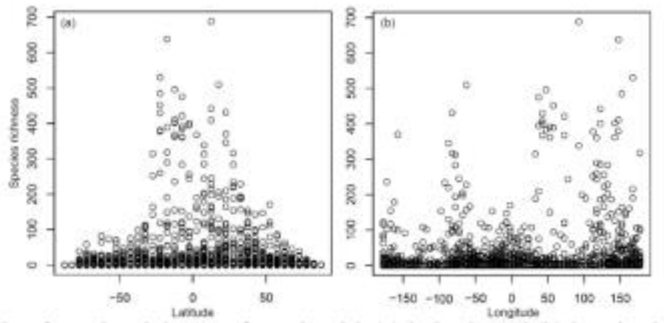

Figure 2. Relationship of species richness of corals with (a) latitude and (b) longitude. Negative numbers indicate southern latitudes and western longitudes.

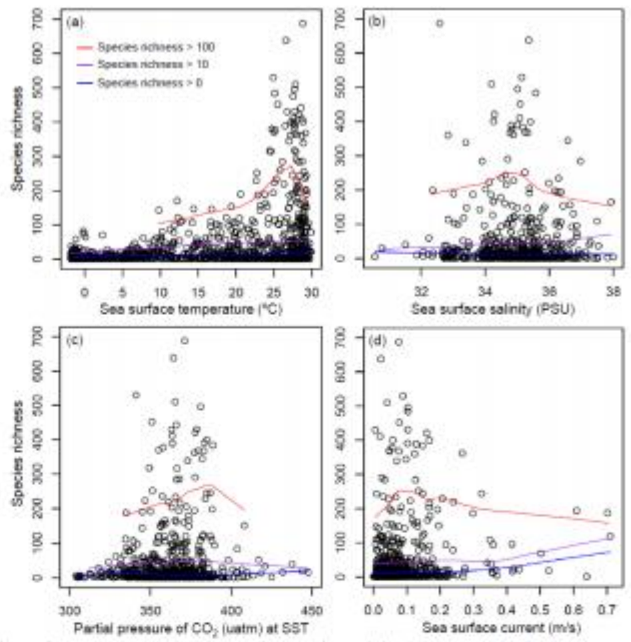

Figure 3. Relationship of species richness of corals with (a) sea surface temperature (SST), (b) sea surface salinity (c) partial pressure of CO2 at SST and (d) sea surface current. PSU, practical salinity unit. µatm, micro-atmosphere. The lines in each panel represent locally weighted scatterplot smoothing (LOWESS) curves for cells with different species richness.

Quantification of the effect of the priors in Bayesian statistics via Stein's Method: An illustration based on the Gamma distribution

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Abstract
In the present paper, we provide sharp lower and upper bounds, at fixed sample size n, for the Wasserstein distance between two posteriors resulting from two distinct prior densities. The methodology relies on a variant of the celebrated Stein's Method. We illustrate the strength of our method by measuring the impact of different priors on the scale parameter of the Gamma distribution.

Keywords
Bayesian statistics, Stein's method for nested densities, Wasserstein distance, Gamma distribution

1. Introduction

The first challenging question in Bayesian statistics is how choosing the prior can affect the posterior distribution. In the Bayesian setting, the parameter of interest is considered as a random variable whose distribution depends on both the available observations and some prior probability law that reflects the researcher's a priori knowledge of the problem at hand. Depending on the degree of information, we can choose different prior distributions, which can be either subjective or objective. Which prior to choose in which situation remains a question of paramount importance. Diaconis and Freedman [1] have provided conditions under which the impact of the prior is waning as the sample size increases. However, in practice it is more important to know what happens at fixed sample size. A way to measure this impact of the prior has been proposed by Ley et al. [2] who measure the Wasserstein distance between the posterior resulting from a given prior and the posterior resulting from the flat data-only prior, in other words, the likelihood. A large Wasserstein distance implies a strong effect of the prior, while a small distance reveals little prior impact. Ghaderinezhad and Ley [3] have further generalized this criterion to the comparison between any two priors. The theoretical result underpinning these criteria is based on a variant of the popular Stein Method, namely Stein's Method for nested densities as developed by Ley et al. [2]. In a nutshell, the principal goal of Stein's Method is to provide quantitative assessment in distributional approximation statements of the form "W is close to Z" where Z follows a known distribution and W is the object of interest. In order to provide such assessments, the method consists of two parts, namely

Part A: a framework allowing to convert the problem of bounding the error in the approximation of W by Z into a problem of bounding the expectation of a certain functional of W.

Part B: a collection of techniques to bound the expectation appearing in Part A; the details of these techniques are strongly dependent on the properties of W as well as on the form of the functional.

The functional appearing in Part A is related to the notion of Stein operators, see Ley et al. [4] for details. Our measure of the impact of priors thus is an approximation problem between two distinct posterior distributions.

The present paper is organized as follows. In Section 2 we present our measure of the distance between two priors, the main result. Afterwards, in Section 3 we illustrate the strength of our measure by considering the Gamma distribution as an example and we compare the effects of distinct priors on the posterior distribution of the scale parameter. Finally, in the last section we will provide a brief explanation about the useful practical aspects of our methodology.

2. Quantification of the effect of two distinct priors

We start by introducing the Wasserstein-1 distance as

$$d_W(P_1, P_2) = \mathrm{Sup}_{h \in H} |E[h(X_1)] - E[h(X_2)]|$$

for $H = \mathrm{Lip}\ (1)$ the class of Lipschitz-1 functions and X_1, X_2random variables with respective distributions P_1 and P_2. Since it is hard to calculate this distance, we provide sharp lower and upper bound for it. To fix the notations, we consider a set of independent and identically distributed observations $\{X_1, \ldots, X_n\}$ from a parametric model with parameter of interest $\theta \in \Theta\ \subset R$ (the methodology is applicable for both continuous and discrete distributions). The likelihood function of $\{X_1, \ldots, X_n\}$ is written $l(x; \theta)$ where $x = \{x_1, \ldots, x_n\}$ are observed values and $p_1(\theta)$ and $p_2(\theta)$ are the prior densities for θ. The two resulting posterior distributions for θ take on the guise

$$p_i(\theta; x) = \kappa_i(x) p_i(\theta) l(x; \theta) \quad , \quad i = 1,2,$$

where $\kappa_1(x)$ and $\kappa_2(x)$ are the normalizing constants. In addition, we write (Θ_1, P_1) and (Θ_2, P_2) the couples of random variables and cumulative distribution functions corresponding respectively to the densities $p_1(\theta; x)$ and $p_2(\theta; x)$.

A crucial concept in the Stein literature is the Stein kernel which can be defined as

$$\tau_i(\theta; x) = \frac{1}{p_i(\theta; x)} \int_{a_i}^{\theta} (\mu_i - y) p_i(y; x) dy, \quad i = 1,2$$

where a_i is the lower bound of the support $I_i = (a_i, b_i)$ of p_i and μ_i is the mean of p_i. A very important condition in developing our methodology is that the posterior densities are nested which means that the support of one of them is included in the other.
With the aforementioned notations in hand we can get the following Theorem, see [3].

Theorem 1. (Ghaderinezhad-Ley [3]): Consider H the set of Lipschitz-1 functions on R. Assume that $\theta \mapsto \rho(\theta) := \frac{p_2(\theta)}{p_1(\theta)}$ is differentiable on I_2 and satisfies (i) $E[|\Theta_1 - \mu_1| \rho(\Theta_1)] < \infty$, (ii)$(\rho(\theta) \int_{a_1}^{\theta} (h(y) - E[h(\Theta_1)]) p_1(y; x) dy)'$ is integrable for all $h \in H$ and $(iii) \lim_{\theta \to a_2, b_2} \rho(\theta) \int_{a_1}^{\theta} (h(y) - E[h(\Theta_1)])\, p_1(y; x)\, dy = 0$ for all h ∈ H. Then

$$|\mu_1 - \mu_2| = \frac{|E[\tau_1(\Theta_1; x) \rho'(\Theta_1)]|}{E[\rho(\Theta_1)]} \leq d_W(P_1, P_2) \leq \frac{E[\tau_1(\Theta_1; x) |\rho'(\Theta_1)|]}{E[\rho(\Theta_1)]}.$$

We refer the interested reader to [3] for the proof of this theorem. It relies on the Stein Method for nested densities developed by Ley et al. [2], the details of which we spare the reader here for the sake of readability of this brief note.

3. Comparison of various priors for the scale parameter of the Gamma distribution

The Gamma distribution has the probability density function

$$p(x; \alpha, \beta) = \frac{\beta^{\alpha}}{\Gamma(\alpha)}\, x^{\alpha - 1} \exp(-\beta x), \quad x, \alpha, \beta \in R^+,$$

where (α, β) are the shape and the scale parameters, respectively, and the associated likelihood function reads $l(x; \beta) = \left(\frac{\beta^{\alpha}}{\Gamma(\alpha)}\right)^n \prod_{i=1}^{n} x_i^{\alpha - 1} \exp(-\beta \sum_{i=1}^{n} x_i)$. It is a popular probability distribution to model size-type and survival data. It contains special cases such as the exponential ($\alpha = 1$) and the Chi-square ($\alpha = \frac{k}{2}$ for some positive integer k) distributions.

Here we compare two prior choices for our parameter of interest β. The first one is the non-informative Jeffreys' prior which is proportional to the determinant of the Fisher information matrix, in other words $p_1(\beta) \propto \frac{1}{\beta}$. Therefore, the resulting posterior is $Gamma(n\alpha, \sum_{i=1}^{n} x_i)$. The second prior $p_2(\beta)$ is $Gamma(\eta, \kappa)$, a Gamma distribution which happens to be the conjugate prior. Considering this prior leads to the Gamma posterior with parameters $Gamma(n\alpha+\eta, \sum_{i=1}^{n} x_i + \kappa)$.

With this in hand, we can easily calculate the lower bound as follows

$$d_w(P_1, P_2) \geq |\mu_1 - \mu_2| = |\frac{\eta \sum_{i=1}^{n} x_i - n\alpha\kappa}{\sum_{i=1}^{n} x_i \left(\sum_{i=1}^{n} x_i + \kappa\right)}|$$

which is of the order of $O(\frac{1}{n})$. In order to calculate the upper bound we need to have the ratio of the priors which is given by

$$\rho(\beta) = \frac{\kappa^\eta/_{\Gamma(\eta)} \beta^{\eta-1} \exp(-\kappa\beta)}{1/_\beta} = \frac{\kappa^\eta \beta^\eta \exp(-\kappa\beta)}{\Gamma(\eta)}.$$

Note that this equality is an abuse of notation, as ρ is actually only proportional to this quantity. The same holds true for its derivative and the subsequent expectations. However, since the proportionality constant appears on both the numerator and denominator in the final upper bound, we do not need its expression, and hence use a simpler "=" symbol. The derivative of ρ with respect to β corresponds to

$$\rho'(\beta) = \frac{\kappa^\eta}{\Gamma(\eta)} \beta^{\eta-1}\, exp(-\kappa\beta)\, (\eta - \kappa\beta)$$

and, writing $\beta_1$the random variable associated with P_1,

$$E\big(\rho(\beta_1)\big) = \int_0^\infty \frac{\kappa^\eta}{\Gamma(\eta)} \frac{\left(\sum_{i=1}^{n} x_i\right)^{n\alpha}}{\Gamma(n\alpha)} \beta^{\eta+n\alpha-1} \exp(-\kappa\beta) \exp(-\beta \textstyle\sum_{i=1}^{n} x_i)\, d\beta = \frac{\kappa^\eta \left(\sum_{i=1}^{n} x_i\right)^{n\alpha}}{Beta(n\alpha,\eta)\left(\kappa + \sum_{i=1}^{n} x_i\right)^{n\alpha+\eta}}.$$

The Stein kernel for the Gamma distribution with parameters $(n\alpha, \sum_{i=1}^{n} x_i)$ is $\tau_1(\beta) = \frac{\beta}{\sum_{i=1}^{n} x_i}$. We have thus

$$E[\tau_1(\beta_1)|\rho'(\beta_1)|] = \int_0^\infty \frac{\beta}{\sum_{i=1}^{n} x_i} \frac{\kappa^\eta}{\Gamma(\eta)} \frac{\left(\sum_{i=1}^{n} x_i\right)^{n\alpha}}{\Gamma(n\alpha)} \beta^{\eta-1} \exp(-\kappa\beta)\, \beta^{n\alpha-1} \exp\left(-\beta \sum_{i=1}^{n} x_i\right) |\eta - \kappa\beta|\, d\beta$$

$$\leq \frac{\left(\sum_{i=1}^{n} x_i\right)^{n\alpha-1} \kappa^\eta}{\Gamma(n\alpha)\Gamma(\eta)} \int_0^\infty \beta^{n\alpha+\eta-1} \exp\left(-\left(\kappa + \sum_{i=1}^{n} x_i\right)\beta\right) (\eta + \kappa\beta) d\beta$$

$$= \frac{(\sum_{i=1}^{n} x_i)^{n\alpha-1}\kappa^{\eta}}{\Gamma(n\alpha)\Gamma(\eta)} (\eta \frac{\Gamma(n\alpha+\eta)}{\left(\sum_{i=1}^{n} x_i + \kappa\right)^{n\alpha+\eta}} + \kappa \frac{\Gamma(n\alpha+\eta+1)}{\left(\sum_{i=1}^{n} x_i + \kappa\right)^{n\alpha+\eta+1}})$$

$$= \frac{\kappa^{\eta}(\sum_{i=1}^{n} x_i)^{n\alpha-1}(\eta + \kappa \frac{n\alpha+\eta}{\sum_{i=1}^{n} x_i + \kappa})}{Beta(n\alpha,\eta)\left(\sum_{i=1}^{n} x_i + \kappa\right)^{n\alpha+\eta}}$$

and, combining all quantities according to Theorem 1, the upper bound becomes

$$d_w(P_1, P_2) \leq \frac{\eta \sum_{i=1}^{n} x_i + n\alpha\kappa + 2\kappa\eta}{\sum_{i=1}^{n} x_i(\kappa + \sum_{i=1}^{n} x_i)}.$$

Finally, the Wasserstein distance for the two posteriors based on the Jeffreys' and the Gamma prior densities can be bounded as follows:

$$|\frac{\eta \sum_{i=1}^{n} x_i - n\alpha\kappa}{\sum_{i=1}^{n} x_i(\sum_{i=1}^{n} x_i + \kappa)}| \leq d_w(P_1, P_2) \leq \frac{\eta \sum_{i=1}^{n} x_i + n\alpha\kappa + 2\kappa\eta}{\sum_{i=1}^{n} x_i(\kappa + \sum_{i=1}^{n} x_i)}.$$

Both bounds are of the order of $O(\frac{1}{n})$, and hence also the distance itself. We observe very similar terms appearing in both the upper and lower bounds. Quite interestingly, these lower and upper bounds reveal that the distance between the Jeffreys' and the conjugate prior diminishes as the sum of the observations increases; in other words, the choice of the prior for the scale parameter in the Gamma distribution matters less for large observations than for small observations.

4. Practical aspect

One of the biggest challenges of practitioners who are working in Bayesian statistics is choosing a prior in a given situation. For instance, Kavetski et al. [5] have considered a storm depth multiplier model to represent rainfall uncertainty, where the errors appear under multiplicative form and are assumed to be normal. They fixed the location parameter μ and have studied various priors for the variance σ^2. Our method gives them a handy tool to quantify the distance of two different posteriors derived under two distinct priors and to decide whether they should stick to both of them or pick just one. This can be especially useful when the practitioner does hesitate between a simple, closed-form prior and a more complicated one. In such a situation, when the effects of the two priors are similar, it is advisable to pick the simpler one. Our theoretical results provide a framework to make the best decision in such practical situations.

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New weighted extreme value index estimator for randomly right-censored data

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Abstract
A tail empirical process for heavy-tailed and right-censored data is introduced and its Gaussian approximation is established. In this context, a (weighted) new Hill-type estimator for positive extreme value index is proposed and its consistency and asymptotic normality are proved by means of the aforementioned process in the framework of second-order conditions of regular variation.

Keywords
Extreme values; Heavy tails; Random censoring; Tail empirical process.

1. Introduction

Let $X_1,\dots,X_n$ be $n \geq 1$ independent copies of a non-negative continuous random variable $(rv)X$, defined over some probability space (Ω, A, P), with cumulative distribution function $(cdf)F$. These $rv's$ are censored to the right by a sequence of independent copies, $Y_1,\dots,Y_n$ of a non-negative continuous rv Y, independent of X and having $a\ cdf\ G$. At each stage $1 \leq j \leq n$, we only can observe the rv's $Z_j := min(X_j Y_j)\ and\ \delta_j := 1\{X_j \leq Y_j\}$, with $1\{\cdot\}$ denoting the indicator function. If we denote by H the cdf of the observed Z's, then, in virtue of the independence of X and Y, we have $1 - H = (1 - F)(1 - G)$. Throughout the paper, we will use the notation $\bar{S}(x) := S(\infty) - S(x)$, for any S. Assume further that F and G are heavy-tailed or, in other words, that F and G are regularly varying at infinity with negative indices $-1/\gamma_1$ and $-1/\gamma_2$ respectively, notation:

$\bar{F} \in RV_{(-1/\gamma_1)}\ and\ \bar{G} \in RV_{(-1/\gamma_2)}$. That is

$$\frac{\bar{F}(tx)}{\bar{F}(t)} \to x^{-1/\gamma_1} \text{ and } \frac{\bar{G}(tx)}{\bar{G}(t)} \to x^{-1/\gamma_2}, as\ t \to \infty, \text{for any } x > 0 \qquad (1)$$

The regular variation of F and G implies that $\bar{H} \in RV_{(-1/\gamma)}$, where $\gamma := \gamma_1\gamma_2/(\gamma_1 + \gamma_2)$. Since weak approximations of extreme value theory based statistics are achieved in the second-order framework, (see de Haan and Stadtmüller, 1996), then it seems quite natural to suppose that $cdf\ H$ satisfies the well-known second-order condition of regular variation: for any $x > 0$

$$\frac{\overline{H}(tx)/\overline{H}(t) - x^{-1/\gamma}}{A(t)}\bigg) \to x^{-1/\gamma}\left(\frac{x^{\nu/\gamma}-1}{\nu\gamma}\right),$$

as $t \to \infty$, where $\nu \leq 0$ is the second-order parameter and A is a function tending to 0, not changing sign near infinity and having a regularly varying absolute value at infinity with index ν/γ. If $\nu = 0$, interpret $\left(x^{\nu/\gamma}-1\right)/(\nu\gamma)$ as $\log x$. Let us denote this assumption by $\overline{H} \in 2RV_{(-1/\gamma,\nu)}(A)$. For the use of second-order conditions in exploring the estimators asymptotic behaviors, see, for instance, Theorem 3.2.6 in de Haan and Ferreira (2006), page 74. In the last decade, several authors showed an increasing interest in the issue of estimating the extreme-value index (EVI) when the data are subject to random censoring. In this context, Beirlant et al. (2007) proposed estimators for the EVI and high quantiles and discussed their asymptotic properties, when the observations are censored by a deterministic threshold, while Einmahl et al. (2008) adapted various classical EVI estimators to the case where the threshold of censorship is random, and proposed a unified method to establish their asymptotic normality. Here, we remind the adjustment they made to Hill estimator (Hill, 1975) so as to estimate the tail index $\gamma 1$ under random censorship. Let $\{(Z_i\delta_i), 1 \leq i \leq n\}$ be a sample from the couple of $rv's\ (Z,\delta)$ and $Z_{1,n} \leq \ldots \leq Z_{n,n}$ represent the order statistics pertaining to $(Z_1,\ldots,Z_n)$. If we denote the concomitant of the ith order statistic by $\delta_{[i:n]}\ \left(i.e.\ \delta_{[i,n]} = \delta_j\ if\ Z_{i,n} = Z_j\right)$, then the adapted Hill estimator of $\gamma 1$ defined by, is given by the formula $\hat{\gamma}_1^{(EFG)} := \hat{\gamma}^{(H)} / \hat{p}$,
where

$$\hat{\gamma}^{(H)} := \frac{1}{k}\sum_{i=1}^{k} log\frac{Z_{n-i+1:n}}{Z_{n-k:n}}\ and\ \hat{p} := \frac{1}{k}\sum_{i=1}^{k}\delta_{[n-i+1:n],} \tag{2}$$

for a suitable sample fraction $k = k_n$, are respectively Hill's estimator (Hill, 1975) of and an estimator of the proportion $p := \gamma/\gamma_1$ of the observed extreme values. For their part Worms and Worms (2014) used Kaplan-Meier integration and the synthetic data approach of Leurgans (1987), to respectively introduce two Hill-type estimators

$$\hat{\gamma}_1^{(WW1)} := \sum_{i=1}^{k}\frac{1-F_n(Z_{n-i+:n})}{1-F_n(Z_{n-k:n})} log\frac{Z_{n-i+:n}}{Z_{n-i:n}},$$

and

$$\hat{\gamma}_1^{(WW2)} := \sum_{i=1}^{k}\frac{1-F_n(Z_{n-i+:n})}{1-F_n(Z_{n-k:n})}\frac{\delta_{[n-i+1:n]}}{i} log\frac{Z_{n-i+:n}}{Z_{n-i:n}},$$

where

$$F_n(x) = 1 - \prod_{Z_{i:n\leq x}} \left(1 - \frac{1}{n-i+1}\right)^{\delta_{[i:n]}}, \tag{3}$$

is the famous Kaplan-Meier estimator of $cdf\ F$ (Kaplan and Meier, 1958). In their simulation study, the authors pointed out that, for weak censoring $(\gamma_1 < \gamma_2)$, their estimators perform better than $\hat{\gamma}_1^{(EFG)}$, in terms of bias and mean squared error. However, in the strong censoring case $(\gamma_1 > \gamma_2)$, they noticed that the results become unsatisfactory for both $\hat{\gamma}_1^{(WW1)}$ and $\hat{\gamma}_1^{(WW2)}$. With additional assumptions on γ_1 and γ_2, they only established the consistency of their estimators, without any indication on the asymptotic normality. Though these conditions are legitimate from a theoretical viewpoint, they may be considered as constraints in case studies. Very recently, Beirlant et al. (2018) used Worms's estimators to derive new reduced-bias ones, constructed bootstrap confidence intervals for $\gamma 1$ and applied their results to long-tailed car insurance portfolio.

2. Methodology

We introduce two very crucial sub-distribution functions $H^{(i)}(z) := P\{Z_1 \leq z, \delta_1 = i\}, i = 0,1$, for $z > 0$, so that one has $H(z) = H^{(0)}(z) + H^{(1)}(z)$. The empirical counterparts are, respectively, defined by

$$H_n^{(0)}(z) := \frac{1}{n}\sum_{i=1}^{n} \mathbf{1}\{Z_i \leq z\}(1-\delta_i)1, \quad H_n^{(1)}(z) := \frac{1}{n}\sum_{i=1}^{n} \mathbf{1}\{Z_i \leq z\}\,\delta_i,$$

and $H_n(z) := \frac{1}{n}\sum_{i=1}^{n} \mathbf{1}\,\{Z_i \leq z\} = H^{(0)}_n(z) + H^{(1)}_n(z)$. From Lemma 4.1 of Brahimi et al. (2015), under the first-order conditions (1), we have $\overline{H}^{(1)}(t)/\overline{H}(t) \to p, as\ t \to \infty$, which implies that $H^{(1)} \in RV_{(-1/\gamma)}$ too. Then it is natural to also assume that $H^{(1)}$ satisfies the second-order condition of regular variation, in the sense that $H^{(1)} \in 2RV_{(-1/\gamma,\nu 1)}(A_1)$.From Theorem 1.2.2 in de Haan and Ferreira (2006), the assumption $H \in RV_{(-1/\gamma)}$ implies that $\int_1^\infty x^{-1}\,\overline{H}(x)dx/\overline{H}(t) \to \gamma, as\ t \to \infty$, which, by integration by parts, gives

$$\frac{1}{\overline{H}(t)}\int_t^\infty \log\left({}^{z}/_{t}\right) dH(z) \to \gamma, \qquad as\ t \to \infty. \tag{4}$$

In other words, we have

$$I(t) := \left(\frac{\overline{H}(t)}{\overline{H}^{(1)}(t)}\right)\frac{1}{\overline{H}(t)}\int_t^\infty \log(z/t)\, dH(z) \to \gamma/p = \gamma_1.$$

Taking $t = t_n = Z_{n-k:n}$ and replacing $H^{(1)}$ and H by their respective empirical counterparts $H_n^{(1)}$ and H_n yield that $I(t)$ becomes, in terms of n,

$$\left(\frac{\overline{H}_n(Z_{n-k:n})}{\overline{H}_n^{(1)}(Z_{n-k:n})}\right)\frac{1}{\overline{H}_n(Z_{n-k:n})}\int_{Z_{n-k:n}}^{\infty} log(z/Z_{n-k:n})dH_n(z) \qquad (5)$$

We have $H_n(Z_{n-k:n}) = k/n \; and \; \overline{H}_n^{(1)}(Z_{n-k:n}) = n^{-1}\sum_{i=1}^{k}\delta_{[n-i+1:n]}$, then it is readily checked that

$$\frac{\overline{H}_n^{(1)}(Z_{n-k:n})}{\overline{H}_n(Z_{n-k:n})} = \hat{p} \; and \; \int_{Z_{n-k:n}}^{\infty} log(z/Z_{n-k:n})\frac{dH_n(z)}{\overline{H}_n(Z_{n-k:n})} = \hat{\gamma}^{(H)}.$$

Substituting this in (5), leads to the definition of $\gamma_1^{(EFG)}$. By incorporating the quantity $\overline{H}(tz)/\overline{H}^{(1)}(tz)$ inside the integral $\int_1^{\infty} log(z)dH(tz)/\overline{H}(t)$, we get we show that

$$\frac{1}{\overline{H}(t)}\int_1^{\infty}\frac{\log(z)\,dH(tz)}{\overline{H}^{(1)}(tz)/\overline{H}(tz)} \to \gamma_1, \qquad as\; t\to\infty.$$

To avoid a division by zero, we show that

$$\frac{1}{\overline{H}(t_n)}\int_1^{\infty}\frac{\log(z)\,dH(tz)}{\overline{H}^{(1)}(tz)/\overline{H}(t_n z)+k^{-1}} \to \gamma^1, \qquad as\; n\to\infty. \qquad (6)$$

By letting $t_n = Z_{n-k:n}$ and by replacing $\overline{H}^{(1)}$ and $\overline{H}$ by $\overline{H}_n^{(1)}$ and $\overline{H}_n$ of formula (6) respectively, the left-hand side becomes

$$\frac{1}{\overline{H}_n(Z_{n-k:n})}\int_{Z_{n-k:n}}^{Z_{n:n}}\frac{\overline{H}_n(z)\log(z/Z_{n-k:n})dH_n(z)}{\overline{H}_n^{(1)}(z)+k^{-1}\overline{H}_n(z)}.$$

This may be rewritten into which

$$\frac{n}{k}\int_0^{\infty}\mathbf{1}(Z_{n-k:n}<z<Z_{n:n})\frac{\overline{H}_n(z)\log\left(z/Z_{n-k:n}\right)dH_n(z)}{\overline{H}_n^{(1)}(z)+k^{-1}\overline{H}_n(z)}$$
$$=\frac{1}{k}\sum_{i=1}^{n}\mathbf{1}(Z_{n-k:n}<Z_{i:n}<Z_{n:n})\frac{\overline{H}_n(Z_{i:n})\log\left(Z_{i:n}/Z_{n-k:n}\right)}{\overline{H}_n^{(1)}(Z_{i:n})+k^{-1}\overline{H}_n(Z_{i:n})},$$

which equals

$$\frac{1}{k}\sum_{i=n-k+1}^{n-1}\frac{\overline{H}_n(Z_{i:n})\log\left(Z_{i:n}/Z_{n-k:n}\right)}{\overline{H}_n^{(1)}(Z_{i:n})+k^{-1}\overline{H}_n(Z_{i:n})}=\frac{1}{k}\sum_{i=n-k+1}^{n-1}\frac{(n-i)\log\left(Z_{i:n}/Z_{n-k:n}\right)}{\sum_{j=i+1}^{n}\delta_{[j:n]}+(n-i)/k}.$$

3. Results

Finally, changing $i \; by \; n-i \; and \; j \; by \; \mathrm{n}-\mathrm{j}+1$ yields a new (random) weighted estimator for the EVI γ_1 as follows:

$$\hat{\gamma}_1 := \frac{1}{k}\sum_{i=1}^{k-1}\frac{i\log(Z_{n-i:n}/Z_{n-k:n})}{\sum_{j=1}^{i}\delta_{[n-j+1:n]} + i/k}$$

Now, we carry out an extensive simulation study to illustrate the behavior of the proposed estimator $\hat{\gamma}_1$ and compare its performance, in terms of (absolute) bias and root of the mean squared error (RMSE), with those of $\hat{\gamma}_1^{(EFG)}$ and $\hat{\gamma}_1^{(WW1)}$. To this end, we consider Burr's, Fréchet's and the log-gamma models respectively defined, for $x > 0$, by:

- Burr (β, τ, λ): $F(x) = 1 - (\frac{\beta}{\beta + x^{\tau}})^{\lambda}, for\ \beta, \tau, \lambda > 0, with\ \gamma = 1/(\tau\lambda)$.
- Fréchet (γ): $F(x) = exp(-x^{-1/\gamma}), for\ \gamma > 0$.
- log-gamma (γ, β): $F(x) = (\beta^{\gamma}\Gamma(\gamma))^{-1}\int_0^x t^{-1}(\log t)^{\gamma-1}\exp(-\beta^{-1}ln\, t)dt, for\ \gamma > 0\ and\ \beta > 0$.

We select two values, 33% and 70%, for the proportion p of observed upper statistics and we make several combinations of the parameters of each model. For each case, we generate 200 samples of size = 500 and we take our overall results (given in the form of graphical representations) by averaging over all 200 independent replications. We consider three censoring schemes, namely Burr censored by Burr, Fréchet censored by Fréchet and log-gamma censored by log-Gamma, that we illustrate by Figure 1, Figure 2 and Figure 3 respectively. In each figure, we represent the biases and the RMSE's of all three estimators $\hat{\gamma}_1$ $\hat{\gamma}_1^{(EFG)}$ and $\hat{\gamma}_1^{(WW1)}$ as functions of the number k of the largest order statistics. Our overall conclusion is that, from the top panels of all three figures, we see that the newly proposed estimator $\hat{\gamma}_1$ and the adapted Hill one $\hat{\gamma}_1^{(EFG)}$ perform almost equally well and better than Worms's estimator $\hat{\gamma}_1^{(WW1)}$ in the strong censoring case. However, the bottom panels of Figure 1 and Figure 2 show that, for the weak censoring scenario, the latter has a slight edge (especially for small values of k) over the other two which still behave almost similarly. This agrees with the conclusion of Beirlant et al. (2018) and means that $\hat{\gamma}_1^{(WW1)}$ is not reliable enough in the strong censoring situation. We notice, from Figure 3, that when considering the log-gamma model with strong censoring, the estimator $\hat{\gamma}_1^{(EFG)}$ outperforms the remaining two. But, with weak censoring, $\hat{\gamma}_1$ is clearly better than $\hat{\gamma}_1^{(EFG)}$ while, after numerous trials, $\hat{\gamma}_1^{(WW1)}$ seems to have a drawback in this case, which is something of very striking.

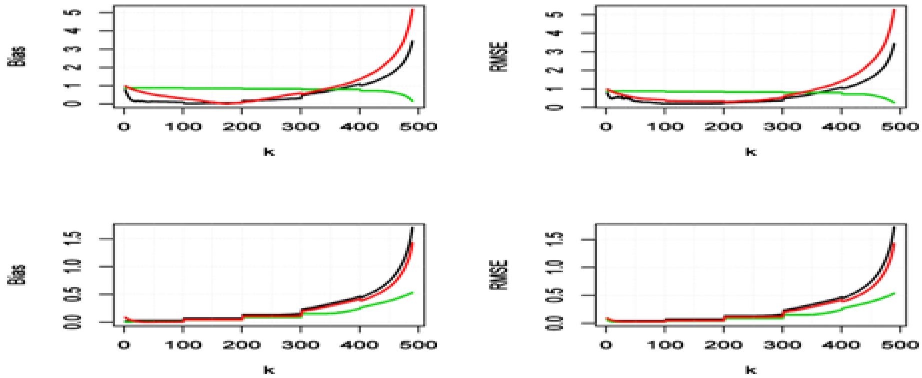

Figure 1. Bias (left panel) and RMSE (right panel) of $\hat{\gamma}_1$ (red) $\hat{\gamma}_1^{(EFG)}$ (black) and $\hat{\gamma}_1^{(WW1)}$ (green) based on 200 samples of size 200 from a Burr distribution censored by another Burr model with p=0.33 (top) and p=0.70 (bottom).

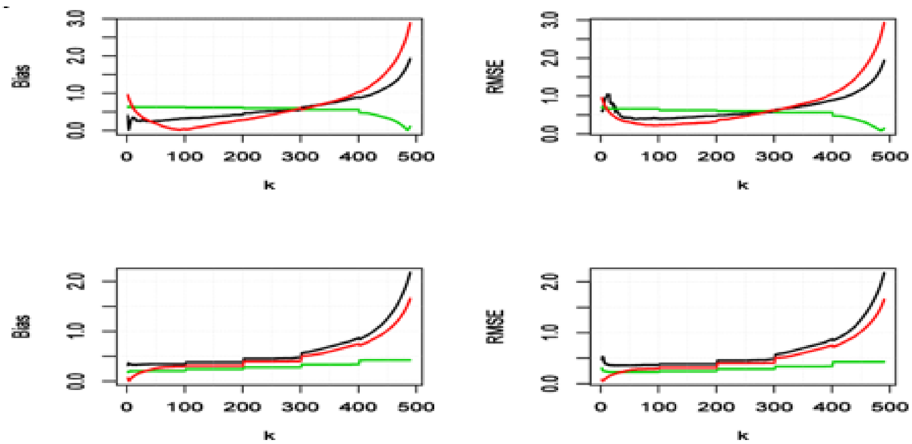

Figure 2. Bias (left panel) and RMSE (right panel) of $\hat{\gamma}_1$ (red) $\hat{\gamma}_1^{(EFG)}$ (black) and $\hat{\gamma}_1^{(WW1)}$ (green) based on 200 samples of size 200 from a Fréchet distribution censored by another Fréchet model with p=0.33 (top) and p=0.70 (bottom).

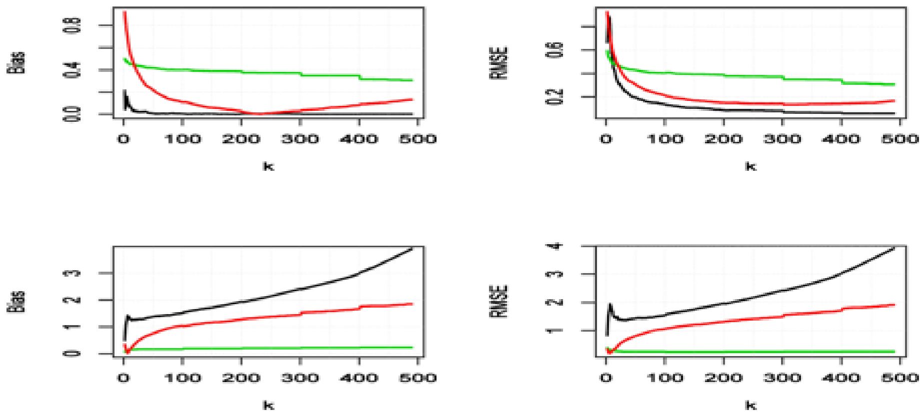

Figure 3. Bias (left panel) and RMSE (right panel) of $\hat{\gamma}_1$ (red) $\hat{\gamma}_1^{(EFG)}$ (black) and $\hat{\gamma}_1^{(WW1)}$ (green)

based on 200 samples of size 200 from a log-gamma distribution censored by another log gamma model with p=0.33 (top) and p=0.70 (bottom).

4. Discussion and Conclusion

In this work, we introduced a new Hill-type estimator for positive EVI of right-censored heavy-tailed data whose asymptotic behaviour (consistency and asymptotic normality). Compared to other existing estimators, the new tail index estimator performs better, as far as bias and mean squared error are concerned, at least from a simulation viewpoint.

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Financial inclusion and stability: Do they matter for monetary policy

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Abstract

The importance of inclusive financing to inclusive growth is no more in doubt. Thus, the Central Bank of Nigeria (CBN) developed a financial inclusion strategy in 2012 to reduce the percentage of adult Nigerians excluded from the formal financial services so as to enable them contribute to the development of the country. The study adopts modified versions of Sarma (2012) and Nicholas and Isabel (2010) methodologies to compute composite indices of financial inclusion (FI) and Financial System Stability (FSS), respectively for Nigeria from 2007Q1 to 2016Q4. The study then empirically examines, using autoregressive distributed lag approach, the dynamic linkages among FI, FSS and the efficiency of monetary policy (MP). The results show that Nigeria has made a remarkable progress in the implementation of her financial inclusion initiative and that the financial system was fairly stable during the study period. The empirical result reveals that financial inclusion enhances the effectiveness of MP. The study, therefore, recommends that the CBN should continue to pursue her financial inclusion drive with all vigour so as to expand not only the coverage but also the ease and pace of accessing financial services, as it is capable of enhancing the efficiency of MP.

Keywords

Financing, Banking, ARDL, inequality, cointegration

1. Introduction

A strong consensus seems to have emerged on the importance of inclusive financing for inclusive growth at a critical time when financial stability is of great concern to monetary authorities. Thus, different policy initiatives by central banks and governments across the world have been initiated to boost access to finance. The 2011 Maya declaration is the first measurable global set of commitments by emerging markets and developing countries (EMDCs) to strengthen effort to unlock the economic and social potentials of about 2.5 billion poorest people of the world through greater financial inclusion (FI). This declaration was endorsed by more than 80 institutions across the globe.

The CBN in 2012, as a sign of her commitment to the Maya Declaration, developed a FI strategy for Nigeria. The aim of the strategy, amongst others, was to reduce the percentage of adult Nigerians excluded from formal financial services from 46.3% as at 2010 to 20.0% by 2020 with a view to enabling them have access to financial services, engage in economic activities and contribute to growth and development of the country. Most public analysts in Nigeria are of the opinion that a remarkable success has been achieved by the CBN in her FI drive (Yaaba, 2017), although no formal measurement framework has been officially adopted, particularly from the perspective of the supply side. This paper is therefore a maiden attempt to measure not only the status of the FI, but how it, coupled with FSS, impact on MP efficiency of the CBN.

The paper is structure into 4 sections including this introduction. Section 2 and 3 present methodologies and analysis of results, respectively, the last section provides conclusion and policy option.

2. Methodology

The standard formulation of the estimated equation is given as:

$$MMP_t = FII_t + BSII_t \quad (1)$$

Where MP represents MP proxy by consumer price index (CPI), FII is FI index/indicators, $BSSI$ denotes banking system stability index/indicators and the subscript t is the time dimension. CPI is used to proxy MP efficiency, since the CBN is statutorily saddled with the responsibility of ensuring low and stable prices (CBN Act, 2007). $BSSI$ is used as proxy for financial stability, because in Nigeria, the banking system covers more than 80.0% of the financial system; hence stability or fragility in the banking system can be taken to mean same for the financial system.

A bounds test approach to cointegration popularly refers to as Autoregressive Distributed Lag (ARDL) developed by Pesaran, Shin & Smith (2001) is deployed to estimate equation (1). Thus, the ARDL format of equation (1) is formulated as:

$$\Delta LMP_t = \vartheta + \sum_{i=1}^{\rho} \lambda_i \, \Delta LMP_{t-i} + \sum_{i=1}^{\rho} \delta_i \Delta LFII_{t-j} + \sum_{i=1}^{\rho} \beta_k \, \Delta BSSI_{t-k} + \omega_1 LMP_{t-1} + \omega_2 LFII_{t-1} + \omega_3 BSSI_{t-1} + \mu_t \quad (2)$$

Where Δ is a differenced operator, L is logarithm, ϑ is an intercept term, λ, δ, β are the respective coefficients of the short-run parameters. The ω_j are the coefficients of the long-run parameters, ρ_s are the optimal lag length of the respective variables, t is the time dimension and μ is error term. All other variables are as defined under equation (1).

The error correction representation of equation (2) becomes:

$$\Delta LMP_t = \vartheta + \sum_{i=1}^{\rho} \lambda_i \, \Delta LMP_{t-i} + \sum_{i=1}^{\rho} \delta_i \Delta LFII_{t-j} + \sum_{i=1}^{\rho} \beta_k \, \Delta BSSI_{t-k} + \Omega EC_{t-1} + \mu_t \quad (3)$$

Where *EC* is the error term derived from the ARDL model and other variables are as defined under equations 1 and 2. Quarterly data from 2007Q1 to 2016Q4 is used for the estimation. The choice of the study period is informed by the availability of relevant data. Three variants of Equations 2 and 3 are estimated, first with the computed indices, *FII* and *BSSI;* second and third with the variables FII and BSSI as vectors. The vector *FII* in the second regression consists of all dimensional indices that sums to the financial inclusion index. The indices include penetration, services and usage indices. On the other hand, the vector *BSSI* covers Banking Soundness Index (BSI), Banking Vulnerability Index (BVI) and Economic Climate Index (ECI). Finally, with *FII* and *BSSI* as another vector of three variables each, where *FII* consists of the ratio of credit to private sector to GDP, number of Automated Teller Machines (ATMs) and number of accounts; and *BSSI* considers regulatory capital to risk weighted assets (CAR), net interest margin (NIM) and non-performing loan to total loans (NPL/TL). The derivation of *FII* and *BSSI* as well as their sub-indices are detailed below.

Financial Inclusion Index (FII)

In line with Sarma (2012), the study constructed a composite index of FI from the supply side. The index is calculated as a weighted average of three dimensions of FI, namely: financial penetration index (FPI), financial services index (FSI) and financial usage index (FUI).

Financial Penetration Index (FPI) is the availability of financial services to the populace modelled as:

$$FPI_t = \frac{ac_t}{p_t} \tag{4}$$

where *ac* represents number of accounts (i.e. covering Deposit Money Banks, Microfinance Banks, Primary Mortgage Institutions and Insurance companies), p depicts total adult population and t is time.

Financial Services Index (FSI) is generally agreed to be an important ingredient of an inclusive financial system. Accessibility is measured as:

$$FSI_t = \delta_1 \frac{fb_t}{p_t} + \delta_2 \frac{atm_t}{p_t}, \ \ \delta_1 + \delta_2 = 1 \tag{5}$$

where δ_1 and δ_2 are the respective weights of number of financial institutions branches (*fb*) and number of automated teller machines (*atm*), respectively[1], p represents adult population and the subscript t is the time dimension.

Financial Usage Index (FUI) is argued to be the next most important besides access to banking services. This dimension is derived as:

$$FUI_t = \frac{cr_t + is_t + d_t}{y_t} \tag{6}$$

[1] Δ_1 and δ_2 are adopted from Udom et al. (forthcoming).

Where cr is credit to private sector, *is* denotes insurance claims, *d* symbolizes deposit liabilities and *y* connotes aggregate output.
The *FPI, FSI* and *FUI* are then combined to form another set of two indices namely; Index 1 and 2, given as:

$$Index\ 1_t = \frac{\sqrt{FPI_t^2 + FSI_t^2 + FUI_t^2}}{\sqrt{\omega_p^2 + \omega_s^2 + \omega_u^2}} \tag{7}$$

$$Index\ 2_t = \frac{\sqrt{\left(\omega_p - FPI_t\right)^2 + (\omega_s - FSI_t)^2 + (\omega_u - FUI_t)^2}}{\sqrt{\omega_p^2 + \omega_s^2 + \omega_u^2}} \tag{8}$$

where ω_p, ω_s and ω_u are the weights of their respective indices. The FII is then derived as the arithmetic mean of Indices 1 and 2:

$$FII_t = \frac{1}{2}(Index\ 1_t + Index\ 2_t) \tag{9}$$

Following Sarma (2012), the following rule can be applied to the resultant *FII* to determine a country's level of inclusive financing $-0.5 < FII < 1 = High\ FII$; $0.3 < FII < 0.5 = Medium\ FII$; $and\ 0 < FII < 0.3 = Low\ FII$.

Banking System Stability Index (BSSI)

The study updated the BSSI computed by Sere-Ejembi et al. (2014). The indicators used for the computation are compiled in line with the IMF-FSIs framework. The indicators were grouped into three, Banking Soundness Index (BSI), Banking Vulnerability Index (BVI) and Economic Climate Index (ECI). The sub-indices for both FII and BSSI were then standardized using statistical normalization technique, given as:

$$Z_t = \left(\frac{X_t - \mu}{\sigma}\right) \tag{10}$$

Where X_t represents the value of the index X during period t; μ is the mean and σ is the standard deviation.

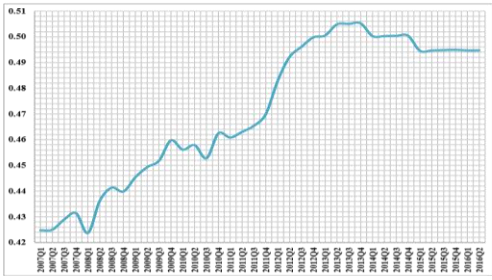
3. Result

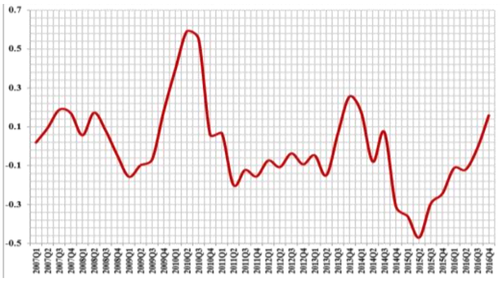
3.1 Financial Inclusion and Stability Indices

Figures 1 and 2 present the results of financial inclusion index and banking system stability index, respectively. Visual inspection of Figure 1 reveals that Nigeria is making gradual progress in her quest for inclusive financing and from the figure can be ranked among the medium FI countries striving to achieve high FI status.

Figure 1: FII Index for Nigeria

Figure 2: BSSI Index for Nigeria





Further investigation reveals that the major drivers of FII are the services and penetration dimensions without remarkable improvement in the usage dimension. The BSSI, on the other hand, indicates that, although the Nigerian banking system has witnessed lot of turbulence during the study period but overall it is fairly stable[2].

3.2 Inferential Results

3.2.1 Unit Root Test

Cursory look at Table 1 suggests that the data contain a mixture of both I(0) and I(1) series based on both Augmented Dickey-Fuller in line with Akaike Information and Schwarz Bayesian Criteria and Phillip Perron (PP). This further justifies the use of bound test which has the capability to accommodate either I(0), I(1) or a mixture of both.

3.2.2 Cointegration Test

Equation (2) is implemented using three scenarios. First, the MP proxy by the log of consumer price index (*LCPI*) which serves as an objective function, was considered with the computed indices – i.e. *FII* and *BSSI*; second *LCPI* was again regressed against the sub-components of *FII* and *BSSI*, such that in the second scenario, *FII* becomes a vector of three variables (*Log of FSI*, *Log of FPI*, log of *FUI*) and *BSSI* another vector of three variables (*BSI*, *BVI*, *ECI*). The third scenario considered the objective function with selected indicators of both FI and BSS. The entire ARDL process was followed to implement each scenario such that overall three set of regressions were carried out. The Cointegration results as shown by Wald test are reported as Table 2. All scenarios yield F-statistics of 11.48, 17.29 and 8.77, respectively. At these levels, the F-statistics were higher than the I(1) bounds (upper critical values) of 5.00 and 3.99 at 1.0% level of significance for *k* equals 2 and 6 respectively, as tabulated in Pesaran, Shin & Smith, (2001). This provides strong evidence in support of cointegration among the *LCPI* and its determinants in all cases.

Table 1: Unit Root Tests

	Augmented Dickey Fuller				Phillips-Perron	
	AIC		SBC			
Regressor	t-Statistics	Remark	t-Statistics	Remark	t-Statistics	Remark

[2] see Yaaba, 2013; Abubakar and Yaaba, 2013; Yaaba & Adamu, 2013; Sere-Ejembi et al. 2014 for more information

LCPI	-5.388774*	I(1)	-5.388774*	I(1)	-5.596424*	I(1)
LFII	-3.208642***	I(1)	-3.208642***	I(1)	-15.37929*	I(1)
BSSI	-6.378092*	I(1)	-6.378092*	I(1)	-6.378376*	I(1)
LFSI	-7.089188*	I(1)	-7.089188*	I(1)	--8.685142*	I(1)
LFPI	-4.624111*	I(1)	-7.612156*	I(1)	-8.474102*	I(0)
FUI	-3.33311**	I(1)	-3.33311***	I(1)	-10.18649*	I(1)
BSI	-6.136781*	I(0)	-6.136781*	I(0)	-6.155085*	I(0)
BVI	-2.738337***	I(0)	-2.738337***	I(0)	-2.691324***	I(0)
ECI	-4.179400*	I(0)	-3.757442*	I(0)	-3.341459**	I(1)
CAR	-4.378873*	I(1)	-4.378873*	I(1)	-4.331400*	I(1)
NIM	-7.409228*	I(1)	-7.409228*	I(1)	-31.59326*	I(1)
NPL_TL	-3.835833*	I(1)	-3.835833*	I(1)	-3.830944*	I(1)
CR	-2.734882*	I(1)	-2.734882*	I(1)	-2.489689**	I(1)
ATM	-6.758138*	I(1)	-6.758138*	I(1)	-29.96073*	I(1)
AC	-1.936422***	I(1)	--5.286642*	I(1)	-3.3924*	I(1)

*Note: *, ** and *** denote 1.0, 5.0 and 10.0 per cent respectively.*

Table 2: Bounds Tests

Dependent Variable: **LCPI**								
Scenario One			**Scenario Two**			**Scenario Three**		
Test Stats	Value	k	Test Stats	Value	k	Test Stats	Value	k
F-stats	11.48	2	F-stats	17.29	6	F-stats	8.77	6
Critical Value Bounds			**Critical Value Bounds**			**Critical Value Bounds**		
Sig.	I(0) Bound	I(1) Bound	Sig.	I(0) Bound	I(1) Bound	Sig.	I(0) Bound	I(1) Bound
10%	2.63	3.35	10%	1.99	2.94	10%	1.99	2.94
5%	3.10	3.87	5%	2.27	3.28	5%	2.27	3.28
2.50%	3.55	4.38	2.50%	2.55	3.61	2.50%	2.55	3.61
1%	4.13	5.00	1%	2.88	3.99	1%	2.88	3.99

3.2.3 Long-Run Coefficients

Table 3 presents the long-run coefficients derived from the ARDL models. The adjusted-R^2 reported for all scenarios are 99.0%, implying that the models are well fitted. The Durbin-Watson Statistics are 2.03, 2.70 and 2.21 indicating that there is no evidence of serial correlation.

A critical look at the table starting with scenario one reveals that, while *FII* yields a negative coefficient; *BSSI* returns a positive coefficient. This implies that while *FII* enhances the efficiency of MP, *BSSI* does not. Astonishingly, the coefficient, although positive but statistically insignificant. For scenario two, the indicators of *BSSI* all return positive coefficients and not statistically significant except *BSI* which is significant at 5.0%. The positive and statistically significant coefficient of *BSI* is an indication that BSI fuels inflation.

FSI and *FUI* – indicators of *FII* – return negative coefficients with *FSI* statistically insignificant. *FPI*, although positive but statistically significant. The statistically significant negative coefficient of *FUI* shows that inflation moderates as the index grows. This is theoretically coherent. It further buttressed the argument that FI should not only be about penetration of financial services but the services should be easily accessible to the people at affordable rate. In the case of scenario three, capital adequacy ratio (*CAR*), net interest margin (*NIM*) and non-performing loan over total loan (*NPL/TL*) return positive coefficients, with *NIM* and *NPL/TL* statistically significant at 1.0 and 10.0%, respectively. On the other hand, two of the *FII* indicators (i.e. automated teller machine (*ATM)* and number of accounts (*AC)*) are negatively sign but only *AC* is statistically significant at 10.0%, while total credit *(CR)* is positively sign and not significant. This implies that mounting NPLs has the tendency of worsening inflation. In a nutshell, therefore, the results reveal that FI enhances MP efficiency in Nigeria during the study period. In the case of BSSI, however, the results can be attributed to the constituents of the index which includes the objective function itself and other indicators that are theoretically known to be instrumental to inflationary spiral.

Table 3: Long-Run Coefficients

Dependent Variable: **LCPI**				
Scenario One: ARDL (4, 0, 2)				
Variable	***Coefficient***	***Std. Error***	***t-statistic***	***Prob.***
C	4.737	0.149	31.796	0.000
$LFII$	-0.407	0.103	-3.943	0.001
$BSSI$	0.383	0.232	1.653	0.110
R 2 =	*0.99;*	*Adj. R2 = 0.99;*	*DW Stats =*	*2.038017*
AIC =	*-6.296226;*	*SBC = -5.900346;*	*HQC =*	*-6.158053*
Scenario Two: ARDL (4, 3, 3, 4, 4, 4, 4)				
Variable	***Coefficient***	***Std. Error***	***t-statistic***	***Prob.***
C	4.600	0.057	81.236	0.000
$LFSI$	-0.233	0.244	-0.956	0.410
$LFPI$	0.473	0.035	13.546	0.001
FUI	-0.141	0.014	-9.901	0.002
BSI	0.405	0.076	5.359	0.013
BVI	0.081	0.041	1.957	0.145
ECI	0.002	0.012	0.135	0.901
R 2 =	*-0.99;*	*Adj. R2 = 0.99;*	*DW Stats =*	*2.214036*
AIC =	*-8.954522;*	*SBC = -7.502963*	*HQC =*	*-8.447889*
Scenario Three: ARDL (4, 4, 4, 4, 3, 4, 3)				
Variable	***Coefficient***	***Std. Error***	***t-statistic***	***Prob.***
c	-3.694	0.852	-4.334	0.023
car	0.110	0.132	0.834	0.465
nim	0.125	0.009	13.782	0.001
npl/tl	0.335	0.137	2.455	0.091
cr	0.080	0.053	1.528	0.224
atm	-0.003	0.002	-1.650	0.198
ac	-0.006	0.002	-2.751	0.071
R 2 =	*-0.99;*	*Adj. R2 = -0.99;*	*DW Stats =*	*-2.214036*
AIC =	*-9.00669;*	*SBC = -7.555131;*	*HQC =*	*-8.500057*

Table 4: Short-Run Dynamics

Dependent Variable: LCPI			
	Scenario One	**Scenario Two**	**Scenario Three**
ARDL	**(4, 0, 2)**	**(4, 3, 3, 4, 4, 4, 4)**	**(4, 4, 4, 4, 3, 4, 3)**
ECM(-1)	-0.068*	-0.817*	-0.171*
R^2	0.99	0.99	0.99
Adj. R^2	0.99	0.99	0.99
AIC	-6.26226	-8.954522	-9.00669
SBC	-5.900346	-7.502963	-7.555131
HQC	-6.158053	-8.447889	-8.500057
DW	2.038017	2.707788	2.214036

*Note: * implies significance at 1.0%. AIC, SBC and HQC are Akaike, Schwarz and Hannan-Quinn Information criterion, respectively. Dw is Durbin Watson statistics*

The error correction coefficients as reported in Table 4 shows that up to 6.8%, 81.7% and 17.1% of errors can be corrected on quarterly basis for all scenario one to three, respectively.

3.2.4 Diagnostic Tests

The results of Breusch-Godfrey Serial Correlation and Autoregressive Conditional Heteroskedasticity (ARCH) Tests as reported in Table 5 shows that the models were both serial correlation and heteroskedasticity free. The cumulative sums (CUSUM) of recursive residual and cumulative sum of squares (CUSUMSQ) of recursive residual tests also reveals that the estimated models and parameters are stable.

Fig.4: CUSUM for Scenario 1

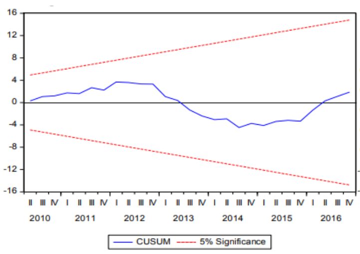


Fig.5: CUSUMSQ for Scenario 1

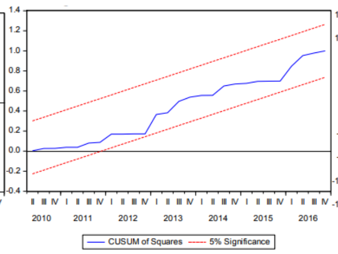


Fig.6: CUSUM for Scenario 2

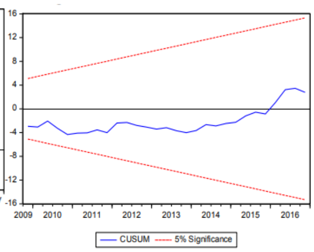


Fig.7: CUSUMSQ for Scenario 2

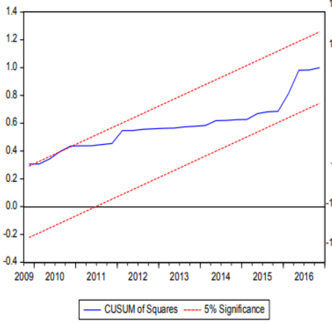


Fig.8: CUSUMSQ for Scenario 3

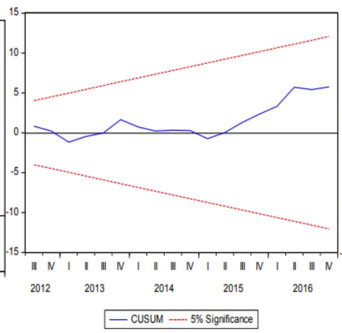
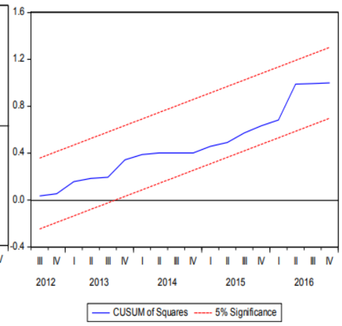


Fig.9: CUSUMSQ for Scenario 3



4. Discussion and Conclusion

Limited access to financial services is generally agreed to have drastic implications not only for inclusive growth and inequality, but also for the efficiency of MP. Starting from the launch of a FI strategy in 2012, Nigeria, as her commitment to the Maya Declaration, has taken various coordinated steps at enhancing FI. Although, there are a lot of hindrances but observers and analysts have generally expressed their opinion that the country had achieved a remarkable success. This study attempts to empirically examine the links among FI, FSS and MP, for a central bank whose statutory responsibility is to curtail inflationary spiral. The study adopted Sarma (2012), and Nicholas & Isabel (2010) to construct indices of FI and FSS, and thereafter deployed ARDL technique to determine the link among the variables.

The results confirm that Nigeria has made remarkable progress in the implementation of her FI initiative and had joined the list of medium financial inclusive nations striving to attain high financial inclusive status. The study also finds that the financial system is fairly stable, despite the turbulence experienced in the banking system during the study period. Overall, the empirical results support that FI has the capability of enhancing the effectiveness of MP, particularly if effort is geared not only towards penetration but also usage. The study, therefore, recommends that the CBN should continue to pursue her FI drive with all vigor so as to expand not only the coverage but also the ease and pace of accessing financial services, as it is capable of enhancing the efficiency of MP.

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A nonparametric test for intervention effect in Markov Regime Switching Model

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Abstract

Many financial market indicators are usually characterized by volatile behaviour and would sometimes switch between regimes through a Markov chain. The dynamic evolution of such time series becomes even more complicated when interventions like policy change or contagion occur. We present a method of testing presence of intervention effect in a Markov regime switching model. The test allows the regimes to be affected by varying nature of interventions at different time points. A simulation study is designed to account different combination of intervention types, magnitude of intervention effect, and distance of two regimes. The simulation study indicated that the test is correctly sized and powerful especially when the intervention effect of a pulse-type intervention variable occurs.

Keywords

Markov Chain Monte Carlo; simulation study; time series; bootstrap; backfitting

1. Introduction

Time series data are easily distorted when a phenomenon has substantial impact on the response (e.g., aberrant random shock) (Wei, 2006). Many researchers are interested in analyzing these interventions, not only to determine if it has a significant effect on the response, but also as an initial step to detect a possible structural change. It is important to know existence of a structural change because its presence calls for substantial revision in the data generating process which facilitates data modeling for better understanding of the phenomenon being monitored.

For time series data, Box & Tiao (1975) used a transfer function that framed the intervention and it can only be done by analyzing the stochastic behavior of the process first through an Autoregressive Moving Integrated Average (ARIMA) model. However, some econometric and financial data (e.g., stock prices) demonstrate frequent vivid change in behavior especially when there is turbulence. This frequent changes result in a series with high and peculiar volatility. Consider a high-frequency time series that is exposed to erratic fluctuations in both mean and variance. While a volatility model like the generalized autoregressive conditionally heteroscedastic model (GARCH) are often proposed, these models may necessitate to postulate too many parameters. Alternatively, if the volatile behavior of the time series persists, then a switching regression model maybe considered. It is possible further that more localized perturbations may exists (e.g., extreme random shocks) then, even a switching regression model may fail to track the dynamics in the time series data. Some researchers modified these linear models using threshold autoregressive models (TAR) (Rambharat, Brockwell & Seppi, 2005) and allow the threshold to be a function of time to account for spikes, or some other nonlinear model structures. However, for oil price data set where the fluctuation depends on the flow of the market, the shift in values of the trend is not deterministic and can be regarded as stochastic in nature (Eichler & Turk, 2013).

Under stochastic regime switching, Quandt (1972) suggested that such occurrences were driven by some threshold probability but this threshold probability does not fit well to some data set of same case. Hamilton (2008) extended the threshold probability by inducing a Markovian process in the switching pattern of the parameters.

Clement & Krolzig (2008) compared the linear models with non-linear models mentioned above and concluded that regime-switching approach has better fit when the data are in-sample. Billio & Monfort (1998) further generalized this regime-switching behavior through general state space switching model that infuse partial Kalman-Filter with sampling technique for the formulation of the likelihood function, but, Eichler & Turk (2013) supported that regime-switching by Hamilton (2008) is better suited for some econometric application like electricity prices.

These current models in literature are only intended to model regime-switching behavior of some highly volatile series, however, when series encountered unexpected interventions other than the switching behavior, the likelihood function used by these models is insufficient.

To deal with this problem, our paper uses the idea of backfitting algorithm in estimating the parameters of the postulated model and test the intervention using non parametric approach. This paper also compared the proposed test with Markov regime switching regression by Goldfeld & Quandt (1973).

2. Methodology

This paper considers a Markov regime switching model that allows intervention parameters at two different time points. The model is defined as:

$$y_t = \begin{cases} \delta_1 + \phi_1 y_{t-1} + \omega_1 I_t^{(T_1)} + a_t; & s_t = 0 \\ \delta_2 + \phi_2 y_{t-1} + \omega_2 I_t^{(T_2)} + a_t; & s_t = 1 \end{cases}$$

for i=1,2 and t=1,2,3,…,T where, δ_i is the intercept of the state i, $\emptyset_i$ is the autoregressive parameter of state i, y_{t-1} is the lag 1 of response variable, ω_i is the fixed impact of intervention felt at time T_i, $I_t^{(T_i)}$ is the type of intervention which is either step or pulse at time T_i, a_t is the Gaussian white noise distributed as $N(0,\sigma_a^2)$ which is not affected by the regime switching, s_t is the state variable that follows an exogenous time-invariant Markov chain process, that is, it follows a transition probability of the form: $p_{ij} = P(s_t = k|s_{t-1} = j)$ for k,j=1,2 and the first state has the unconditional probability of

$$P(s_0 = j) = \frac{1-p_{22}}{2-p_{11}-p_{22}}.$$

2.1. Estimation

A regime-switching model can be estimated using Markov Chain Monte Carlo (MCMC) or through Kalman-Filter approach (Hamilton, 2008). For this study, MCMC was embedded into backfitting algorithm discussed by Buja, Hastie & Tibshirani (1989). This hybrid algorithm facilitates simultaneous estimation of the first-order autocorrelation parameter and the intervention parameter while improving the estimates. The proposed algorithm is as follows:

(1) Estimate the parameter space $\boldsymbol{\theta_1} = \{\delta_1, \phi_1, \delta_2, \phi_2, \sigma^2_a, p_{00}, p_{11}\}$ through Metropolis-Hastings algorithm. Series that is free from intervention effect (i.e., at initial iteration, it is the pre-intervention part of the series) should be used under this step. The likelihood function was adopted from the conditional log likelihood proposed by Hamilton (2008). This study considered a non-informative prior hence, the selection of parameter values by MCMC will only depend on the likelihood function. Also, the proposal distribution is assumed to be uniformly distributed.

(2) Following likelihood function model by Hamilton (2008), the exogenous state process would be predicted from this likelihood function after the MCMC estimation of the $\boldsymbol{\theta_1}$, i.e., estimate s_t through $f(\boldsymbol{s_t}|\boldsymbol{\theta_1}, y_{t-1}, y_{t-2}, \ldots, y_1)$ and take the state process with least mean square error.

(3) After obtaining the estimates for $\boldsymbol{\theta_1}$ and state process, residuals will be calculated by removing the effects of $\hat{\theta}_1$ leaving the pure residuals and the intervention effect as illustrated below.

$$y_t - \delta_1 - \phi_1 y_{t-1} - s_t(\delta_2 - \delta_1 + (\phi_2 - \phi_1)^* y_{t-1}) = \omega_1 I_t^{(T_1)} + s_t(\omega_2 - \omega_1) + a_t = \varepsilon_{1t}$$

(4) This estimate of first residual $\hat{\varepsilon}_{1t}$ no longer encompasses the regime-switching effect hence ω_1 and ω_2 can now be estimated through Box & Tiao (1975) model.

(5) Estimate of intervention effects will be deducted from the original series leaving $\boldsymbol{\theta_1}$ with the pure residual illustrated by the equation below.

$$y_t - \omega_1 I_t^{(T_1)} - s_t(\omega^*) = \delta_1 + \phi_1 y_{t-1} + s_t(\delta^* + \phi^* y_{t-1}) + a_t = \varepsilon_{2t}$$

The estimate of second residual $\hat{\varepsilon}_{2t}$ will enter the step (1) again and the algorithm will stop when the parameter space $\boldsymbol{\theta_1}$ converges with maximum tolerance of 0.05%.

2.2. Hypothesis Testing

In testing the significance of intervention effect parameterized with $\boldsymbol{\theta_2}$ = {ω_1, ω_2}, bootstrap resampling algorithm by Bühlmann (1997) was employed. Given the following hypotheses: Ho: ω_i = 0; The series has no intervention at time T_i, versus, Ha: $\omega_i \neq 0$; The series has intervention effect at time T_i, for i = 1 or 2.

The series of an individual regime which contains intervention effect was recreated and replicated. The empirical distribution of the statistics was obtained for each intervention ω_i by repeating the process B = 200 times. A (1-α)*100% confidence interval for each ω_i was constructed and reject the null hypothesis if the interval does not contain 0. In order to assess the goodness of the test, power and size was tabulated using number of rejection frequencies. The confidence interval (C.I.) was reconstructed R=200 times and number of times that the bootstrap rejects the null hypothesis at 5% level of significance was observed. Bonferroni adjustment was used for algorithm with simultaneous hypothesis testing (i.e., test for two interventions).

3. Results

The results focused on the size and power of the test when intervention occurred at regime 2. The size is the probability of error committed when the researcher falsely fitted the regime switching intervention model to a series with no intervention. The test is said to be of good performance when the power is high and size is lower than the pre-set nominal level which is 5%.

It is important to highlight that most part of the series came from regime 1 (i.e., setting of this simulation study is that 67% of the series came from regime 1). Hence, intervention at regime 1 would result to either structural change or difficulty in estimation procedure. The results below were summarized according to the mean difference of two regimes and type of intervention.

3.1. Series with no intervention

Table 3.1. Size of test for single intervention occurred under Regime 2

Type of intervention (time of occurrence)	Proposed test			Markov Switching Regression test		
	Mean difference ($\mu_1 - \mu_2$)			Mean difference ($\mu_1 - \mu_2$)		
	3	***6***	***16***	***3***	***6***	***16***
Pulse (t = 0.55 $*$ T)	0.105	0.06	0.065	n/a	n/a	n/a
Pulse (t = 0.85 $*$ T)	0.03*	0.03*	0.07	n/a	n/a	n/a

Step (t = 0.55 ∗ T)	0.8	0.71	0.79	0.8	0.02*	0*
Step (t = 0.85 ∗ T)	0.56	0.58	0.54	.99	0.04*	0*

*size < 0.05;

Table 3.1. shows that sizes are acceptable for pulse-type of intervention test with mean difference less than or equal to 6 and occurred at the latter part of the series (t = 0.85 ∗ T). The proposed test for step function is inflated as expected because time series with step intervention assumes the behavior of nonstationary time series even after the backfitting algorithm. Generally, test has size less than or equal to 0.105 for pulse-type of intervention.

Markov switching regression model by (Goldfeld & Quandt, 1973) is not working for pulse-type of intervention. It requires its independent variable to have non-zero values for both regimes. Pulse type function cannot satisfy this requirement because it can only have at most 2 time points that is non-zero and the probability that these two time points do not belong on same regime is not certain. Although it is not working for pulse-type of intervention, the said test is working for step-type of intervention. As observed in Table 3.1, the probability of committing type 1 error decreases as mean difference increases.

In fact, the test is good for mean difference higher than 6 provided that $\sigma_a < (\mu_1 - \mu_2)$. Generally, for pulse-type of intervention, the proposed model is better and for step-type of intervention, the Markov switching regression by Goldfeld & Quandt (1973) is better.

3.2. Intervention on Single regime

The results below were summarized according to the mean difference of two regimes and type of intervention. It can be observed that power of proposed test increases with magnitude of pulse intervention (refer to Table 3.2. below). Table above also shows that smaller mean difference has higher power over higher value of mean differences (i.e., power and mean differences have indirect relationship). In terms of time of occurrence, intervention which occurred at the latter part (t = 0.85 ∗ T) of the series has relatively lower power than that intervention which occurred at the middle part (t = 0.55 ∗ T) of the series. However, based on Table 3.1., the pulse-type of intervention at the latter part of the series is correctly sized while pulse intervention at the middle of the series is somewhat inflated.

Table 3.2. Power of the test for single intervention of intervention on Regime 2

Pulse-type of Intervention							
Time of occurrence of the intervention	Intervention effect at Regime 2	Proposed test			Markov Switching Regression test		
		Mean difference ($\mu_1 - \mu_2$)			Mean difference ($\mu_1 - \mu_2$)		
		3	***6***	***16***	***3***	***6***	***16***
(t = 0.55 ∗ T)	$\omega_2 = 4$	0.765	0.7	0.53	n/a	n/a	n/a
	$\omega_2 = 6$	0.975	0.845	0.73	n/a	n/a	n/a
	$\omega_2 = 9$	1	1	0.935	n/a	n/a	n/a

(t = 0.85 $*$ T)	ω_2 = 4	1	0.245	0.275	n/a	n/a	n/a
	ω_2 = 6	1	0.945	0.48	n/a	n/a	n/a
	ω_2 = 9	1	1	1	n/a	n/a	n/a
Step-type of Intervention							
Time of occurrence of the intervention	Intervention effect at Regime 2	Proposed test			Markov Switching Regression test		
		Mean difference ($\mu_1 - \mu_2$)			Mean difference ($\mu_1 - \mu_2$)		
		3	***6***	***16***	***3***	***6***	***16***
(t = 0.55 $*$ T)	ω_2= 4	0.9	0.85	0.915	1	1	1
	ω_2= 6	0.775	0.665	0.77	1	1	1
	ω^2=9	0.715	0.665	0.71	1	1	1
(t = 0.85 $*$ T)	ω_2=4	0.825	0.625	0.775	1	1	1
	ω_2=6	0.825	0.625	0.99	1	1	1
	ω_2=9	0.625	0.91	0.99	1	1	1

On the other hand, for step-type of intervention, the power of proposed test when mean difference is below 6 decreases as magnitude of intervention increases. Moreover, the proposed test is robust for mean differences in step-function. Markov regime switching regression test (Goldfeld & Quandt, 1973) cannot be used for pulse type of intervention for the reason that was stated above, but this test has perfect rejection power for step-type of intervention. It can also be said from Table 3.1. that step-type of intervention with above 6 mean difference is correctly-sized.

3.3. Series with pulse-type of intervention at Regime 1

When pulse-type of intervention happened at latter part of regime 1, not well-estimating it might affect the detection of intervention at regime 2 located at the middle part of the series. The table below shows the power of proposed test and Markov switching regression test by Goldfeld & Quandt (1973) when pulse-type of intervention occurred at regime 1 at latter part of the series.

Table 3.3. Power of the test for intervention with aberrant pulse-intervention at regime 1, ω_1= 6 (grouped by the mean difference of the series).

Type of intervention	Intervention effect at Regime 2	Proposed test			Markov Switching Regression test		
		Mean difference ($\mu_1 - \mu_2$)			Mean difference ($\mu_1 - \mu_2$)		
		3	***6***	***16***	***3***	***6***	***16***
pulse-type	ω_2= 4	0.765	0.7	0.62	n/a	n/a	n/a
	ω_2 = 6	0.975	0.255	0.65	n/a	n/a	n/a
	ω_2= 9	1	0.255	0.665	n/a	n/a	n/a
step-type	ω_2 = 4	0.7	0.44	0.395	1	0.52	0.54
	ω_2= 6	0.488	0.45	0.4	0.5	0.72	0.62
	ω_2 = 9	0.42	0.495	0.84	0.54	0.42	0.36

When mean difference is not 6, the power increases with mean difference. The size of the test for pulsetype of intervention is less than the nominal level when mean difference is below 6 (Table 3.1.). On the other hand, the power of Markov switching regression test (Goldfeld & Quandt, 1973) is above 50% for step-type of intervention with mean difference equal to 3 but the size of the test under this case is inflated. The series with mean difference of at least 6 has power ranging from 0.36 to 0.72.

3.4. Application

S&P 500 index encompassed the 500 companies with the highest stock capitalization in the U.S. thus, it is one of the most influential indices worldwide, even in Asian countries like Philippines. Some financial analysts use the average true range [ATR] of an index to study volatility and risks of buying and selling stocks. This ATR is the rolling x-day weighted average of the range of price on that period, where lag opening price serves as the weights. Ziemba (2016) listed 7 declines in stock market from 2001 to 2016 and identified February 27, 2017 as one of them. This is due to unexpected drop in Shanghai stock exchange known as Chinese stock bubble of 2007 - the "largest drop in 10 years". During this period, there were allegations that Chinese government planned to "institute a capital gains tax" and some analysts attributed the sudden decline in stock market to this issue (Shu & Kwok, 2007). As an application of the proposed test, this section would determine if this happening in February 27, 2007 has an effect on 1-day ATR of S&P 500. Hence, it is of interest to test if happenings during February 27, 2017 has an intervention effect on 1-day rolling ATR of S&P 500.

Model 3.1. The fitted postulated model

$$\hat{y}_t = \begin{cases} 1 + 0.9554 y_{t-1}; & s_t = 0 \\ 21 + 0.1958 y_{t-1} + 7.2556 P_t^{(Feb27)}; & s_t = 1 \end{cases};$$

$$\text{where } P(s_t|s_{t-1}) = \begin{bmatrix} 0.9325 & 0.0675 \\ 0.9300 & 0.0700 \end{bmatrix} \text{ and } \hat{\sigma}_a = 0.5094$$

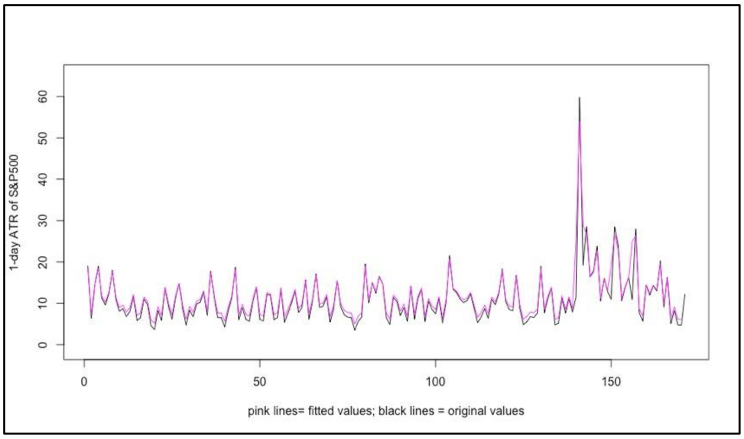

Figure 3.1. Fitted values of the postulated model

Table 3.4. Estimated statistics of the fitted model

Model	MAPE	$\hat{\sigma}_{resid}$	Pre-intervention $\hat{\sigma}_{resid}$
Postulated model – Pulse	8.75%	1.45	0.1741
Goldfeld & Quandt (1973) – Step	33.8%	4.14	3.54

Table 3.5. Summary statistics of the test

	Postulated model – using Pulse function	Goldfeld & Quandt (1973) model – using Step function	
95% Bootstrap C.I. Lower limit Upper limit	 2.6437 4.2844	Under Regime1: 11.8301 Regime1: 18.3007	Under Regime2: -0.6870 Regime2: 1.8974
Decision	Reject Ho	Reject Ho on Regime1	

The large gap in the standard error of pre-intervention series and the whole series supports presence of intervention and the postulated model has less than 20% mean absolute percentage error (refer to Table 3.4). The bootstrap replicates also showed lower than 15% MAPE and the estimated confidence intervals (Bootstrap C.I.) for the two interventions do not include zero (refer to Table 3.5). Thus, the proposed algorithm for testing the presence of intervention rejects the null hypothesis, that is, there is enough evidence to say that intervention occurred last February 27, 2017, at 5% level of significance.

4. Discussion and Conclusion

Many econometric data sets are highly volatile that simple linear time series models fail to fit. For this reason, some researchers find a way through the use of nonlinearity in their models. Two of the most known regime-switching models are TAR and Markov Chain Regime switching models. However, for many econometric applications, Markov Chain Regime switching models is more flexible. Since available models in the literature do not allow interventions on their model, the researcher decided to conduct a study in order to test the presence of intervention.

A hybrid of MCMC and backfitting approach was used as estimation and bootstrap for dependent series was employed for testing of hypothesis. Each of 200 cases were replicated 200 times to determine the power and size of the test.

Using simulation study, results have shown powerful test for pulse-type function when the intervention is at regime 2 for single intervention. Moreover, the test is still of good performance for pulse-type of intervention even though the base regime (i.e., regime 1) has aberrant intervention at the latter part of the series. On the other hand, step yielded a very sensitive test yet low convergence rate. Also, the sensitivity of step function is risky since it has scenarios of inflated size of the test. The Markov switching regression by Goldfeld & Quandt (1973) was also fitted and it showed that it has good performance when intervention is step but it cannot estimate a pulse-type of intervention. The model is also fitted for case of rolling one-day mean of S&P 500 and the test rejects the null hypothesis with competitive fit of the model when intervention is pulse-type.

Thus, for the proposed test for intervention, the test is said to be powerful for pulse-type of intervention, while Markov switching regression is recommended for step-type of intervention.

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Adjusting tolerance limits for difference between coordinates used to link agricultural producers' records

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Abstract

Most Brazilian agricultural statistics are still based on decennial censuses, surveys over subpopulations of establishments and subjective surveys. Together, those sources provide an important range of high quality data. However, there exist some limitations such as the natural obsolescence of census data as time passes and the impossibility of providing error estimates or precision measurement associated to the subjective surveys. To improve agricultural statistics, the Brazilian Institute of Geography and Statistics – IBGE plans to implement a probabilistic survey which is compatible with the Agricultural Integrated Survey – AGRIS. A sampling frame based on the 2017 Census of Agriculture will be soon available and strategies to update it considers use of administrative registers. As part of the working plan finding a method for using geographic coordinates as linking variable is on the way, what includes finding best tolerance limit for difference between coordinates values when using it as linking variable. An empirical study was conducted to identify an optimal tolerance limit for difference between coordinates values to be used as linking variable. Registers from a disease control agency in the State of Tocantins was linked to producers registered in the 2017 Brazilian Census of Agriculture. Unique ID was used as auxiliary variables while coordinates were used as linking variables. The harmonic mean of precision and recall (FMeasure) was used to decide the optimal tolerance limit.

Keywords

Rural Statistics, Sample Frame, Data Integration; Record Linkage, Geographic Coordinates.

Acknowledgment

The views in this paper are those of the authors and not necessarily those of either the Brazilian Institute of Geography and Statistics or National School of Statistical Science.

1. Introduction

The current agricultural survey system of the main producer of public statistics in Brazil, the Brazilian Institute of Geography and Statistics - IBGE, is based on decennial censuses, surveys over subpopulations of establishments and subjective surveys. Despite providing a broad range of high quality data, limitations of such sources include natural obsolescence of data as it gets far from the reference date, restricted coverage of products and producers or impossibility of providing error estimates or precision measurement, depending on the survey. In addition, data produced on the tripod system presents distinct figures on agricultural production in the census reference years due to conceptual differences and coverage between census and surveys (Proposta..., 2011).

To improve agricultural statistics, in order to meet accordingly national and international demands, IBGE is promoting reformulation of its survey system. Action plan includes implementation of a probabilistic survey which is compatible with the Agricultural Integrated Survey – AGRIS as proposed by Global Strategy to improve Agricultural and Rural Statistics (2018). However, to move ahead, a key component is still missing: a sampling frame.

A sampling frame, based on the 2017 Census of Agriculture, will be soon available. However, at medium term it will lose correspondence to reality so that it is necessary finding strategies to update it. The use of administrative registers is the best chance to update the frame before next census, expected to 2028, but it still depends on access to data sources and setting a method up.

Study conducted by Silva (2018) have shown superiority of tree-based methods to integrate Registers when only name and address of producers are available. Present study provides results for integrating Census and Registers when geographic coordinates, i.e., latitude and longitude, are available.

2. The Empirical Study

The data used come from two lists: one corresponding to producers registered in a disease control agency called Agencia de Defesa Agropecuária do Estado do Tocantins, maintained by the State Government; and another to producers counted in the 2017 Census of Agriculture, conducted by IBGE. In both lists, geographic coverage is the State. Producers present in both datasets, for which unique ID and coordinates were available defined the population of interest. From now on, subsets will be called ADEPEC and CENSO, respectively.

Coordinates provided by both sources were taken at the farm headquarter (the holder dwelling in the case of the family farm) when headquarter (or dwelling) was located within the holding. Otherwise, coordinates were taken in the main agricultural parcel (cropland or pasture).

Experiment was conducted in four steps. Step one was dedicated to data preparation, corresponding mainly to standardization as files neither was in same format nor used same labels; and transformation of coordinates to degree by dividing minute by 60 and second by 3,600 and obtaining the sum of all components. Step two corresponded to comparing each record in ADAPEC to each one in CENSO and computing the difference between the coordinates values. Differences were obtained applying algorithms for the computation of geodesics on an ellipsoid proposed by Karney (2013). The number of comparisons corresponds to the product of the sizes of the files, i.e., 387 x 387, what means 149,769 comparisons. Then in step three, records whose difference between coordinates value was smaller than a limit (L) were considered to belong to the same producer. Finally, in step four, unique ID was used to check whether or not classification was according to the deterministic rule considering distance were correct and then attribute one of four labels: **TP** for true positives, **FP** for false positives, **TN** when true negative and **FN** for false negatives.

The experiment considered 1,000 tolerance limits. Starting tolerance limit was related to the precision of a standard handheld GPS navigator, what corresponds to approximate 100 meters. Initial tolerance limit was then increased by 50 meters until 50,050 meters.

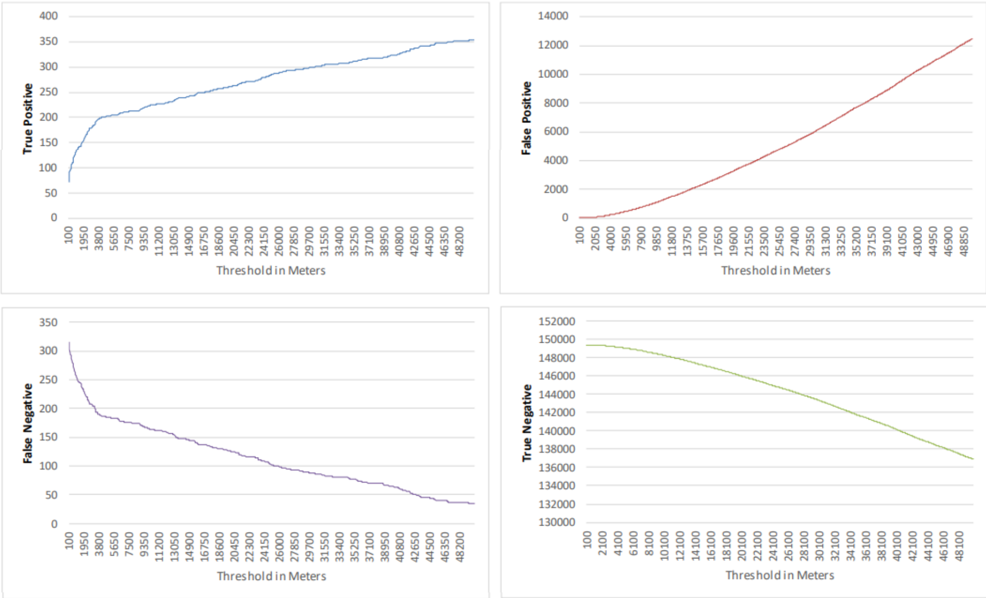
R Language was used to perform the four steps. Packages used in data preparation are stringr, dplyr (Wickham, 2018; Wickhan et. al., 2017). Difference between coordinates values were computed using package geosphere (Hijmans, 2017).

3. Comparison of Tolerance Limits

Overview of tolerance limits performances is given by the quantities of TP, FP, FN and TN. The decision criteria to choose the optimal tolerance limit is F-measure, a synthetic measure representing the harmonic mean of precision and recall $F = 2pr/(p + r) where\, p = TP/(TP * FP)\, and\, r = TP/(TP * FN)$.

As expected, the number of positive, i.e., records pairs considered to belong to the same producer, increased with tolerance limit. It is explained by the increase of both, true and false positive. The number of true positive approaches the maximum (387) when tolerance limit is close to 50,000 meters; while number of false positives goes on growing beyond such threshold (Figure 1). Consistently, number of negative decreases with tolerance limit. False negative is as low as 40 when tolerance limit is close to 50,000 meters, but such difference between coordinates is not reasonable to reach low level of false as coordinates are supposed to be captured under same instructions, as mentioned before. Also, true negative is decreasing while tolerance limit increases, as it is losing record pairs to false positive class (Figure 1).

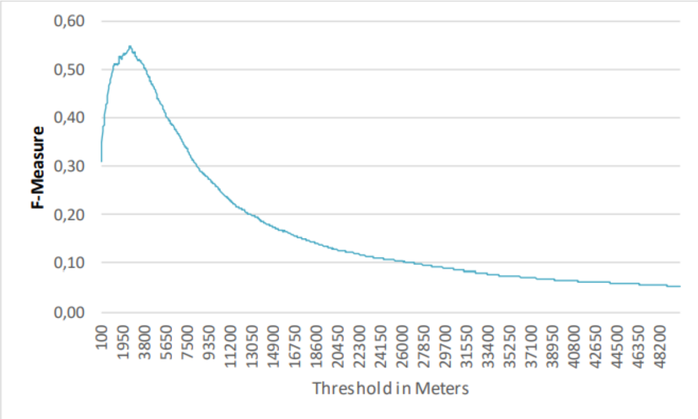
Figure 1: True Positive, False Positive, False Negative and True Negative by Tolerance Limit (Threshold)



Empirical results do not indicate a tolerance limit that leads to highest number of true (positive and negative) and lowest number of false, concomitantly, and for this reason, using a synthetic measure, such as the **F-Measure**, to compare the overall efficacy of the threshold, becomes even more important. It should be noted that general efficacy here refers to a consensus measure, since the F-Measure is the harmonic mean of the two others. In specific cases, choosing to maximize number of true classification or minimize false may be preferable.

Efficacy associated to threshold, expressed through F-Measure, starts at F=0,31, what corresponds to initial tolerance limit (100 meters), and reaches the highest value (F=0.55) at 2,600 meters. It means that if tolerance limit is set equal to 2.600 meters classification will reach the best compromise between precision and recall.

Figure 2: F-Measure by Tolerance Limit (Threshold)



4. Discussion and Conclusion

The experiment has shown that better performance of linkage using coordinates as linking variables is reached when tolerance limit for the difference between coordinates in compared registers approaches 3 kilometres. Such a big difference is not completely unexpected because there is a well-known effect of many errors in measuring coordinates playing on data from both sources. Then, the effect of presence of such errors is amplified according not only to the number of sources of errors but also by the double effect (one from each source).

In theory, data used in the experiment were captured under same condition in what concern the most common sources of errors, i.e., system, environment, device, measurement instructions and the operator. However, in practice, it is never possible to ensure completely the same conditions because even if the same procedures are adopted the result may be different due to the context. Furthermore, standard procedures may introduce error due to the use of flexible instructions such as "...taking the coordinates at the farm headquarter (the holder dwelling in the case of the family farm) when headquarter (or dwelling) was located within the holding. Otherwise, coordinates were taken in the main agricultural parcel (cropland or pasture).". When it comes to soybeans, "main agricultural parcel" may be as big as 3 kilometres and coordinates may have been taken in different points of cropland.

The suggested tolerance limit is that comparatively better considering the selected method and data. Therefore, the results presented should be seen with some caution. Difference between coordinates can vary in other applications. For this reason, extending the present work to other data sources, preferably for different cultures and parts of the Brazilian territory, may provide better understanding on patterns and contribute better to sound decision in setting tolerance limit.

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Multiple Imputation: An iterative regression imputation

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Abstract
Multiple Imputations (MI) is a commonly applied method of statistically handling missing data. It involves imputing missing values repeatedly in order to account the variability due to imputations. There are different techniques of MI which have proven to be effective and available in many statistical software. However, the main problem that arises when statistically handling missing data, namely the bias still remains. Indeed, as multiple imputation techniques are simulation-based methods, estimates of a sample of a fully complete data may substantially vary at every application using the same original data and the same implementation method. Therefore, the uncertainty is often under or overestimated, exhibiting then a poor predictive capability. We proposed an iterative procedure based on regression imputation. The procedure start by fitting a regression model using available data. Then, missing data are replaced by the predicted values increased with residuals draw from a normal distribution which depends on the observed values and current imputed values for the missing data and under the condition that the sum of squares of residuals (SSE) arising from the fully complete data is within the constructed limit. This process is repeated for a fixed number of times. The SSEs of the prediction are used to assess the performance of the proposed approach comparatively to the expectation-maximization imputation (EM) and multiple imputation by chained equations (MICE). Results indicate that the three methods work reasonably well in many situations, particularly when the amount of missingness is low and when data are missing at random (MAR) and missing completely at random (MCAR). However, when the proportion of missingness is severe and the data are missing not at random (MNAR), the proposed method performs better than MICE and EM algorithms.

Keywords
Missing data; multiple imputation by chained equations (MICE); expectation-maximization (EM); sum of squares of residuals (SSE)

1. Introduction

Multiple imputations (MI) is a simulation-based method highly praised to provide consistent and asymptotically efficient estimates for the statistical analysis of missing data. The method was first proposed by Rubin (1986) to impute missing data while solving some of the issues relied on the efficiency of classical missing data handling methods such as case deletion and single imputation. Indeed, case deletion and single imputation are known to be sensitive to the missing data mechanisms (MCAR, MAR, and MNAR) and to underestimate the standard error which leads to an overestimation of test statistics (Schafer, J. L., & Graham, J. W. (2002); Rubin (1996)). Multiple imputations address these issues and provide more consistent estimates by increasing the number of imputations in order to reduce bias in the standard error whereby introducing additional uncertainty due to imputations (Allison, (2002); Rubin, (1996); Schafer, J. L, & Graham, J. W. (2002); Little, R. J. A., & Rubin, D. B. (2002)). In addition, unlike other methods, they tend to be less sensitive to the different missing data mechanisms: missing completely at random (MCAR), missing at random (MAR), and missing not at random (MNAR) (Rubin, (1987)). Various methods of multiple imputations have been developed to handle missing data in different circumstances such as non-normality of data or the pattern of missing data. Among them, the Expectation-Maximization (EM) algorithm, the Multiple Imputation by Chained Equations (MICE), based on a Monte-Carlo Markov Chain (MCMC) algorithm, Imputation-Posterior (IP) method and the multiple imputation by Predictive Mean Matching (PMM) technique (Dempster et al. (1977); Rubin, (1986, 1987); Oudshoorn et al. (1999); King et al. (2001); White et al. (2011); Azur et al. (2011); Morris et al. (2014); and Kleinke (2018)). However, as multiple imputation techniques are inherently simulation-based methods, estimates of a sample of multiply-imputed data may substantially vary at every application using the same original data and the same implementation method (Nakai, M. & Weiming, K., (2011); Hippel, 2018). Therefore, the uncertainty is often under or overestimated, exhibiting then a poor predictive capability. The determination of the full additional uncertainty is not straightforward. In addition, the discrepancy between the true and the estimated parameters becomes considerably large as the fraction of missing data increases. A Possible reduction of this bias require much more imputation, which require more resources to generate, store and analyze the multiply-imputed data.

The present work proposes a new approach of MI that addresses these issues by avoiding or at least reducing bias and improving precision. Contrary to existing MI techniques, the proposed approach consists of constructing a possible low and upper bound around the sum of square of residuals (SSE) that would have been obtained in complete case (if there have been no missing data) based on the available observations and the SSE obtained by fitting a regression model with these available data. Then, iteratively implement a regression imputation (RI) to replace the missing values and fit a regression model with the fully completed data. If the corresponding SSE does not fall in the constructed bound, the RI method is repeated until the SSE estimated fall into that bound. For a multiple imputation, this procedure is repeated for a predefined number of times. The rest of the paper is organized as follows: section 2 provides a brief description of MICE and EM algorithms and presents the proposed method with a detailed discussion of the framework. An illustrative example using real data, and conclusion are given in Sections 3 and 4 respectively.

2. Methodology

2.1 Brief description of MICE and EM algorithms

MICE procedure fit a regression model for each variable having missing data and uses fully observed variables as covariate. In case where all variables have missing values, the procedure initially fills in at random all missing variables and then regressed each missing variable on the other fully observed variables. Missing values are imputed using the posterior predictive distribution (see Azur et al. (2011); Raghunathan et al., (2001); Van Buuren, (2007)).

The EM algorithm (Dempster, Laird, & Rubin, 1977) is a general method for obtaining Maximum Likelihood estimates which involves two steps: The E-step and M-step. The first, essentially calculates the expected values of the complete data sufficient statistics given the observed data, $X_{obs,i}$ and current estimates, $\Theta^t = (\mu, \sigma^2)$. While, the second step computes new parameter estimates, $\Theta^{t+1} = (\mu^{t+1}, \Sigma^{t+1})$

Where, $\mu_j^{t+1} = \sum_{i=1}^{n} \frac{x_{ij}^t}{n}$ and $\sigma_{jk}^{t+1} = \frac{1}{n} \sum_{i=1}^{n} \{(x_{ij}^t - \mu_j^{t+1})(x_{ik}^t - \mu_k^{t+1}) + \gamma_{jki}^t\}$

The algorithm iteratively proceeds between E-step and M-step until the discrepancy between Θ^t and Θ^{t+1} converges to a specified criterion. At the final E-step, imputed values are supplied to missing values.

2.2 Proposed method

Basically, imputation-based techniques involve replacing missing values using available observations. The purpose of imputation is to provide consistent test statistics, which means providing a sampling variance as close as possible to the sampling variance without missing data. The aim of our method is to improve the accuracy by constructing a limit around the true SSE, although this is unknown. Indeed, the main idea is to restrict the imputation to values for which the SSE is close as possible to the true SSE. The method requires at least one fully observed variable and can be applied for any missing data pattern. For the first step of iteration, a regression model is fitted for each variable having missing values and the estimation is restricted to individuals with observed values. Then, missing values are replaced by the predicted values increased with residuals draw from a normal distribution. For the rest iterations, new values are imputed with respect to the observed values and current imputed values for the missing data. In each iteration, missing values are replaced under the condition that the SSE obtained from the completed data set is within the constructed interval. The proposed iterative method can be summarized as follows:

Step 1: Define the number of missing and non-missing variables.

Step 2: Fit a regression model with available observations,

$$\mathrm{Y_j}^{\mathrm{obs}} = \beta_0 + \sum_{k=1}^{q} \beta_k X_k^{obs} + \varepsilon_j,$$

Where, $\mathrm{Y_j}^{\mathrm{obs}}$ is the available part of the missing variable, Y_j $(j = 1,2, \dots , p)$; X_k^{obs} are the available part of the fully observed variables; p and q are the number of missing and non-missing variables respectively; β_0 and β_k are the coefficients of the regression; ε_j is the residual ($\varepsilon_j \sim N(0, \sigma^2)$).

Compute the corresponding sum of squares of residuals, SSE_{obs}^{j},

$$\mathrm{SSE}_{obs}^{j} = \sum_{\mathrm{i}=1}^{n_{obs}^{j}} \hat{\varepsilon}_{\mathrm{ij}}^{2} = \sum_{\mathrm{i}=1}^{n_{obs}^{j}} \left(\mathrm{Y_{ij}}^{\mathrm{obs}} - \hat{\mathrm{Y}}_{\mathrm{ij}}{}^{\mathrm{obs}}\right)^2, \quad i = 1,2, \dots , n_{obs}^{j};$$

Step 3: Use the estimated regression coefficients, $\hat{\beta} = (\hat{\beta}_0, \hat{\beta}_{j-1})$ to replace the missing values, $\mathrm{Y_j}^{\mathrm{mis}}$

$$\mathrm{Y_j}^{\mathrm{mis}} = \hat{\beta}_0 + \sum_{j=1}^{q} \hat{\beta}_{j-1} X_k^{mis} + \hat{\varepsilon}_j,$$

Where, $\hat{\varepsilon}_j$is draw from $N(0, \hat{\sigma}_j . v)$ with $\hat{\sigma}_j$ being the sum of squares of residuals for observed data, and v is generated from a chi-square distribution with df degree of freedom.

Step 4: Construct an approximate limit around the true sum of squares of residuals. This is done as follows,

- Compute: $\mathrm{SSE}_{ref}^{j} = \frac{\mathrm{SSE}_{obs}^{j}}{c_j}$, with $c_j = \frac{n_{obs}^{j}}{\mathrm{n}}$, n, the sample size and n_{obs}^{j}, the number of non-missing values in the corresponding variable, Y_j.
- Compute $\delta_j = c_j(1 - c_j) + 0.05$. Then, generate a sequence r_{lj} from $c_j - \delta_j$ to $c_j + \delta_j$, with 0.01 as the increment of the sequence.
- Calculate the quantities $\mathrm{SSE}_{r_l}^{j} = \frac{\mathrm{SSE}_{obs}^{j}}{r_l}$, with $r_l \in R_j; l = 1,2, \dots s$ (s is the length of the sequence).
- Set B as the set of $\mathrm{SSE}_{r_l}^{j}$ $<$ the integer rounding of $\mathrm{SSE}_{ref}^{j} + \frac{1}{2}\mathrm{SSE}_{ref}^{j}$.
- Set SSE_{low}^{j} as the mean of the set of B less than the integer rounding of SSE_{ref}^{j}.
- Set $\mathrm{SSE}_{\mathrm{up}}^{j}$ as the mean of the set of B greater than the integer rounding of round SSE_{ref}^{j}.

Step 5: fit a regression model for the fully complete data. If the corresponding SSE^{j} does not fall into the interval $\left[\mathrm{SSE}_{low}^{j} - \mathrm{SSE}_{\mathrm{up}}^{j}\right]$, repeat step 2-4 until this condition is met.
Step 6: For each missing value, draw new $\widehat{\varepsilon_{ij}}$ from $N(0, \widehat{\sigma_{ij}}.\, v)$ with $\widehat{\sigma_{ij}}$ being the sum of squares of residuals (SSE^{ij}) for the current fully complete data and add to the initial predicted value, $\mathrm{Y_{ij}}^{\mathrm{mis}}$.
Step 7: Repeat the steps1-5 for each missing variable, for a fixed number of times.

3. Results

Dataset used in this study is the estimate of government effectiveness collected by the Word Bank institution for 213 countries in the world over 17 years. Originally, the dataset contains missing values, but we took the available complete observations (n=182), almost ignoring the possible dependencies of the missing values in the data. We used as variables the estimate of government effectiveness collected over 1996, 2003, 2007, and 2010, with the first two years as predictors and the two years remaining as missing variables. Missing values were generated under the main three missing data mechanisms (MCAR, MAR and MNAR) using R software with the function "ampute" including in MICE's package. For the purpose of demonstration, each missing value is imputed five times for each missing variable using EM, MICE and the proposed method, and the results are presented in Table 1.

Table 1 shows the sum of squares of residuals arising from the use of three different techniques under the condition that data are MCAR, MAR and MNAR respectively. Column 2 provides the amount of missing values in each variable (Y1 and Y2), while column 3 and 4 give the constructed bounds (low and upper) around the true sum of squares of residuals (SSE) in column 5. The three remaining columns show the SSE arising from the three imputation techniques: MICE, EM and PM.

Y1	N.mis	Low	Upper	True	MICE	EM	PM	Y2	Low	Upper	True	MICE	EM	PM
MCAR	5	8.67348	10.1258	9.3151	9.7395	9.7722	9.36		12.3243	14.388	13.30855	13.3737	13.5326	13.2585
	10	8.55988	10.5904	9.3151	10.364	10.282	9.4595		12.3014	15.2194	13.30855	14.0902	13.8183	14.1601
	18	8.40893	11.3886	9.3151	10.584	10.283	9.9149		11.7613	15.9287	13.30855	15.5506	15.1741	13.4568
	36	7.8078	13.2014	9.3151	11.899	12.205	9.1846		10.6571	18.019	13.30855	15.3601	16.5956	12.9549
	55	7.82264	11.2932	9.3151	11.603	12.475	8.9501		11.4209	16.6117	13.30855	18.3583	17.1985	13.7546
	73	6.68571	10.2436	9.3151	9.7966	10.87	8.0189		9.93184	15.1793	13.30855	14.3128	14.6456	12.0647
	91	7.25975	11.658	9.3151	14.931	12.716	8.4517		11.8683	18.4889	13.30855	18.6878	19.1183	14.5525
	109	5.27142	8.8164	9.3151	10.398	9.8927	7.9908		9.28329	15.1176	13.30855	14.4278	18.4212	13.7646
	127	6.64192	11.7138	9.3151	13.572	17.338	10.127		10.7228	18.4555	13.30855	21.9708	31.6509	16.8492
MAR	5	8.79664	10.2696	9.3151	9.5222	9.6094	9.2506		12.5535	14.6555	13.30855	13.709	13.5618	13.3505
	10	8.55414	10.5833	9.3151	9.8496	9.8428	9.3514		12.2666	15.1764	13.30855	14.2115	13.5344	14.0913
	18	7.56884	10.2508	9.3151	9.8847	9.9969	8.9988		11.1989	15.1671	13.30855	13.8068	13.6584	12.889
	36	7.67377	12.9748	9.3151	11.133	12.029	9.4578		11.3107	19.1241	13.30855	16.4912	16.9257	13.7574
	55	7.79288	11.2607	9.3151	11.859	11.51	9.1952		11.8632	17.1424	13.30855	16.9726	16.5702	13.4449
	73	9.0928	13.7472	9.3151	14.31	14.882	10.861		13.2819	20.033	13.30855	23.0195	21.8117	14.7588
	91	6.39041	10.262	9.3151	11.264	10.753	8.5284		10.1789	16.1347	13.30855	14.4793	15.6275	14.9975
	109	8.42757	14.0008	9.3151	16.635	17.881	11.35		12.2084	19.8811	13.30855	21.1317	20.7962	15.9713
	127	5.86269	10.3734	9.3151	17.714	16.889	8.7946		11.4998	19.7928	13.30855	26.9311	21.291	15.0145
MNAR	5	8.78431	10.2552	9.3151	9.738	9.9855	9.3294		12.3138	14.3757	13.30855	13.5481	13.6318	13.2058
	10	7.59826	9.40065	9.3151	8.813	8.9204	8.5477		11.3266	14.0134	13.30855	12.6284	12.9213	13.301
	18	7.7749	10.5299	9.3151	9.9857	9.9386	9.0218		11.8877	16.1001	13.30855	14.6709	15.403	13.4561
	36	7.82027	13.2225	9.3151	11.475	10.963	9.335		11.7398	19.8495	13.30855	17.7909	18.1661	14.0918
	55	6.91312	10.2094	9.3151	10.691	9.1451	8.5186		10.5839	15.5549	13.30855	17.1281	17.0028	12.9565
	73	6.66968	10.2062	9.3151	11.597	12.023	8.3331		9.93688	15.187	13.30855	15.0493	16.2449	12.9912
	91	8.56902	13.5828	9.3151	19.737	22.462	10.066		11.0973	17.5623	13.30855	22.5529	22.9957	14.0125
	109	8.42642	13.9988	9.3151	21.869	18.652	11.497		11.5177	19.1345	13.30855	28.9392	25.3928	14.5682
	127	6.52093	11.2585	9.3151	17.048	15.751	10.4		11.0017	18.8785	13.30855	21.473	22.0808	13.8547

Table 1: Comparison of three imputation techniques under MCAR based on SSE for the two variables Y1 and Y2.

4. Discussion and Conclusion

In this work, we proposed an iterative method based on regression for imputation of missing values. Data sets from real life is tested to evaluate the performance of the proposed method compared to other imputation methods such as EM and MICE algorithms. Some elements are removed from these data matrices following the three main missing data mechanisms (MCAR, MAR and MNAR) and the amount of removed data vary from 5 to 127. The removed data are replaced five times for each variable and the mean of the SSEs obtained from individual analysis of the multiply-imputed data is used for the comparison.

Through the results, we find that PM can perform either like or better than the EM and MICE does in estimating missing values. With respect to the sum of squares of errors (SSE), it is confirmed that the three methods work reasonably well in many situations with slight deviation from the true SSE. But this deviation becomes substantially large as the degree of missingness increases and under MNAR mechanism. But even in such a situation, PM seems to be better than the EM and MICE. Indeed, we can observe that the low and upper bounds of SSE estimated are close to the true SSE under the three missing data mechanisms and PM always provide SSE within these bounds. However, MICE and EM tend to provide SSE that are considerably different than the true SSE when the amount of missing data increases and under MNAR.

In conclusion, we would like to emphasize that the proposed method is effective only if certain conditions are fulfilled. These conditions are: (i) the chosen regression model should adequately describe the data under study; (ii) the increment of the sequence used to construct the low and upper bounds should be very small (0.01). Otherwise, it will be very likely to get bounds that do not include the true SSE.

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Exploring potential Leading Economic Indicator System of the Philippines

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Abstract
With the continuous enhancement of the Leading Economic Indicator System (LEIS) of the Philippines, looking of different combinations of potential leading economic indicators were explored. The focus of this paper is to provide a new set of indicators that performs better than the six (6) proposed leading economic indicators of the Philippines, namely, Peso/US Dollar Exchange Rate, Stock Price Index, Business Expectation, Gross International Reserves, National Government Revenues, and Universal and Commercial Bank Loan Outstanding. In this study, various criteria were created to shortlist the indicators and some considerations were taken into account in order to have a better outlook of the behavior of the countrys economy. Furthermore, assessments based on the movement and growth rate of the GDP were conducted to see the performance of the groups of indicators. The new proposed leading economic indicators includes the six aforementioned indicators together with the indicators Tourist/Visitor Arrivals and Volume of Palay. These eight (8) indicators are believed to follow the behavior of the countrys economy better than the originally proposed six leading economic indicators.

Keywords
Seasonal adjustment, detrending, Hodrick-Prescott, predictive ability

1. Introduction

In 2014, the Philippines Statistics Authority (PSA) discontinued its system of Leading Economic Indicators (LEI) for its decline to correctly predict the movement of the country's economy. The LEI is used to forecast the short-term direction of the country's economic performance. However, changes in the structure of the economy over the years may have led to the said decline of prediction. Consequently, in 2016, with the initiation of the PSA, the LEI System was recently studied wherein a new methodology to generate the composite LEI was proposed[1]. It was suggested that TRAMO-SEATS of DEMETRA+ and Hodrick-Prescott of EViews are to be used in deseasonalization and detrending; the GDP would be the new reference series; and six economic indicators would comprise the composite index[2,3]. This study focuses mainly on creating new groups of potential economic indicators using the same list of 33 indicators.

To select the best indicators in forming various combinations of indicators, different sets of criteria were made. One way is by assessing the ability of the LEIs to forecast quarter-to-quarter movement of the GDP, through checking its direction upward or downward. Another way is by assessing the closeness of the estimated GDP growth rate to the actual GDP growth rate computed with the use of the LEI index. The main objective of this study is to come up with a group of potential leading economic indicators that could perform better than the previously selected six economic indicators[4]. Specifically, this study aimed to: (a) form different groups of potential economic indicators based on different sets of criteria; (2) assess the predictive ability of each group of potential economic indicators in terms of the movement and closeness to the growth rate of the country's GDP; and (c) utilize the LEI index in computing the GDP Growth rate.

2. Methodology

2.1 Indicator Series

The 33 potential economic indicators include: (1) Consumer Price Index (2000 = 100) (CPI), (2) Electric Energy Consumption (EEC), (3) Peso/US Dollar Exchange Rate (ERATE), (4) Hotel Occupancy Rate (HOR), (5) Money Supply (M1) (MSM1), (6) Number of New Business Incorporations (NNBI), (7) Stock Price Index (SPI), (8) Terms of Trade Index for Merchandise Goods (TTRADE), (9) Total Merchandise Imports (TMI), (10) Tourist/Visitor Arrivals (TVA), (11)Wholesale Price Index (WPI), (12) Business Confidence Index (Current Quarter) (BESCQ), (13) Business Outlook Index (Next Quarter) (BESNQ), (14) Export of Goods (EG), (15) Government Final Consumption Expenditure (2000 =100) (GFCE1), (16) Government Final Consumption Expenditure (Current) (GFCEC), (17) Gross International Reserves (GIR), (18) Lending Rate (LR), (19) London Inter-Bank Offered Rate (LIBOR), (20) Meralco Sales (GwH) (MS) (21) Money Supply (M2) (MSM2), (22) National Government Expenditures (NGE), (23) National Government Revenues (NGR), (24) OFW Remittances (OFWR), (25) Savings Deposit Rate (SDR), (26) Singapore Inter-Bank Offered Rate (SIBOR), (27) Time Deposit Rates (Long-Term Rates) (TDLR), (28) Time Deposit Rates (Short-Term Rates) (TDSR), (29) Treasury Bill Rates (364-Day Tbill Rates) (TBR3), (30) Treasury Bill Rates (91-Day Tbill Rates) (TBR9), (31) Universal and Commercial Bank Loan Outstanding (UCBLO), (32) Volume of Palay (VP), (33) Volume of Production Index (VOPI).

There were three main criteria considered throughout the study which are the Correlation, Granger Causality, and Timeliness. For the Correlation, there were two choices of coefficient cut-offs, | 0.20 | and | 0.25 |. For the Granger Causality, there were also two choices of levels, 0.10 and 0.15. Lastly, the

Timeliness criterion filters the indicators as to whether the timely release of the data is to be considered or not.

2.2 Assessment of Predictive Ability

With the country's GDP as the reference series, the behavior of the LEIs was compared with the behavior of the country's GDP. The first assessment conducted was by comparing the directions of both the LEI and the country's GDP. The second assessment, on the other hand, was by checking the closeness of the estimated GDP growth rate using the LEI index with the true GDP growth rate using the actual GDP. This is important as it shows how the much the difference is between the change year-on-year of the estimated GDP and the country's current GDP.

The simple average and simple standard deviation of the *GDP Cycle* were computed $\bar{X}_{GDP\ Cycle} = \frac{\sum_{i=1}^{t} GDP\ Cycle_i}{t}$, $S_{GDP\ Cycle} = \sqrt{\frac{\sum_{i=1}^{t}(GDP\ Cycle_i - \hat{X}_{GDP\ Cycle})^2}{t-1}}$,

where t was the total number of quarters from the starting point until the current quarter, and $GDP\ Cycle_i$ was the GDP Cycle value for quarter i. The Standardized *LEI* is computed by standardizing the potential LEIs, based on which group of indicators is being ran. The formula is, $z_{cycle} = \frac{cycle - \bar{x}_{cycle}}{s_{cycle}}$,

where: z_{cycle} is the standardized cycle, $\bar{X}_{cycle}$ is the mean of the cycle and s_{cycle} is the standard deviation of the cycle. The *Unstandardized LEI* is, $LEI_{Unstandardized} = (z_{cycle} \times S_{GDP\ Cycle}) + \bar{X}_{GDP\ Cycle}$.

The *estimated GDP Trend-Cycle* is $GDP\ TC_{Estimated} = LEI_{Unstandardized} + GDP\ Trend_{Forecast}$. The *Estimated GDP Level* is the assumed GDP value calculated through the LEIs, $Estimated\ GDP\ Level = Seasonal_{Forecast} \times Irregular_{Forecast} \times GDP\ TC_{Estimated}$. The *Estimated GDP Growth Rate*, $Estimated\ GDP\ Growth\ Rate_t = \frac{Estimated\ GDP\ Level - True\ GDP_{t-4}}{True\ GDP_{t-4}}$ where t = quarter being forecasted. The True GDP Growth Rate, $True\ GDP\ Growth\ Rate_t = \frac{True\ GDP\ Level - True\ GDP_{t-4}}{True\ GDP_{t-4}}$. The Estimated GDP Growth Rate and the True GDP Growth Rate are then compared. The difference between the two is computed. This was done for each group of indicator. A small difference indicates that the group is a good estimator as it only varies slightly from the actual GDP growth rate.

3. Results

3.1 Assessment of the GDP Movement

Here the behavior of the LEIs were assessed as to whether their movement from quarter to quarter goes up or down. Their behavior was put side by side with the movement of the actual GDP for each quarter. For each quarter, if the LEI's movement is the same as the GDP's movement, then it would be considered as a correct prediction1. In addition, the dataset was divided into two, the training dataset and the testing dataset. The procedure of dividing of the quarters was 70% the quarters were the training dataset while 30% of the quarters were the testing dataset. For comparability between the two studies, the training dataset covers also the same quarters for this paper while the testing dataset was only added with the latest quarters. The training dataset starts from the first quarter of 2002 until the fourth quarter of 2011. On the other hand, the testing dataset starts from the first quarter of 2012 until the fourth quarter of 2017.

Correlation. From Table 1 below, it was observed that in the training dataset, groups A1 and B1 have high percentages of correct predictions, while in the testing dataset, groups B2 and A3/B3 have the highest percentage of correct predictions, followed by the groups A1 and A2. Among these groups, group A1 seemed to have the best performance in terms of correct predictions for both the training and testing datasets.

Correlation and Timeliness. From Table 2, it shows that group C2 is consistent to have high percentages of correct predictions for both the training and the testing datasets. Following this, on one hand, group C1 has the highest percentage in the training dataset and on the other hand, group C3 has the same percentage with the group C2. Note that these are the groups wherein indicators with untimely release of data are considered.

Table 1. Summary of Correct Predictions using the In-Sample and Out-Sample of the groups formed from Correlation criterion only

Group Name	Number of Indicators	Correct Prediction (%)	
		Training Dataset 2002 Q1-2011 Q4 (38 Quarters)	Testing Dataset 2012 Q1-2017 Q4 (24 Quarters)
A1	18	74%	88%
A2	14	66%	88%
A3=B3	9	58%	92%
A4	5	68%	75%
B1	17	76%	83%
B2	13	68%	92%
B3=A3	9	58%	92%
B4	4	63%	67%

Table 2. Summary of Correct Predictions using the In-Sample and Out-Sample of the groups formed from Correlation and Timeliness criteria

Group Name	Number of Indicators	Correct Prediction (%)	
		Training Dataset 2002 Q1-2011 Q4 (38 Quarters)	Testing Dataset 2012 Q1-2017 Q4 (24 Quarters)
C1	12	74%	79%
C2	9	71%	83%
C3	6	61%	83%
C4	3	68%	75%

Correlation and Granger Causality Test. It can be observed from Table 3 below that only group E4 has high percentages of correct predictions for both training and testing datasets. Also, it is noticeable that in the testing dataset, groups with HOR got high number of correct predictions. However, group E1, which does not contain the indicator HOR, still leads the rank of percentages in the testing dataset.

Other Possible Drivers of Economic Growth. From Table 4, groups F3 and F5 both have high percentages of correct prediction for both the training and testing datasets. Meanwhile, group F6 has a high percentage of correct predictions for the testing dataset, but note that it includes HOR as one of its indicators.

Table 3. Summary of Correct Predictions using the In-Sample and Out-Sample of the groups formed from Correlation and Granger Causality criteria

Group Name	Number of Indicators	Correct Prediction (%) Training Dataset 2002 Q1-2011 Q4 (38 Quarters)	Testing Dataset 2012 Q1-2017 Q4 (24 Quarters)
D1	11	61%	83%
D2	14	63%	87%
D3	12	74%	83%
D4	15	63%	87%
E1	10	68%	91%
E2	13	63%	87%
E3	11	68%	87%
E4	14	71%	87%

Table 4. Summary of Correct Predictions using the In-Sample and Out-Sample of the groups formed from other possible drivers of economic growth

Group Name	Number of Indicators	Correct Prediction (%) Training Dataset 2002 Q1-2011 Q4 (38 Quarters)	Testing Dataset 2012 Q1-2017 Q4 (24 Quarters)
F1	8	53%	75%
F2	8	58%	75%
F3	8	63%	79%
F4	9	55%	75%
F5	9	66%	79%
F6	10	55%	79%

Consolidating all of the best groups under each criteria, the performances based on the number of correct predictions of each group are presented on Table 5. For comparability with the proposed six indicators of the previous[1], denoted as P, its performance was also included below. It can be observed that group A1 leads the training dataset with 74% correct predictions followed by groups C2 and E4. Meanwhile, group E1 leads the testing dataset with 91% correct predictions, followed by group A1 and then by group E4.

Table 5. Summary of Correct Predictions using the In-Sample and Out-Sample of the leading groups in terms of GDP movement

Group Name	Number of Indicators	Correct Prediction (%) Training Dataset 2002 Q1-2011 Q4 (38 Quarters)	Testing Dataset 2012 Q1-2017 Q4 (24 Quarters)
P	6	53%	79%
A1	18	74%	88%
C2	9	71%	83%
E1	10	68%	91%
E4	14	71%	87%
F3	8	63%	79%
F5	9	66%	79%

Table 6. Actual and Predicted GDP Growth Rate of groups formed from the Correlation Criterion, 1st Quarter to 4th Quarter of 2017

Group Name	1st Quarter Est.	1st Quarter Act.	2nd Quarter Est.	2nd Quarter Act.	3rd Quarter Est.	3rd Quarter Act.	4th Quarter Est.	4th Quarter Act.	Annual Est.	Annual Act.
A1	6.67	6.40	6.33	6.70	6.46	7.02	6.89	6.56	6.59	6.67
A2	6.63		6.37		6.47		6.97		6.61	
A3=B3	6.72		6.47		6.49		7.10		6.70	
A4	6.91		6.64		6.69		7.28		6.88	
B1	6.65		6.36		6.44		6.96		6.60	
B2	6.74		6.39		6.38		6.88		6.60	
B3=A3	6.72		6.47		6.49		7.10		6.70	
B4	6.55		6.20		6.27		6.49		6.38	

3.2 Assessment of the GDP Growth

The second assessment done was in terms of the rate of GDP Growth. The GDP Growth rate was the basis of how good the performance of the LEIs. A small difference between the actual GDP and the estimated GDP computed through the LEIs indicates that how good the LEIs were as an estimator of the GDP. For this assessment, there were only four quarters chosen. These were from the first until the fourth quarter of 2017. The estimated annual growth rate was estimated and this was computed by simple averaging.

Correlation. From the Table 6, group A3/B3 has the most number of closest predictions of the GDP Growth Rate. Note that its estimate was also closest to the annual GDP Growth Rate. It was then followed by groups A2, A4, and B4, wherein each of these three have two estimates that are close to the true GDP Growth Rate. However, take note that A3/B3 and A2 have HOR as an indicator.

Correlation and Timeliness. Table 7 indicates that all of the groups of indicators have estimates that are close to the actual GDP Growth Rate. Group C1 has the most number of closest estimates, followed by group C3, then group C2 and lastly, by group C4. Note that Group C1 also estimated closely to the annual GDP Growth Rate.

Correlation and Granger Causality Test. As seen in Table 8, group D1 has the most number of closest estimates with the GDP Growth Rate. This was then followed by groups D2, D4, E1, E3, and E4. However, notice that groups D1 until D4, these groups were less likely to be considered due to the presence of the indicator HOR. In addition, groups E1 and E2 are most likely to be considered as the best groups under this criteria.

Table 7. Actual and Predicted GDP Growth Rate of groups formed from the Correlation and Timeliness criteria, 1st Quarter to 4th Quarter of 2017

Group Name	1st Quarter		2nd Quarter		3rd Quarter		4th Quarter		Annual	
	Est.	Act.	Est.	Act.	Est.	Act.	Est.	Act.	Est.	Act.
C1	6.68		6.39		6.47		6.98		6.63	
C2	6.69	6.40	6.37	6.70	6.36	7.02	6.91	6.56	6.58	6.67
C3	6.78		6.36		6.47		6.97		6.65	
C4	6.62		6.27		6.30		5.94		6.28	

Table 8. Actual and Predicted GDP Growth Rate of groups formed from the Correlation and Granger Causality Criteria,1st Quarter to 4th Quarter of 2017

Group Name	1st Quarter		2nd Quarter		3rd Quarter		4th Quarter		Annual	
	Est.	Act.	Est.	Act.	Est.	Act.	Est.	Act.	Est.	Act.
D1	6.70		6.48		6.45		6.92		6.64	
D2	6.69		6.40		6.43		6.94		6.62	
D3	6.72		6.33		6.45		6.91		6.60	
D4	6.75	6.40	6.40	6.70	6.43	7.02	6.91	6.56	6.62	6.67
E1	6.77		6.38		6.50		7.02		6.67	
E2	6.72		6.39		6.48		7.01		6.65	
E3	6.78		6.37		6.50		7.03		6.67	
E4	6.77		6.38		6.48		7.00		6.66	

Table 9. Actual and Predicted GDP Growth Rate of groups formed from the other possible drivers of economic growth, from 1st Quarter to 4th Quarter of 2017

Group Name	1st Quarter		2nd Quarter		3rd Quarter		4th Quarter		Annual	
	Est.	Act.	Est.	Act.	Est.	Act.	Est.	Act.	Est.	Act.
F1	6.51		6.45		6.54		7.18		6.67	
F2	6.45		6.49		6.68		7.27		6.72	
F3	6.60	6.40	6.68	6.70	6.88	7.02	7.06	6.56	6.80	6.67
F4	6.43		6.48		6.68		7.26		6.71	
F5	6.66		6.71		6.89		7.15		6.85	
F6	6.49		6.46		6.66		7.23		6.71	

Table 10. Actual and Predicted GDP Growth Rate of groups leading in terms of the GDP Growth Rate, 1st Quarter to 4th Quarter of 2017

Group Name	1st Quarter		2nd Quarter		3rd Quarter		4th Quarter		Annual	
	Est.	Act.	Est.	Act.	Est.	Act.	Est.	Act.	Est.	Act.
A3=B3	6.72		6.47		6.49		7.10		6.70	
C1	6.68		6.39		6.47		6.98		6.63	
C2	6.69		6.37		6.36		6.91		6.58	
C3	6.78		6.36		6.47		6.97		6.65	
D1	6.70		6.48		6.45		6.92		6.64	
D4	6.75	6.40	6.40	6.70	6.43	7.02	6.91	6.56	6.62	6.67
E4	6.77		6.38		6.48		7.00		6.66	
F3	6.60		6.68		6.88		7.06		6.80	
F5	6.66		6.71		6.89		7.15		6.85	
F6	6.49		6.46		6.66		7.23		6.71	
P	6.67		6.71		6.89		7.16		6.86	

Other Possible Drivers of Economic Growth. For the last groups of indicators, groups F3, F5, and F6 have the most number of estimates closest to the actual GDP Growth Rate. However, note that Group F6 includes HOR as its indicator. Meanwhile, between groups F3 and F5, the only difference is the indicator OFWR. Considering parsimony and the fact that the indicator OFWR is released with a two-month lag, group F3 is considered better than group F5.

Table 10 shows the consolidated estimated growth rates of the GDP from the different criteria of choosing indicators. The performance of group P was also included. Among the different groups of indicators, it can be observed that F3 and F5 gave the closest estimates of the actual GDP Growth Rate. Notice also that the proposed six gave two close estimates of the actual GDP Growth Rate.

4. Discussion and Conclusion

Based on the results presented in the previous section, groups A1 and E4 performed well in the assessment in terms of the GDP movement, while groups F3 and F5 performed well in the assessment in terms of the GDP Growth Rate. However, upon further research, it was decided that groups F3 and F5 are to be considered better than the groups E1 and E4. Even though groups F3 and F5 were not the highest in terms of the GDP movement, these were still included in the top groups with high number of correct predictions. This specific decision was done due to the fact that groups F3 and F5 have the presence of agriculture, tourism and overseas indicators which suggests that these could cover well the country's economy. To further narrow down, it was observed that groups F3 and F5 have almost the same performance in the two assessments. The only difference between F3 and F5 is the presence of the indicator OFWR. Thus, group F3 was deemed to be better than group F5 because of parsimony and the fact that OFWR has a two-month lag in the release of the data.

Finally, comparing the performance of the group F3 with the group P, the former performs better than the latter in terms of the two assessments - the GDP movement and the GDP Growth Rate. Hence, indicators ERATE, SPI, BESNQ, GIR, NGE, UCBLO, VP, and TVA are proposed as the new leading economic indicators. However, further explorations of the new combinations of indicators are made. It is still a possibility that there are other indicators unexplored which might have a better contribution to the LEI. Other criteria in choosing the potential economic indicators can also be set and applied in order to have a better grasp of the country's economy.

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Dealing with seasonal commodities on Prices Received Index for farmers in Indonesia: Simulation scenarios of horticultural commodities in Central Java Province

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Abstract
The aim of this study is to improve the calculation of prices received index by taking into account seasonal behaviour of agricultural commodities. Prices received index is one of the most important statistical indicators constructed by Statistics Indonesia (BPS) to measure price development of agricultural commodities received by farmers in Indonesia. However, the seasonal behaviour of the commodities is still not taken into account in the current prices received index that utilizing modified Laspeyres Index formula. The use of the formula needs to be reconsidered so that a better assessment of price development of agricultural commodities can be achieved. To this end, modified Bean and Stine Type C Index (modified Rothwell Index) has been simulated in various scenarios in dealing with seasonal commodities especially for horticultural commodities in Central Java Province. The results of the simulation scenarios show that the modified Rothwell Index can reduce fluctuations of prices received index by considering seasonal variations both for prices and the production quantity of commodities marketed. In this sense, the implementation of the modified Rothwell Index results in getting more accurate price development measurement of agricultural commodities.

Keywords
Seasonal Commodities; Laspeyres Index; Rothwell Index; Prices Received Index

1. Introduction

Prices received index is an index that measures changes in the prices received for agricultural commodities. Currently, BPS publishes the index on a 2012=100 base year. A ratio of the prices received index to the prices paid index on the 2012 base year that is greater than 100 indicates that farm commodity prices have increased at a faster rate than prices paid by farmers. When the ratio is less than 100, prices paid by farmers are increasing a more rapid pace than farm commodity prices. The prices received index and the prices paid index are used to calculate the Farmer's Terms of Trade. BPS calculated the prices received index using the modified Laspeyres Index. The formula assumes that production volume is constant during a certain period (fixed quantity). In fact, there are several weaknesses in using the modified

Laspeyres Index formula in calculating price indices especially when associated with the agricultural production price index. The use of modified Laspeyres Index on the prices received index which assume constant production volume is considered inaccurate because agricultural commodities can experience productivity growth, technological progress, and increase development improvement. Moreover, the modified Laspeyres Index formula cannot accurately represent the quantity of production sold by farmers which actually varies from month to month due to using the fixed annual quantities sold in the formula. Another problem also arises when commodities are available in a particular month but they are not available in the following months. In this case, calculating price change from month to month or relative price is difficult while the relative price of these commodities is one of the important components in calculating the price index using the modified Laspeyres Index formula.

For the Indonesian case, there are many agricultural commodities that have seasonal pattern. These agricultural commodities can experience a very high surge in production volume during the harvest period and experience a sharp decline in production volume during famine. But, the seasonal patterns of agricultural commodities cannot be captured at all in calculating prices received index using the modified Laspeyres Index formula. Therefore, the use of the modified Laspeyres Index formula on the components of the prices received index needs to be reconsidered so that a better assessment of agricultural performance can be achieved. It should be noted that in calculating the price index, statisticians will deal with seasonal commodities for agricultural production commodities. Producer Price Index Manual (2004) has recommended the use of the Bean and Stine Type C Index (Rothwell Index) to overcome seasonal commodities problems in calculating the price index. The Rothwell Index can be better to capture the economic phenomenon in the agricultural sector in comparison with the modified Laspeyres Index in dealing with seasonal commodities. However, to date, the seasonal behaviour has not been taken into account especially for prices received index. BPS has never implemented the Rothwell Index on agricultural commodities that have seasonal patterns. The aim of this study is to improve the calculation of prices received index by taking into account seasonal behaviour of agricultural commodities. To this end, the modified Rothwell Index has been simulated in various scenarios in dealing with seasonal commodities especially for horticultural commodities in Central Java Province. It is hoped that the implementation of the modified Rothwell Index results in getting more accurate price development measurement of agricultural commodities

2. Methodology

Based on the Producer Price Index Manual (2004), seasonal commodities can be categorized into 2 (two) types namely strongly seasonal commodities and weakly seasonal commodities. Strongly seasonal commodities have the concept that agricultural commodities are only available in certain seasons for a year. Meanwhile, weakly commodities are available throughout the year but prices and their quantities experience regular movements. Bean & Stine (1924) states that in analyzing agricultural prices, it is very important to consider seasonal variations both for prices and the quantity of commodities marketed. For the case of Indonesia, the modified Laspeyres Index formula is utilized in calculating the current prices received index. The formula is as follows:

$$I_L^{t,m}(p^0, p^{t,m}, p^{t,(m-1)}, q^0) = \frac{\sum_{i=1}^{n} \frac{p_i^{t,m}}{p_i^{t,(m-1)}} p_i^{t,(m-1)} q_i^0}{\sum_{i=1}^{n} p_i^0 q_i^0} \quad \text{.........(1.1)}$$

where:

$p_i^{t,m}$: price of commodity ***i*** at month ***m*** year ***t***

$p_i^{t,(m-1)}$: price of commodity ***i*** at month ***m-1*** year ***t***

$p_i^{t,(m-1)} q_i^0$: production value estimate of commodity at month ***(m-1)*** year ***t***

$p_i^0 q_i^0$: production value of commodity ***i*** at month ***m*** of base year

Nevertheless, as shown in equation (1.1), the modified Laspeyres Index formula cannot accurately represent the production quantity sold by farmers which actually varies both in numbers and types from month to month due to the use of fixed annual quantities sold in the formula. This formula has an advantage to describe changes in prices of each period with a quantity of commodity that remains at a certain point reference. But, at the same time, the modified Laspeyres Index does not take into account changes in the quantity of production each period so that the seasonal patterns that greatly affect the size of agricultural commodity production are not caught in the movement.

Meanwhile, the original Rothwell Index formula is constructed using seasonal baskets at the base year. At the base year, the quantity of production change every month while the price is obtained from the monthly average in particular year. Meanwhile, the original Rothwell Index formula is constructed using seasonal baskets at the base year. At the base year, the quantity of production change every month while the price is obtained from the monthly average in particular year.

$$I_R^{t,m}(p^0, p^{t,m}, q^{0,m}) = \frac{\sum_{i=1}^{n} p_i^{t,m} q_i^{0,m}}{\sum_{i=1}^{n} p_i^0 q_i^{0,m}} \quad \text{.........(1.2)}$$

The equation (1.2) is the original Rothwell Index formula which has monthly quantity of production at base year. The application of this formula is basically easy to implement because only the price and quantity of commodity production components are needed. The Rothwell Index formula is considered to be able to capture the seasonal patterns of a commodity. For this reason, the quantity of commodity production is considered to always change following the seasonal patterns that have occurred in previous times. In practice, however, the data collection of price and quantity of production are conducted separately. Moreover, there is a time lag to obtain current quantity of production. In other words, price data collection is faster than quantity of production data. For the sake of calculation prices received index using Rothwell Index, the production quantity is not used but production value which is resulted from weighting diagram survey in the base year. By doing so, the production value of each commodity is obtained every month in the base year. The production value is calculated by multiplying the price data on the production quantity. In order to apply production value data into Rothwell Index formula, it is necessary to modify the original Rothwell Index. By taking into account the data availability, we modify the equation (1.2) into equation (1.3). The modified Rothwell Index is as follows:

$$I_R^{t,m}(p^0, p^{t,m}, p^{0,m}, p^{t,(m-1)}, q^{0,m}) = \frac{\sum_{i=1}^{n} \frac{p_i^{t,m}}{p_i^{t,(m-1)}} \frac{p_i^{t,(m-1)}}{p_i^{0,m}} p_i^{0,m} q_i^{0,m}}{\sum_{i=1}^{n} \frac{p_i^0}{p_i^{0,m}} p_i^{0,m} q_i^{0,m}} \quad \text{.....................................(1.3)}$$

where:

$p_i^{0,m}$: price of commodity ***i*** at month of base year

p_i^0 : average of monthly price of commodity ***i*** at base year

$q_i^{0,m}$: production quantity of commodity ***i*** at month ***m*** of base year

$p_i^{0,m} q_i^{0,m}$: production value of commodity ***i*** at month ***m*** of base year

For simplification reason, we change equation (1.3) into equation (1.4) as follows:

$$I_R^{t,m} = \frac{\sum_{i=1}^{n} rp_i^{t,m} \bullet cfp_i^{t,(m-1)} \bullet v_i^{0,m}}{\sum_{i=1}^{n} cfap_i^{0,m} \bullet v_i^{0,m}} \quad \text{...(1.4)}$$

where:

$rp_i^{t,m}$: relative price of commodity ***i*** at month ***m*** year ***t***

$cfp_i^{t,(m-1)}$: correction factor of price commodity ***i*** at month ***m-1*** year ***t***

$cfap_i^{0,m}$: correction factor of average price of commodity ***i*** at month ***m*** of base year

$v_i^{0,m}$: production value of commodity ***i*** at month ***m*** of base year

The equation (1.4) consists of monthly price relative of commodity ***i*** at month ***m*** year ***t*** $\frac{p_i^{t,m}}{p_i^{t,(m-1)}}$, price correction factor of commodity *i* at month ***m-1*** year ***t*** $\frac{p_i^{t,(m-1)}}{p_i^{0,m}}$, correction factor of average price of commodity ***i*** at month ***m*** of base year $\frac{p_i^0}{p_i^{0,m}}$, and production value of commodity ***i*** at month ***m*** of base year $p_i^{0,m}q_i^{0,m}$. From the equation (1.4), it can be seen that the price correction factor of $\frac{p_i^{t,(m-1)}}{p_i^{0,m}}$, is a counterweight of price relative of commodity at current period and production value at base year.

In terms of data availability utilized in this paper, all the data are obtained from BPS. The data consists of monthly series quantity of production and price of 10 horticultural commodities i.e.: red chili, small chili, shallot, potato, watermelon, cabbage, jackfruit, spring onion, melon, and durian of Central Java Province from January 2012 to December 2013. The 10 horticultural commodities are considered to have clear seasonal patterns. Meanwhile, Central Java Province is a good example to represent area which produce large seasonal commodities in Indonesia.

3. Results

On the simulation scenarios, prices received index are calculated by using 3 (three) methods namely the modified Laspeyres Index, original Rothwell Index, and modified Rothwell Index. Data utilized in calculating prices received index are monthly series quantity production and price of 10 horticultural commodities.

Table 1: Prices received index using modified Laspeyres Index formula (2012=100)

2013	Jan	Feb	Mar	Apr	May	Jun
Index	107,18	84,85	133,22	117,07	104,87	104,68
Change (%)		*-20,84*	*57,01*	*-12,12*	*-10,42*	*-0,18*

2013	Jul	Aug	Sep	Oct	Nov	Dec
Index	136,61	136,33	107,19	119,16	109,22	105,72
Change (%)	30,50	-0,21	-21,37	11,17	-8,34	-3,21

Table 2: Prices received index using original Rothwell Index formula (2012=100)

2013	Jan	Feb	Mar	Apr	May	Jun
Index	111,83	120,33	160,05	159,20	160,13	162,27
Change (%)		*7,60*	*33,01*	*-0,53*	*0,58*	*1,34*

2013	Jul	Aug	Sep	Oct	Nov	Dec
Index	208,64	222,50	168,71	167,77	156,84	176,79
Change (%)	*28,58*	*6,64*	*-24,17*	*-0,56*	*-6,52*	*12,72*

Table 3. Prices received index using modified Rothwell Index formula (2012=100)

2013	Jan	Feb	Mar	Apr	May	Jun
Index	111,51	117,02	145,53	155,42	152,30	154,71
Change (%)		*4,95*	*24,36*	*6,80*	*-2,01*	*1,59*

2013	Jul	Aug	Sep	Oct	Nov	Dec
Index	193,39	209,95	160,16	150,67	142,78	154,38
Change (%)	*25,00*	*8,56*	*-23,71*	*-5,93*	*-5,24*	*8,12*

In the aggregate, the simulation results of prices received index in 2013 in Central Java Province for the 10 horticultural commodities using modified Laspeyres Index formula (Table 1), original Rothwell Index (Table 2), and modified Rothwell Index (Table 3) show different results. It is known that the value of the prices received index calculated using the modified Laspeyres Index method has a lower tendency than the Rothwell Index method in both the original and modified Rothwell Index formulas.

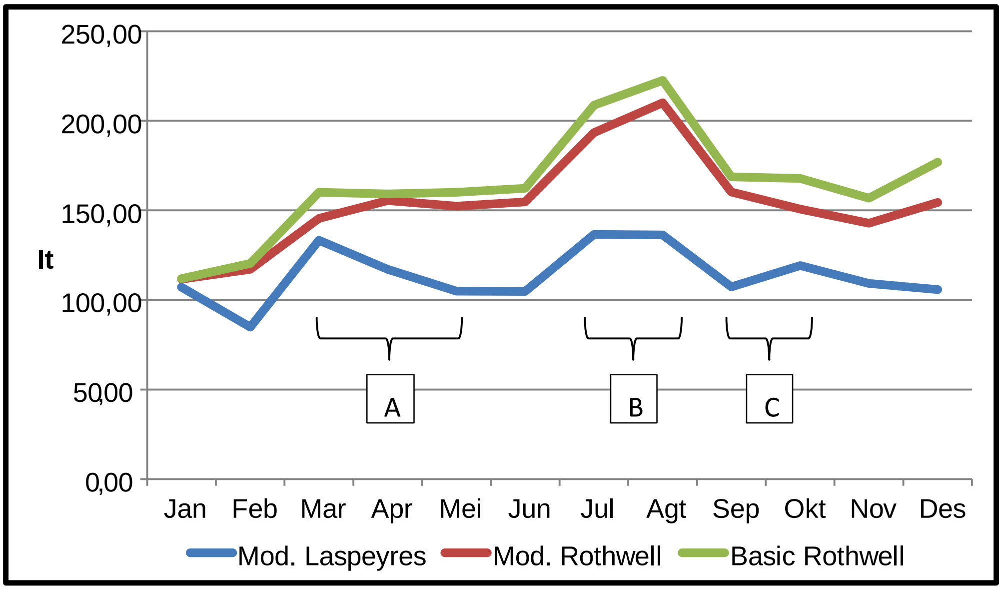

Figure 1. Prices Received Index using Modified Laspeyres Index, Modified Rothwell Index and Original Rothwell Index

Based on the Figure 1, it can be seen that since April 2013 there is a wide gap between prices received index using the modified Laspeyres Index formula in comparison with that using the Rothwell Index formula. The gap is largely affected by the behaviour of production quantity movements. In other words, monthly changes in the quantity of production in the base year also contribute to the results of prices received index as a form of seasonal patterns that occur.

In phase A (March-May), it can be seen that there is a significant difference in the direction of change of prices receive index between modified Laspeyres Index and Rothwell Index formula. In this time period, there is a decline in prices on commodities with large weight (red onion). This fall in prices is due to an increase in the quantity of production in that period. However, this increase in quantity is not captured in the modified Laspeyres formula so that the prices received index formed tends to decrease sharply. On the other hand, the magnitude of the decline in prices is able to compensate for the large increase in the quantity of production so that based on certain prices received indices using the Rothwell Index formula have a more stable tendency.

Furthermore, different things happened in phase B (July-August). The calculation of prices received index using modified Laspeyres Index has a stable tendency in August 2013 due to non-fluctuating price changes. However, in the particular months, there are harvests of shallots and seasonal fruits, especially watermelon and melon which cause the quantity of production of these commodities to increase. The movements of quantity of production are not captured on the modified Laspeyres Index formula. Moreover, the prices received index using Rothwell Index formula in August 2013 tends to be higher than that in July 2013. This happens due to the increased quantity of production in commodities that are entering the harvest period.

In phase C (September-October), there are increases in commodity prices that have considerable weight (red chili, small chili, spring onion, and *durian*). The prices received indices using the Laspeyres Index formula are able to explain the economic phenomenon well. However, the cause of the increases of price are due to the declining in production quantity of certain commodities such as onion, red onion, red chili, spring onion, and melon. The decrease in quantity is able to compensate for the increase in prices that occur so that the results of the calculation of the index using the Rothwell Index formula appears that the trend of the resulting prices received index is lower than the previous month.

4. Discussion and Conclusion

The simulation scenarios of the modified Rothwell Index on prices received index give more rational results in terms of seasonal patterns that occur. The seasonal patterns both in price and quantity have been considered in the modified Rothwell Index formula. The modified Rothwell Index allows the use of historical quantity of production data to get seasonal patterns. This is an important point since there is a time lag between the availability of production quantity data and the agricultural commodity prices.

Based on the simulation scenarios, it can be said that prices received index for 10 selected horticultural commodities in Central Java Province of 2013 shows different results in the use of the modified Laspeyres Index, original Rothwell Index, and modified Rothwell Index. In particular, the Rothwell Index both the original formula and the modified one can reduce price fluctuations by considering seasonal variations both for prices and the quantity of commodities marketed.

Therefore, the modified Rothwell Index should replace the modified Laspeyres Index on prices received index so that a better assessment of price development of agricultural commodities can be achieved. The calculation of the prices received index should not be inseparable from the change in the production quantity of the commodity. The modified Rothwell Index is an alternative that is able to capture seasonal behaviour in both price and production quantity especially for agricultural commodities. The implementation of modified Rothwell Index results in getting more accurate price development measurement of agricultural commodities.

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Simultaneous Confidence Bands for Copula Density Based on Linear Wavelet Estimator

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Abstract
In this paper, we first establish the exact rate of uniform convergence, in supremum norm, for the linear wavelet estimator of the bivariate copula density. We then derive asymptotic optimal confidence bands for this curve. These bands may be used as a graphical tool to determine the most suitable parametric copula family for a given data set. Their performance bands is shown through a simulation study. Finally, an application to coral reef data reveals that the dependence structure between human population density within 50 kilometers and macroalgae coral density might be fitted by the FGM (Farlie-Gumbel-Morgentsen) copula.

Keywords
Copula density; Nonparametric estimation; Wavelet approximation, Rate of convergence; Confidence bands

1. Introduction

Copula is currently one the most important tools for modelling dependence between two or several random variables. It is applied in many areas such as: Finance, Actuarial science, Econometrics, Climatology, etc. For more details on the subject, the reader is referred to books by Joe (1997) and Nelsen (2006). Examples of applications in insurance and risk management can also be found in the books by Cherubini et al. (2004) and McNeil et al. (2005). A copula can be defined as a multivariate distribution function C, with [0; 1] – uniform margins. For example, in the bivariate case, we have

$$C\,(u,v) = \mathbb{P}(U \le u, V \le v), \qquad \forall (u,v) \in [0,1]^2,$$

where U and V are uniform random variables on the interval [0,1].

In this paper we are interested in nonparametric estimation of the bivariate copula density

$$c(u,v) = \frac{\partial^2}{\partial u \partial v}\, C(u,v), \;\; for\ all\ \ (u,v) \in (0,1)^2,$$

by providing asymptotic optimal confidence bands based on linear wavelet estimators. These optimal confidence bands, derived from uniform convergence results, can serve as graphical tools for selecting the parametric copula family that best fits the data at hand.

2. Methodology

Our theoretical approach is inspired by the methodology of Giné et Nickl (2009), who established uniform convergence rates for linear wavelet estimators, in *sup-norm*, in the classical framework of univariate probability densities. Here, we extend their methodology to bivariate copula densities. That is, we will establish exact convergence rates for the linear wavelet estimator of the bivariate copula density, using supremum norm. We will also study the convergence of the bias, and derive simultaneous confidence bands for the true copula density c, with asymptotic optimal confidence level (100%).

3. Results

Using wavelet theory, the density c may be decomposed as follows:

$$c(u,v) = \sum_{k,l\in\mathbb{Z}} \alpha_{j0,k,l}\phi_{j0,k,l}(u,v) + \sum_{m=1}^{3}\sum_{j\geq j0}\sum_{k,l\in\mathbb{Z}} \beta_{j,k,l}^{(m)}\,\psi_{j,k,l}^{(m)}(u,v), \tag{1}$$

where

$$\begin{aligned} \emptyset_{j0,k,l}(u,v) &= 2^{j0}\phi(2^{j0}u-k)\phi(2^{j0}v-1)\\ \psi_{j,k,l}^{(1)}(u,v) &= 2^{j}\phi\left(2^{j}u-k\right)\psi\left(2^{j}v-1\right)\\ \psi_{j,k,l}^{(2)}(u,v) &= 2^{j}\psi\left(2^{j}u-k\right)\phi\left(2^{j}v-1\right)\\ \psi_{j,k,l}^{(3)}(u,v) &= 2^{j}\psi\left(2^{j}u-k\right)\psi\left(2^{j}v-1\right), \end{aligned}$$

$j_0 \in \mathbb{Z}\, is\ called\ a\ resolution\ level, \alpha_{j0,k,l}\ and\ \beta_{j,k,l}^{(m)}\ are\ real\ coefficients\ defined\ as,$

$$\alpha_{j0,k,l} = \int_{[0,1]^2} c(u,v)\phi_{j0,k,l}(u,v)duvu \tag{2}$$

and

$$\beta_{j,k,l}^{(m)} = \int_{[0,1]^2} c(u,v)\psi_{j,k,l}^{(m)}(u,v)duvu\,. \tag{3}$$

The linear wavelet estimator of c is defined by

$$C_n^L(u,v) = \frac{1}{n}K_{j_n}\left[\left(\widehat{U}_i,\widehat{V}_i\right);(u,v)\right] = \frac{2^{2jn}}{n}\sum_{i=1}^{n} K\left[\left(2^{jn}\widehat{U}_i,2^{jn}\widehat{V}_i\right);\left(2^{jn}u,2^{jn}v\right)\right], \tag{4}$$

where $K(\cdot,\cdot)$ is a kernel, and $\widehat{U}_i$ and $\widehat{V}_i$ are pseudo-observations of the copula distribution C, whose density is c. Let

$$D_n(u,v) = C_n^L(u,v) - \mathbb{E}c_n^L(u,v)$$

and

$$B_n(u,v) = \mathbb{E}c_n^L(u,v) - c(u,v)$$

Under the following hypotheses, we prove the two proposition below:

(H.1) $\emptyset \in L^2(\mathbb{R})$ is bounded and compactly supported;

(H.2) The projection kernel K onto the central subspace of the multi-resolution analysis is multiplicative, i.e. $K[(x,y);(w,z)] = \widetilde{K}(x,w)\widetilde{K}(y,z)$;
where $\widetilde{K}$ represents the projection kernel onto the one-dimension central subspace.

(H.3) There exists a bounded and integrable function $\Phi\colon \mathbb{R} \to \mathbb{R}_+$ such that

$$\left|\widetilde{K}(x,y)\right| \le \Phi(x-y);$$

and the function $\theta_{\emptyset}(x) = \sum_{k\in\mathbb{Z}}|\phi(x-k)|$ is bounded.

(H.4) The kernel $\widetilde{K}$ is of 2-order, that is, for all $y \in \mathbb{R}$,

$$\int_{-\infty}^{\infty} \widetilde{K}(x,y)dx = 1; \qquad \int_{-\infty}^{\infty} \widetilde{K}(x,y)xdx = y; \quad and \quad \int_{-\infty}^{\infty} \widetilde{K}(x,y)x^2dx \neq y^2;$$

(H.5) $\widetilde{K}$ satisfies the localization property

$$\int_{-\infty}^{\infty} |\widetilde{K}(x,y)\,(x-y)^2|dx < M, \quad M > 0;$$

(H.6) The density copula $c(s,t)$ admits bounded second-order partial derivatives;

(H.7) As $n \longrightarrow \infty$, the sequence (j_n) satisfies:

$$\frac{n}{j_n 2^{2j_n}} \to \infty, \qquad \frac{n}{2^{2j_n}} \to \infty, \qquad \frac{j_n 2^{6j_n}}{n} \to \infty$$

Proposition 3.1 *Suppose that the father wavelet $\emptyset$ is of bounded variation and uniformly continuous, with compact support [0, B], B positive integer, and c(·, ·) is a bounded and continuous copula density. If the hypotheses H.1), H.2), H.3) and H.7) hold, then*

$$\lim_{n\to\infty} r_n \sup_{(u,v)\in[0,1]^2} \frac{\left|c_n^L(u,v) - \mathbb{E}c_n^L(u,v)\right|}{\sqrt{||c||_\infty \int_{\mathbb{R}^2} K^2[(x,y);(2^{j_n}u, 2^{j_n}v)]dxdy}} = 1, \qquad (5)$$

with

$$r_n = \sqrt{\frac{n}{(4\log 2) j_n 2^{2j_n}}} \tag{6}$$

and $\|c\|_\infty = sup_{u,v\in[0,1]^2}$

Proposition 3.2 Under the hypotheses (H. 1-7), we have almost surely,

$$\lim_{n\to\infty} r_n \sup_{(u,v)\in[0,1]^2} |\mathbb{E}c_n^L(u,v) - c(u,v)| = 0, \tag{7}$$

with $r_n = \sqrt{\frac{n}{(4\log 2)_{j_n} 2^{2j_n}}}$.

Propositions (3.1) and (3.2) yields the following corollary, which enables us to construct simultaneous confidence bands for the bivariate copula density c (see remark below).

Corollary 3.1 Assume that the conditions of Propositions 3.1 et 3.2 are satisfied. Then, for all 0 < ∈ < 1, we have, as $n \longrightarrow \infty$

$$\mathbb{P}(\, c(u,v) \in [c_n^L(u,v) - (1+\epsilon)L_n(u,v), c_n^L(u,v) + (1+\epsilon)L_n(u,v)], \forall 0 \leq u,v \leq 1) \to 1 \quad (8)$$

and

$$\mathbb{P}(\, c(u,v) \in [c_n^L(u,v) - (1-\epsilon)L_n(u,v), c_n^L(u,v) + (1-\epsilon)L_n(u,v)], \forall 0 \leq u,v \leq 1) \to 0 \quad (9)$$

Remark 1 Whenever the statements (8) and (9) hold simultaneously for all ∈ > *0, then the intervals*

$$[\alpha_n(u,v), \beta_n(u,v)] = [c_n^L(u,v) - L_n(u,v), c_n^L(u,v) + L_n(u,v)], \tag{10}$$

provide simultaneous asymptotic confidence bands for the copula density *c (u, v),* with asymptotic confidence level tending to 100%.

4. Discussion and Conclusion

A simulation study was performed and shows that our proposed confidence bands are satisfactory for Archimedian copulas, as the true density curve is lying in the bands. However, for the Gumbel copula the results were only satisfactory for values of copula parameter θ close to 1, which corresponds to the product copula.

For the Gaussian case too, the bands were also satisfactory for small values of the dependence parameter θ less than 0.2.

Finally, an application to real data sets was carried out, and reveals that the dependence structure between the macroalgae coral reef and human population density within 50 kilometers may be fitted by the FGM (Farlie-Gumbel-Morgensten) copula.

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Producing and disseminating more and better agriculture data for SDGs in Egypt: Progress and challenges

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Abstract

In September 2015, the United Nations launched the sustainable development goals (SDGs), Egypt was one of the 193 countries that adopted the SDGs and ratified the related agreements.

Starting from 1 January 2016, the 2030 Agenda for Sustainable Development, including the 17 Sustainable Development Goals (SDGs), replaced the Millennium Development Goals, reshaping national development plans over the next 15 years with, among others, the new global objectives of ending poverty and hunger, responding to climate change and promoting the sustainable use of natural resources, and food security and agriculture lying at the heart of this new global strategy ; because it has the most direct impact on development aims related to rural development, natural resources and the environment, and also indirectly effects on the other sectors.

So Sustainable development also requires a re-thinking of rural development and smallholder agriculture to bring greater benefits to the poor people, Structural formations of farming systems, technologies and business models are needed to enhance productivity and market participation and to create new job opportunities.

On the other hand, the success of the SDGs rests to a large extent on new and effective ways of collecting data and measuring progress for a global indicator framework comprising a proposed 232 indicators to monitor the 169 targets is the foundation of the SDGs' accountability structure. The sheer weight of indicators, however, represents an immense challenge for countries; four times greater in number than for the MDGs, each indicator is also set to be disaggregated by gender, age, income, geography, occupation etc. to reflect the 2030 Agenda's guiding principle of "leaving no one behind".

Based on above and to meet the ambitions and demands of the 2030 Agenda, NSO in all over the world has started to review their statistical survey, capabilities and their statistical programs to monitor the challenges of measuring and follow-up SDGs, so This paper aims to discuss the efforts exerted by NSO in Egypt to assess the current status for agriculture indicator (21 indicators) , and the challenges of assessing and monitoring it this besides Shed light on the technological innovations for dissemination agriculture data related SDGs for all data users to benefit from it in the decision-making in all fields.

Keywords
food security; hunger; biodiversity; nutrition; SDG observatory; data portal

1. Introduction

Egypt is committed to the implementation of the 2030 Agenda and the SDGs and has already taken important steps. In February 2016, the Government of Egypt officially launched its Sustainable Development Strategy: the *Program for Economic Development and Social Justice* (*Egypt Vision 2030*). The strategy spans the three dimensions of sustainable development, namely: economic, social and environmental, aiming at inclusive growth, building national and regional competitiveness, promoting innovation, and sustainable use of natural resources. Efforts are underway to align the Strategy's key performance indicators to the 2030 Agenda and the SDGs.

Within this framework, the Government of Egypt also established the Sustainable Agricultural Development Strategy 2030, as instrumental to Egypt Vision 2030, setting as objectives:

1. Making sustainable use of natural agricultural resources.
2. Increasing the productivity of both land and water units.
3. Raising the degree of food security in strategic food commodities.
4. Increasing the competitiveness of agricultural products in local and international markets.
5. Improving the climate for agricultural investment; the living standards of the rural inhabitants, and reducing poverty rates in rural areas.

This strategy would promote a better climate for agricultural investment and developing agricultural information systems to facilitate investments, as well as fostering the increase of agricultural productivity, the improvement of food security in strategic food commodities, and the sustainable use of natural resources in agriculture.

Another important policy instrument of *Egypt Vision 2030* is the *2011 National Strategy for Adaptation to Climate Change and Disaster Risk Reduction*, which focuses on bringing resilience by using natural resources sustainably, building biodiversity, reducing the risk of climate change disasters, and implementing actions for adaptation to climate change.

✓ The national statistical Efforts for Monitoring SDGs (agriculture indicators).

1- Establishing Sustainable Development Unit (SDU): According to the decision No. 18 of 2016 issued by CAPMAS' president, a working group was formed as the "Sustainable Development Unit" to do the following points:

- Coordinating between the different statistical departments inside NSO (Members of SDU) to obtain data for SDG to identify the most important challenges that face monitoring SDGs.
- Identify the most important capacity-building programs to meet the needs of SDGs.
- Building an integrated database and update it Periodically.
- Preparation of statistical reports to monitor and follow up SDGs.
- Raising awareness with SDG and develop a action plan for preservation and documentation metadata related to SDG to build institutional memory and Electronic library.

2- Central Agency for Public Mobilization and Statistics (CAPMAS) and the Food and Agriculture Organization of the United Nations (FAO) was coordinated to monitor six indicators of goal 2 of sustainable development goals and 14.4.1 of goal 14 on the conservation of oceans, seas and marine resources, this agreement was developed during 2018 to achieve this out puts:
   - An Action Plan for SDG 2's monitoring is developed to integrate SDGs in national development strategies related to food security and nutrition policies.

3- A country-specific road map aiming to identify the main challenges in monitoring the SDGs relevant to achieving food security and nutrition and eventually zero hunger for the Egyptian statistical system and to measure the progress in achieving the SDG 2, by addressing key sustainability issues including policy related challenges.

4- Lunching the Egypt SDG Observatory for raising statistical awareness for all users.
   The observatory provides a digital platform for tracking progress towards the SDGs in Egypt, also provides a summary of the number of indicators available, not available and not applicable for each goal.

See http://www.egyptsdgobservatory.info.)

✓ **Evaluation the Current Situation for SDGs in Egypt.**

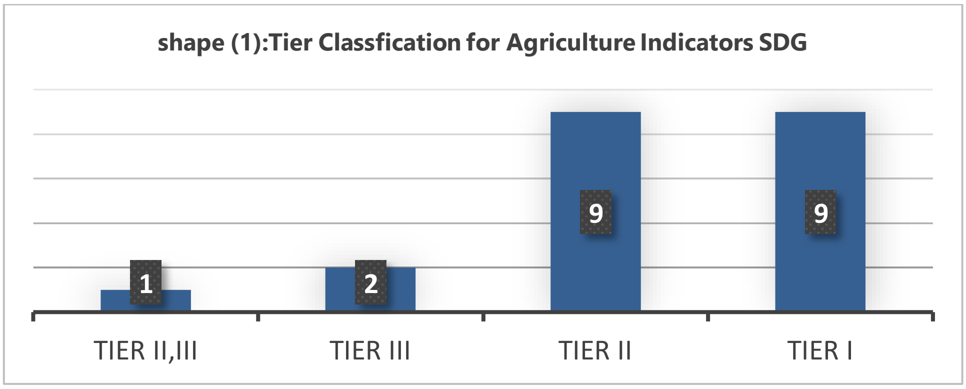
1. The first national statistical report on the SDG indicators was launched in May 2018; it outlines the classification of SDG indicators

into the three tiers prescribed by the global indicator framework on the basis of their level of methodological development and the availability of data, (the percentage of indicator that available was around 40%, Tier1 (35.7%), Tier2 (29.1%), Tier3 (32.4%), not applicable (2.9%), notated that there are many indicators with gaps related with disaggregation such as migration, disability …etc.).

2. The results of evaluations SDGs in Egypt refers to many challenges facing statistical coverage of goals and indicators of sustainable development 2030 in Egypt in the framework of data ecosystem, and classifies them into general, legislative, legal, organizational, technical, technological, human, and consultative challenges as follows:
   - The large increase in size and details of required data, and backwardness of tools and methods of collecting, processing, and analyzing related Big Data.
   - Absence of developing statistical legislations, and its reflection on statistical activity and relations with partners.
   - Multiple challenges related to transforming administrative registers into statistical registers.
   - Shortage of suitable finance and technical support, and developing national statistical cadres according to global standards.
   - Gaps in data and methodologies, globally, regionally, and locally.

3. Situation of agriculture indicator – SDG in Egypt

✓ FAO is the 'custodian' UN agency for 21 SDG indicators, across SDGs 2, 5, 6, 12, 14 and 15, and a contributing agency for other four indicators (the total indicator was 21 indicators (9 tier I,9Tier II,1 Tier II, II)



Source: UNSD, Tier Classification for Global SDG Indicators 31 December 2018

✓ the situation of agriculture indicators according to measuring SDGs-Egypt can summarize in the following points:

- **6.4.1Change in water use efficiency over time**

Indicator	Value (Amount of water with billion m3)
Quantity of water used in agriculture	63.5
Quantity of water used in industry	5.4
Quantity of water used in services	10.75
The total amount of water used for the three sectors	79.65
Value added for the three sectors (million dollars	308412
Total Water Use Efficiency (US $ / m3)	3.87
Source: CAPMAS, report on Sustainable Development Indicators 2030 - Goal 6 - Water and Sanitation (Methodology and Evaluation 2018)	

- **2.1.1 Prevalence of undernourishment**

The prevalence of undernourishment (PoU) is an estimate of the proportion of the population whose habitual food consumption is insufficient to provide the dietary energy levels that are required to maintain a normal active and healthy life. It is expressed as a percentage.

- **2.1.2 Prevalence of moderate or severe food insecurity in the population, based on the Food Insecurity Experience Scale (FIES).**

The food insecurity (moderate and Sharpe) was 28% - Carrie Index-(sourse HICS 2015).

- **2.4.1 Proportion of agricultural area under productive and sustainable agriculture.**

The Percentage of agricultural area allocated for agriculture was 3.7%.

- **2.a.1 The agriculture orientation index for government expenditures**

The agriculture orientation index for government expenditures 1.5% (2015/2016).

- **6.4.1 Change in water use efficiency over time**

Total water use efficiency is 3.87$ / m 3 water

- **6.4.2 Level of water stress: freshwater withdrawal as a proportion of available freshwater resources**

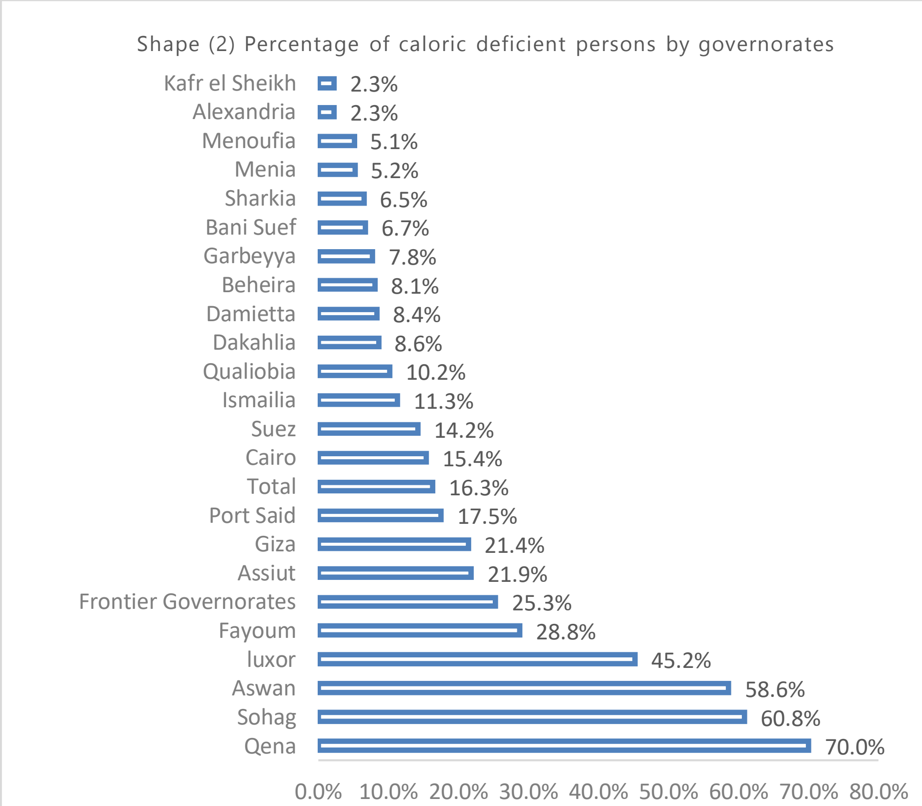
  (The level of water stress was 117.5 m3/ year.)

  15.4.2 - Mountain Green Cover Index.

- Percentage of the mountain area over total area:7.58%, Mountain Green, Cover Index (MGCI) 2%.

  source: http://www.fao.org/sustainable-development-goals/indicators. 1 March2018.

- **The total Percentage of caloric deficient persons 16.3% and we can summarize the percentage of caloric deficient persons by governorates as following chart:**



Source: Household income, expenditure and consumption surveys, Egypt (HIECS 2015).

- Household size is consistently positively correlated with food deprivation. The prevalence rate is only 2 percent for households with one or two members; it increases as household size increases to reach 33.9 percent for household with seven to nine members and 50 percent for households with more than nine members.
- As part of the 2015 HIECS questionnaire, households were asked about the adequacy of food consumption during the last 30 days. In response, 23.4% percent of households reported that they could barely meet their basic food needs, and 4.7 %reported insufficient access to food. Urban governorates and Rural Upper Egypt have the highest prevalence of households reporting insufficient food consumption in 2015 (8.1% and 7.1% respectively).

✓ **5.a.1(a) Percentage of people with ownership or secure rights over agricultural land (out of total agricultural population), by sex; and (b) share of women among owners or rights-bearers of agricultural land, by type of tenure.**

The Percentage of people with ownership or secure rights over agricultural land is (99% male,1%female).

✓ **15.2.1 Progress towards sustainable forest management.**

- Proportion of forest area with a long-term forest management plan (6.28%)- (2010),1.94% (2005),0.67% (2000).

- Proportion of forest area within legally established protected areas (26.85%) (2010), (26.85%) (2005), (26.85%) (2000)., - Forest area annual net change rate (0.84%) (2015), 0.88% (2010), 2.58% (2005). -- Above-ground biomass in forest, per hectare (tons/ha) =168 tons per hectare.
- Above-ground biomass in forest, total (million tons) = 12.26 Million tons (2015), 11.76 Million tons (2010), 11.25 Million tons (2005), 9.91 Million tons (2000)

  source: FAO, Global Forest Resources Assessment http://www.fao.org/sustainable-development-goals/indicators/1521/en/.

✓ **Indicator 14.4.1 - Proportion of fish stocks within biologically sustainable level**

The Evaluation of stocks of natural resources in Egypt (Red Sea, Mediterranean Sea):

- **Berbers:** (Mullussurmuletus and M. barbatus) are important target species for Mediterranean fisheries exploited by more than one type of nets (Trawl trawl and Trammel). Fishing has declined steadily in the last five years to reach only 881 tons in 2016 That the proportion of births of the Barboon extract has increased in the catch and found that the production in 2017 returned to rise again, where it became 989 tons.
- **Sardine (in The Mediterranean Sea):** the fishing of Sardine is considered a great importance in Egyptian marine fisheries before the construction of the Aswan High Dam. Before 1966, sardines accounted for 608 tons, about 40% of the total catch of the Egyptian Mediterranean waters. In 2016, the catch was 9147 tons, about 16.8% of all Egyptian-Mediterranean catch. While in 2017 (8580 tons) decreased by 6.2% about 14.6% of all Egyptian Mediterranean catch.
- **Lizardfish (in The Red Sea):** The fishing of pasta is about 32% of the traction of the Gulf of Suez and about 40% of trawling in the Red Sea (Sustainable production of this type is 4500 tons).

  Source: General Authority for Fisheries Development- National Institute of Oceanography and Fisheries-Arab Academy for Technology and Maritime Transport, 2018.

✓ **2-5-1 Number of plant and animal genetic resources for food and agriculture secured in medium or long term conservation facilities.**

The conservation plan in Egypt for breeds depends on:

1. Continue to represent all current local breeds at the Institute's stations with continuous selection and improvement of production rates.
2. Increase the current numbers by 10% annually if necessary, funding.
3. Continue to develop new poultry strains distinct productive and artificial.

4. To increase the rate of genetic improvement by genetic examination of animals using molecular genetics.
5. Medium-term conservation: Conservation laboratory medium and ultra-cold tissues (250 component is pitiful-150 A genetically modified component of grapes)
6. There are between 35-40 thousand doses were stored as reserve stocks (cows and buffaloes) - (source: Animal Production Research Institute, 2018)

✓ **2-5-2 Proportion of local breeds, classified as being at risk, not-at-risk or unknown level of risk of extinction.**

- The Institute of Animal Production Research in Egypt maintains different breeds of livestock, animals and poultry so as not to be endangered and this is the number of 16 stations distributed throughout Egypt.
- in 2017, the Egyptian campaigns vaccinations for livestock against diseases have been immunized 11.6 million animals with foot-and-mouth disease, 1.7 million animals against nodal skin disease and 1.3 million birds against bird flu, resulting in lower infection rates. (source: Institute of Animal Production Research in Egypt ,2018).

✓ **Indicator 2.2.1: Prevalence of stunting (height for age <-2 standard deviation from the median of the World Health Organization (WHO) Child Growth Standards) among children under 5 years of age.**

- Stunting rate for children 6-59 months is 16.2%, as revealed by anthropometric data collected as part of the 2015 HIECS., stunting amongst children 6-59 months vary between regions and between governorates within each region. Both Sohag and Cairo have the highest stunting rates of about 37%, followed by Menofia (25.8%) in Lower Egypt.
- Stunting and obesity tend to be higher in Urban areas, reaching 18.4% and 13.7% respectively, compared to 15.2% and 7.7% in rural areas.
- stunting rate is higher by 8 percentage points among children whose households do not have ration card. Disaggregating by poverty status, stunting rate among poor households showed only 3 percentage points higher than that among non-poor households, reaching 18.5 percent and 15.3 percent respectively.

✓ **<u>Discussion and Conclusion (Challenges can be fruitful opportunities)</u>**

Measuring SDG indicators face significant challenges in Egypt, where the major challenge to SDG monitoring and follow up is expanding the goals as they cover a wide range of issues, including the human activity on earth, using water, energy, food, agriculture, health, sustainable consumption and production, manufacturing, urbanization, education, inequality, poverty, as well as gender issues. and disaggregated data that not available to ensure measuring the indicators and making international comparisons., however there are many opportunity to face this challenges by:

1. Speed up the finalization of the National Strategy for the Development of the Egyptian Statistical System, which will ensure the provision of a framework for partnership and collaboration with all the elements of the statistical system in a manner that serves the acceleration and legalize the processes of monitoring 2030 SDG indicators.
2. Promote communication with the partners producing data on the international/ regional/ national levels and in coordination and collaboration with NSO, in order to hold regular meetings to identify the most significant challenges, conduct technical reviews for the work methodologies, and determine the most important indicators that may need surveys, which may positively impact monitoring the progress towards SDGs.
3. Expand the use of the administrative records to produce official statistics and achieve the sustainable measurement of 2030 SDG indicators.
4. Introduce new sources and techniques to obtain the data related to sustainable development indicators and employ modern technologies, like using GIS and big data.
5. Strengthen the relationship between CAPMAS and all its partners in the statistical work by fostering the culture of participation in producing the indicators (the private sector, NGOs, scientific research centres, universities and others).
6. The need to disseminate the culture of paying attention to the data and information and raising awareness of their importance in planning, and accordingly the need to raise awareness of the 2030 SDGs.

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Two sides of the same statistical medal - Academic and official statistics, examples for the Bosnia and Herzegovina

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Abstract
The role and importance of statistics in society has experienced significant expansion in last few decades. This expansion has followed by the appearance of large amount of data sets in the world, so called big data, and modernisation of IT technologies and IT solutions suitable for statistical purposes. Most of official data is produced by official statistics - National Statistical Institutes (NSIs) of the countries. Academic statistics is mainly focused on theoretical aspects of data science and contributes to development of official statistics. Consequently, it can be said that academic and official statistics represent two sides of the same statistical medal. However, practical experiences on the nature and characteristics of cooperation between academic and official statistics vary from country to country. This paper is focused on examination of main characteristics of academic and official statistics, their touchpoints as well as the differences, from theoretical point of view. Also, practical aspects of cooperation of academic and official statistics, needs for statisticians as a profession and benefits from work in academic and official statistics in parallel will be described in this paper on the example of Bosnia and Herzegovina.

Keywords
National Statistical Institute; Statistical Literacy; Education; Training

1. Introduction

Historically, statistics as a science has built its role and significance in different spheres of society. Official statistics originated several hundred years ago, and in its initial form, statistics' role was counting/recording of the resources that the countries possessed at the time. In recent decades, special attention has been paid to the development of modern statistics, particularly by using new statistical methods and appropriate IT solutions whose effects are immeasurable for society. Institutionalization of statistics, either through statistical societies, associations or official statistical institutes has led, to some extent, to "discrepancies" in the perception and the role of official statisticians and statisticians from academic community. Academic statisticians primarily contribute to the theoretical development of statistics and work on teaching students who will become a part of the community of official statisticians. On the other hand, in day-to-day work, official statisticians work on conducting very complex statistical surveys and produce statistical indicators for various statistical domains. Bearing in mind the scope and specificity of academic and official statisticians' work, their pathways often differs which leads to more or less "reduced" communication. Practical experiences regarding the cooperation of academic and official statistics and statisticians differ from country to country.

2. Methodology

This paper will describe the basic characteristics of official and academic statistics, similarities and differences between them, and the way in which these relations manifest in Bosnia and Herzegovina (B&H), with the aim of using statistics as a powerful tool for the production of quality statistical indicators which will be used by decision-makers to create socio - economic policies.

Methodology used in this paper refers to reviewing of characteristics of academic and official statistics, links and differences as well as main aspects of cooperation of academic and official statistics in B&H. Methodological approach implies reviewing of scientific papers related to this topic, examination of adequate information sources, interviewing colleagues who have work experience in both fields of statistics as well as sharing author's experiences and thoughts regarding cooperation of academic and official statistics on the example of B&H.

2.1. Characteristics and differences of academic and official statistics

Very often the literature and practice divides the term of statistician into two concepts used by Ryten (1997): "blue collars" for official statisticians and "white collars" for academic statisticians. In that sense, the interpretation of the statistician's role is related to the use of scientifically-based methods for production of official statistics, but also the application of methods whose adaptation is required from time to time in order to consider the specificity of the observed phenomenon. This is primarily done with the aim of providing a better and clearer presentation of data on social phenomena to the users.

Official statistics is mainly produced by National Statistical Offices (NSOs) and is focused on massive phenomena. The aim is to produce statistical indicators for all domains of the country (industry, agriculture, environment, etc.) in accordance with appropriate statistical standards and recommended methodologies in order to provide timely, accurate, reliable and internationally comparable data. Official statistics providers aim to collect and analyse the data, and report findings in an impartial and ethically sound way, and work in ways that create and retain public trust and confidence in the national statistical system (Holt 2008). The production of official statistics implies, above all, possession of theoretical knowledge of statistics, but also of specific practical knowledge of statistics. According to Biemer et al. (2014), official statistics provide to users' free access to their products via web site in order to raise the level of confidence in official statistics and users' satisfaction with their products. One of the official statistics producer characteristics is its operation as a governmental institution that has to respect the official legal regulations of the country. A special challenge in such a situation is the application of scientific statistical methods and best practices, respecting the quality principles of official statistics, especially independence, objectivity, accuracy, etc. In the most developed statistical systems, there is a growing specialization of official statisticians within the statistical domains, as well as for individual phases of survey. One person is often solely responsible for one phase of the survey while in less developed statistical systems, the picture is somewhat different, and one statistician covers several survey stages. Another feature of official statistics is the possession of capacity (financial, material and human resources) for conducting large-scale surveys (with a large number of reporting units and/or a large number of variables – such as population census) that an individual can hardly do. Official statistical institutions are in constant need for the modernization of statistical processes and the application of modern statistical methods and appropriate IT solutions. Hence there is a large need for using academic experience and the application of scientific methods.

Academic statistics is primarily focused on the education of students - young people, on basic statistical postulates and theoretical methods, most commonly in undergraduate studies as well as more advanced methods, techniques and their empirical application (postgraduate or doctoral studies). Droesbeek et al. (1990) use the term 'mathematical statistics' for academic statistics and its origins bind to 17^{th} century. There are several academic institutions which offer degrees in official statistics. Zwick (2016) described in details the European Master in Official Statistics (EMOS) as full academic degree related to official statistics for the EU level. Academic statistics is largely based on theoretical statistics and often, for better understanding, explains the characteristics of theoretical statistical methods and models by using, in the most cases, "hypothetical" examples in which solutions most often shows the "ideal" situation. According to Gal (2002), they pay special attention to statistical literacy for its staff but also for potential users. Academic statistics mostly use secondary data sources contrary to official statistics, which focuses on the collection of official data for different phenomena and publication of results - official statistical indicators. Academic statistics have a great deal of freedom to choose the subject area for conducting survey that aims to follow the basic steps from the prescribed survey methodology to demonstrate the relevance of certain scientific statistical methods. Academic statisticians are mostly supported by theoretical knowledge of certain methods and having, to some extent, limited practical experience.

2.2. Links and differences between official and academic statistics

Collaboration between official statistics and academic statistics can be observed from multiple angles. Based on the previous experience of the author of this paper, both statistics can contribute to the mutual improvement of the quality of work in the following areas:

Table 1. Contribution of academic statistics to official statistics and vise versa (Author's own work)

Academic statistics	***Official statistics***
- Teaching students on the scientific theoretical basis of statistics, primarily	- Sharing of practical experience in the field of official statistics with students and academic staff
- Training of students in the field of statistics for work in official statistics	- Enabling professional training of students through surveys conducting, their engagement as interviewers, etc.
- Providing expert assistance in solving methodological problems with the aim of improving the quality of statistical surveys	- Asking for advice from academic staff with the aim of solving methodological issues
- Use of advanced scientific statistical and econometric methods for the data modelling	- Production of official data in different statistical domains. Data serve as an input for empirical analysis of students
- Participation in the development of new statistical surveys, mostly through the implementation of development projects	- Provision of deindividualized databases for a large number of statistical domains, for the purpose of scientific work of students and academic staff
- Promoting statistics as a science, and benefits from theoretical methods and tools for producing official statistics	- Providing students with opportunities to learn and work on statistical surveys through training, internships, etc.
- Providing trainings for official statisticians regarding new techniques and methods in statistics	- Providing trainings for students regarding scope of work of official statistics, the ways and experiences of its production

When it comes to *differences*, it is very difficult to distinguish between academic and official statistics. Even more, the characteristics of academic and official statistics often reflect their interaction, which suggests that there is a strong link between these two statistics which, acting together, result in improving the quality of statistics as a whole and many other benefits. Greater commitment of official statistics to practical statistics can be considered as one of the differences, as opposed to academic statistics whose primary focus is on the theoretical approach. Consequently, academic statisticians possess theoretical knowledge and the lacks of practical experience of problems in statistical surveys, unlike official statisticians who are well versed in practical surveys issues but have incomplete knowledge on theoretical statistics issues. However, these differences would disappear or become negligible through greater cooperation. Also, one more thing can be considered as difference: the fact that statisticians in official statistics must pass the overall survey process, while academic statisticians are most often devoted to a certain survey phase, or several of them, through their scientific work. A very important difference between academic and official statistics is the fact that in official statistics significant numbers of employed „statisticians" are those whose education is not directly related to statistics (varies from country to country). Academic statisticians, in this sense, have directed their education solely to theoretical and empirical postulates of statistics. Also, one of the differences is reflected in the fact that official statistics take into account actual phenomena in society and their characteristics are, in a certain way, embedded in statistical procedures and methods unlike academic statistics, which in most cases relies on theoretical basics and principles. Inadequate dedication to the cooperation of these two statistics and the inability to fully implement the principles of work in the field of theoretical (academic) and practical (official) statistics most often indicate the conclusion on the existence of certain differences. These differences are mutually exclusive if the academic and official statistics are compatible.

3. Results

3.1. Academic and official statistics in Bosnia and Herzegovina, current situation

Although statistics has not yet reached the desired level of popularity in B&H, it has become increasingly important in recent years. It can be said that official and academic statistics are speeding up the development and promotion of statistics in B&H, primarily through the production of a growing number of official statistical indicators in B&H, using the best practices of the NSIs of the European Union countries, scientific research concepts and methods, and internationally recommended methodologies

Official statistics in B&H, meaning the statistical system in B&H is organized in a complex way. There are three statistical institutes in B&H, one at the state level - BHAS (Agency for Statistics of B&H) and two at the entity level - the Federal Institute of Statistics of the FB&H (FIS) and the RS Institute of Statistics (RSIS). There are approximately 450 people employed in those three institutions, mostly economists, agricultural engineers, demographers, and, to a lesser extent, mathematicians. Unfortunately, there are no statisticians who have completed higher education in the field of statistics. Basically, these are economists or mathematicians who have gained certain knowledge on statistical theory, through undergraduate or postgraduate studies.

There is still no statistical association established in B&H that would directly assist in the development of official statistics and contribute to the theoretical improvement of statistical knowledge and skills. In its organizational structure, BHAS has an established Statistical Council as a permanent body composed of representatives of the academic community, producers and data users. The Council contributes to the implementation of official statistical surveys plans and programs in B&H. A lot of national and regional projects are implemented for the development of official statistics in B&H for the past decade. As a result, a large number of statistical indicators complying with EU regulations and recommended methodologies and standards have been produced. Statistical staff is provided with internships in Eurostat, or one of the NSIs of the EU in the quarterly or semi-annual period, on topics directly related to a particular statistical domain (eg. analysis of time series, sampling, business statistics, national accounts, etc.). Trainings and workshops in the field of statistics are often organized by faculties, institutes of statistics or NSIs. BHAS has a *Sector for methodology, sampling, statistical standards, planning and quality,* which brings together methodologists/ samplers who provide methodological support to statistical surveys in B&H. All three statistical institutions in B&H have successfully conducted one of the largest statistical surveys – Population and housing census in B&H 2013. Also, in official statistics in B&H, the use of statistical software solutions, above all R and SPSS, is becoming more and more intensive. However, their use must be even greater in the future. Regarding academic statistics in B&H, there is no active study on undergraduate, postgraduate or doctoral studies at any of the public or private faculties in B&H where the students are profiled exclusively in the field of statistics. Most of the B&H faculties in undergraduate studies, primarily economics, mathematics, faculties of political sciences, criminology, etc., have subjects of statistics that study the basics of descriptive and inferential statistics. At the undergraduate study, the subject of statistics covers, basic statistical methods with an emphasis on practical areas of application. There are also other subjects that deal with topics related to statistics and conducting surveys such as Methodology of Scientific Research, Statistical Analysis and Applied Statistics, etc. Students generally acquire knowledge on theoretical bases of statistics with very limited use of practical examples and statistical software tools. Also, statistics is still not "popular" among students in B&H. BHAS maintains relatively good relations with the academic community in the field of statistics through signed Memorandum of Cooperation.

3.2. Forms of cooperation between official and academic statistics in B&H

3.2.1 Needs for statisticians as profession - employment opportunities

Higher education institutions offer limited opportunities for studying the majors dedicated to statistics. Also, students usually find that the statistics is very demanding, have a narrow application in everyday life and do not offer great employment opportunities. The insufficiently developed awareness of the statistics importance in B&H society is partially to blame for this attitude. The reason for this is also very limited promotion of statistics, both by the statistical institutions in B&H and by the academic community. Some of reasons lie in the fact that B&H economy is very small, dominated by small and medium-sized enterprises and insufficient research and development resources are being invested in which the statisticians could take part. Data on investments in research and development in B&H shows that small and insufficient amount is invested in R&D, approximately 0.2% of total GDP[1]. Also, the B&H market has generally not recognized the need for a "statistician" profile. However, according to a survey conducted by *Posao.ba d.o.o*. and *Plata.ba* on the topic "Is It worth to study in B&H?"[2] conducted on a sample of 7,500 people, on the list of faculties that can make the highest earnings in B&H are the Faculty of Electrical Engineering, Faculty of economics and business, and Faculty of Pharmacy. Demand for profiles such as Data analyst, Researcher (for research purposes for various non-governmental organizations, marketing agencies, etc.) in certain sectors (branches) of B&H has demand for knowledge and skills that the statistician could successfully respond to. One of the strategic priorities of official statistics in B&H, defined in the "Strategy of Official Statistics Development in B&H 2020"[3], is to promote the role and significance of official statistics in society with the aim of its wider use.

3.2.2 Work in academic and official statistics production in parallel

In B&H, as in other countries, there is established practice of work in official statistics with engagement in some of the public or private higher education institutions. When it comes to public faculties, in most cases it is about the engagement of statisticians coming from official statistics, such as visiting teachers - "practitioners" or as part-time jobs, because according to the Labour Law in state institutions it is not possible to split working time. In that sense, as a 'statistician from practice' I had a 4 years' engagement at the Faculty of Economics and Business at the University of Sarajevo for the subjects of Statistics in Economics and Management and Business Statistics and 3 years at the Faculty of Political Science of the University of Sarajevo. Based on the experience gained, work in official and academic statistics brings many benefits in parallel. First of all, engagement in academic statistics requires constant learning and mastering of theoretical statistical methods and models and transferring knowledge to students. Practical experience of teachers greatly contributes to a better students understanding of statistical methods and models, as well as the specificities of their practical application. Also in the past few years, the Faculty of Economics and Business at the University of Sarajevo has been introducing practical exercises through MS Excel, SPSS and other tools by using data produced by official statistics. Through the work in academic statistics in parallel, we have often discussed

[1] http://bhas.ba/saopstenja/2017/RDE_01_2016_Y1_0_BS.pdf

[2] https://www.posao.ba/#!employer/profile;id=1;postId=746

[3] http://bhas.gov.ba/planiprogram/STRATEGIJA%20%20RAZVOJA%20STATISTIKE%20BIH%202020FINAL%20BH.pdf

practical issues of application of certain statistical methods, methodologies and their adaptation to specific conditions in B&H with the aim of producing official statistical indicators. A number of scientific papers devoted to theoretical models and their empirical application on specific statistical data for B&H have been published in recent years.

3.2.3 Cooperation between academic and official statistics producers in B&H

The cooperation of official and academic statistics in B&H is at a relatively good level and has great potential for further expansion. This cooperation should become more intensive in the future. Through several segments, Strategy puts focus on strengthening the cooperation of official statistics with the scientific institutions. There are numerous examples of this cooperation in B&H. BHAS has a signed Memorandum of Cooperation with three faculties of economics at three universities in B&H: Faculty of Economics of the University of Sarajevo, Faculty of Economics of the University of Mostar and Faculty of Economics of the University of East Sarajevo. Intensive cooperation is planned primarily in the organization of training for BHAS statisticians in selected statistical areas according to needs, training in the use of statistical software like SPSS as well as other forms of cooperation (conducting practice of students, using the official statistics data for scientific research work etc.). Also, this cooperation opens up the possibilities for participation of representatives of both statistics in conducting of special surveys, development of studies, and organization of scientific events (conferences, workshops, etc.) of importance for academic and official statistics. An example of such co-operation is the development of the document "Study on regulations impact assessment (RIA) in the European Integration process in Bosnia and Herzegovina"[4], which represents a significant contribution to official statistics. Another example is certainly the organization of the first statistical conference in B&H: "ICOS 2017: Challenges, Opportunities and Future Directions in Official Statistics"[5], organized by FIS of FB&H and supported by two other statistical institutions in B&H. The contribution of academic statistics to official statistics is also reflected through the work of the permanent body of BHAS - the Statistical Council of BHAS, whose work includes the representatives of the academic community (academic statisticians) which, in addition to regular commitments, provides suggestions for improving the surveys implementation process in order to improve the quality of statistical data. Also, a good example of cooperation between official and academic statistics was provided by the London School of Economics Consortium in order to improve the knowledge and skills of statisticians in B&H and to develop their capacity to implement

[4] http://www.dei.gov.ba/bih_i_eu/RIA_u_BiH/default.aspx?id=6626&langTag=bs-BA

[5] http://www.icos2017.fzs.ba/

surveys in B&H (for example, the Household Budget Survey for B&H[6]). Certainly, the inevitable form of cooperation is the mutual participation of statisticians in the lectures and trainings as lecturers, which significantly contributes to the promotion of official statistics as well as to the overcoming of theoretical methods and models.

4. Discussion and Conclusion

All facts and characteristics stated in the paper indicate that we can lead debates about links between academic and official statistics, its differences, depending on the viewing angle. Also, the indisputable facts are that statistics is a science, an indispensable part of evidence based policy making, gives the power in creating a picture of economics and society, etc. Empowering of statistical literacy is essential for improving the quality and position of statistics in society. Academic and official statistics go hand in hand and have a direct impact on each other. We can surely say that academic and official statistics are two sides of the same medal, statistical medal. Cooperation between official and academic statistics is of crucial importance for the development of high-quality official statistics in various statistical domains, as well as its adequate promotion and use in all social segments.

In B&H, there is currently a relatively good cooperation between official and academic statistics whose forms are shortly described above. In order to complete the development of official statistics in B&H, to strengthen cooperation with academic statistics in the future and to reduce the differences between them, the key *challenges* facing academic and official statistics are:

- complexity of the statistical system in B&H,
- lack of active academic studies in the field of statistics that would contribute to the production of quality staff – statisticians,
- accelerated changes in society that official statistics will have to follow with adequate support of academic statistics,
- insufficient financial, technical and other resources that would contribute to improving the quality of academic and official statistics.

The main perspectives of the future cooperation of academic and official statistics in B&H are:

- promotion of transparency in the work of official and academic statistics in B&H,
- use of the EU and other funds with the aim of achieving cooperation through joint work on the implementation of R&D projects,
- use of scientific approaches in production of official statistics in BH by applying modern methods and techniques in practice,

[6] http://www.bhas.ba/ankete/hbs_07_000-bh.pdf

- establish a Statistical Association that will encourage the cooperation of these two statistics, establish a common working environment - working groups between academic and official statistics (networking),
- organization of joint sessions, seminars, trainings and conferences.

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Flipping a statistics classroom for pre-service english language teachers

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Abstract
Flipped classroom approach has gained attention for educational practitioners and researchers in recent years. In contrast with traditional classroom, in flipped classroom, students gather basic knowledge out of class, so that class time can be used by them to engage in active learning experience. While rich body of research has been investigated the effectiveness of flipped classroom, yet little is known about student's perspective towards the implementation of flipped classroom, especially for non-mathematics students that enrol statistics course. This study aims to describe preservice English language teacher's perceptions with regard to the implementation of the learning approach in Statistics for Research course. Online questionnaire is employed in capturing student's perceptions. Students were generally positive regarding the implementation of flipped classroom. Although, the students still had difficulty with regard to online learning environment, they felt that many features of flipped classroom are helpful for their learning experiences.

Keywords
flipped learning; inverted classroom; student perception; LMS; pre-service teacher

1. Introduction

Recently flipped classroom pedagogical approach acquire popularity in educational research and practice. This learning approach flip the events that usually occurs in classroom to be happen out of class, and vice versa (Lage, Platt, & Treglia, 2000). Educational practitioner and researchers implemented the approach in various models (e. g., Lai & Hwang, 2016; Lee, Lim, & Kim, 2017). However, the basic idea of flipped classroom is to move basic knowledge acquisition out of class, so that students have preparation to deepen their knowledge and understanding when they are in class. In flipped classroom, students typically watch videos and take quiz in their own learning environments (e.g. home, library, boarding house, etc.) and then, in class, they will engage in group activities or practicum.

Rich body of research has investigated the effectiveness of flipped classroom. In nursing education, Betihavas, Bridgman, Kornhaber, and Cross (2016) found that flipped classroom has impact on improving academic performance outcome. Some literature reviews (e. g., Long, Logan, & Waugh, 2016); O'Flaherty & Phillips, 2015) also give the evidences of its effectiveness. However, little is known about student's perceptions towards flipped classroom, particularly for nonmathematics students that is "forced" to enrol mathematics course. Therefore, the aims of the present study are to describe pre-service English language teacher's perceptions with regard to the implementation of the learning approach in Statistics for Research course.

The manuscript is organized as follows: the implementation of flipped classroom is described in Section 2; methodology of the current study is described in Section 3; statistical summaries of the data and their corresponding analysis are presented in Section 4; and discussion of the results and concluding remark appear in Section 5.

2. The description of the study

In Statistics for Research course, there was an introductory lecture in week 1, to explain the course syllabus, then followed by two subsequent terms that conducted in different learning approach. Flipped classroom approach was implemented in first term of the course, spanning 4 weeks, which was taught by the first author. In the first until fourth weeks of the first term, students learned basic descriptive statistics, measures of central tendency, measures of dispersion, and normal curve respectively. The course, then, was delivered using traditional approach in the second term in which students learned inferential statistics.

Pre-class activity. In general, flipped classroom approach has two learning stages, namely preclass activity and in-class activity. In pre-class activity, students listened podcasts, watched videos, took online quizzes, and did self-assessment through the Exelsa (http://exelsa2012.usd.ac.id/), Moodle-based learning management system (LMS) provided by the university. The podcasts provided introduction regarding the topic to be learned. The videos were used to introduce concepts, demonstrate procedures, and illustrate with real life scenarios (Lim, & Wilson, 2018). The online quizzes were aimed to facilitate students in recalling their knowledge right after they watched the videos. The self-assessment was aimed to facilitate students' reflection about their learning. Those learning materials were arranged so that they were sequential.

Table 1.
Number of audio plays in Soundcloud

Audio	Audio title	Duration in minutes	Soundcloud plays
1	Basic Descriptive Statistics: An Introduction	0:57	21

2	Measures of Central Tendency: An Introduction	1:41	11
3	Measures of Dispersion: An Introduction	2:31	9
4	The Normal Curve: An Introduction	1:11	7

The podcasts were produced using smartphone's audio recording feature. This production technique usually obtained low quality audios. Therefore, the recorded audios then were edited using an audio editor software in order to produced more clear sounds. After the audios were settled up, they were uploaded in Soundcloud. Details of the podcasts used in the present study were shown on Table 1.

Table 2.
The statistics summaries of videos in each topic

Topic	Number of videos	Duration average (in minutes)	YouTube views average	YouTube time watched average (in hours)
Basic Descriptive Statistics	8	6.65	36.13	1.18
Measures of Central Tendency	5	6.74	25.8	1.09
Measures of Dispersion	4	6.46	45	1.7
The Normal Curve	3	6.71	47	2.11

Screencast was employed in producing the videos. Screencast is a digital record of computer screen output that often contains audio narration (Udell, 2005). The use of screencast has several benefits for students' learning. Students can view the screencast at their own convenience. They also will have more rich learning experiences when watching the combination of images and sounds compared with tradition textbooks (Sugar, Brown, & Luterbach, 2010). Both of video and audio editor software were used to produce the screencasts. The final videos then were uploaded to YouTube and embedded in LMS. The accompanying PowerPoint slides for the videos also uploaded to LMS so that students can download and use them to learn the covered topics. In total, 20 videos were provided to students that covered 4 main topics. Details of the videos is shown in Table 2 and an example of the video is shown in Figure 1.

Figure 1. Screencast in the topic of Application of Normal Distributions

In-class activity. Aside from pre-class activity, in-class activity is another critical component of flipped classroom approach. In-class activity consists interactive group activities that addresses student-centred learning (Bishop & Verleger, 2013). In 3 out of 4 face-to-face meetings, the instructor began the class with peer instruction for approximately 15 minutes. This peer instruction aimed to help students recalling their prior knowledge and understanding about the materials they learned in pre-class activity (Crouch & Mazur, 2001). In this phase, the instructor used Desmos in presenting a multiple-choice question in front of class and poll the students' answer. When there was disagreement in students' answer, the instructor urged them to convinced their fellow students in order to agree with their answer by explaining the underlying reasoning. Finally, the instructor continued the learning activity by conducting poll again with the same question. If necessary, the instructor gave a brief explanation about the answer of the question. One meeting did not employed the peer instruction in the beginning. Rather, the instructor directly gave a brief lecture about the topic to be learned.

In the main body of lesson in face-to-face sessions, the present study uses problem-based learning as in-class activity for 4 weeks implementation of flipped approach. In each face-to-face meeting students were given a set of problems to be solved in group. When students work in group, the instructor walked around the class to check whether the students had questions. The instructor also gave questions to students in order to know their understanding and to challenge the students' thinking. This instructor's role were important principles in implementing problem-based learning (Savery & Duffy, 1995). In the end of the meeting, students should submit their works through the LMS.

3. Methodology

The present study takes descriptive methods in exploring students' learning experiences in flipped classroom by using their perceptions. The study was conducted in a Statistics for Research course in the department of English language education at a private university in Yogyakarta. Thirty third-year students were enrolled in the course, of which, 5 were males and 25 were females. After the implementation of flipped approach, students were asked to take online survey that can be accessed through the LMS. The online survey consisted 14 close questions and 2 open questions. The close questions were 5-point scale that asked the agreement of the given statement, whereas the open questions asked students' opinion regarding their favourite and unpleasant experiences in flipped classroom.

The quantitative data of student's perceptions were analyse using the Statistical Package for Social Sciences (SPSS) version 24. Statistical summaries of student's respond in each questionnaire item were calculated. In analysing student's written respond regarding their positive and negative learning experiences in flipped classroom, Atlas.ti version 7 was employed. The student's written responds were categorized with codes and then the occurrence of the categories were calculated to see how grounded the categories is.

4. Results

Table 3 provides the means, standard deviations, standard errors, and 95% confidence intervals for the mean of student perceptions towards flipped classroom.

Table 3.

Student's perceptions towards flipped classroom

Statement	M	SD	SE Mean	95% CI
Pre-class perceptions				
The videos were useful to my learning.	4.034	0.778	0.145	(3.738, 4.331)
The quizzes in online lesson were useful to my learning.	3.793	0.62	0.115	(3.557, 4.029)
In-class perceptions				
The lesson review in the beginning of every faceto-face meeting was useful to my learning.	4.069	0.704	0.131	(3.801, 4.337)
The due date and time for in-class assignments were set reasonably	3.138	1.06	0.197	(2.735, 3.541)
The in-class group questions were thoughtprovoking and helped me to deepen my knowledge.	3.793	0.774	0.144	(3.499, 4.087)
My in-class discussions with peers and the instructor helped me learn.	4.207	0.774	0.144	(3.913, 4.501)
The class time is structured effectively for my learning.	3.69	1.004	0.186	(3.308, 4.071)
The class time is critical to my learning.	3.69	0.85	0.158	(3.367, 4.013)
The structure of this flipped class supports my learning in and out of class.	3.276	0.96	0.178	(2.911, 3.641)
Having to communicate mathematics in class helped me learn the concepts better.	3.69	0.891	0.165	(3.351, 4.028)

Student's written opinions with regard to their positive and negative experiences in flipped classroom are classified into several categories. Table 4 shows the number of occurrences of the category in student's positive or negative experiences and the examples of student's written opinion related with their experience.

Table 4.
The number of occurrences of student's opinion in their learning experience

Student's opinion category	Positive Experience	Negative Experience	Example of student's opinion
Statistical Topic	9	7	I enjoy to study this course because it can help me to answer research question or in skripsi/thesis. The materials so interesting and make me fun to study it.
Group Discussion	9	1	My favourite experience is when we learn and discuses together with my friends. It makes me interested to follow this lesson even though it is very difficult.
Internet Connection	0	7	I had many troubles when assessing online class especially internet connection.
Instructor Role	5	0	... the teacher gives us example and make students answer the question.
Online Environment	0	4	I prefer to use a traditional method that classroom activity should give a learning and also practice in a same time.
Peer Instruction	4	0	I like the interactive learning platform: Desmos.
Time Management	0	3	I need more time to understand the material, and i cannot think clearly when I need to submit the exercise in short time.
Class Structure	0	1	When I forgot to watch the video before class because I always come home late after I sing at the night before.
Language	0	1	The lecture didn't use English.
Result-Based	0	1	The class doesn't encourage me to do the assignment or quiz, etc. Because it is more result based, not process based. All we know just we submit our answer, but I actually don't have the passion to do it.
Autonomy	1	0	I can learn a review the material by myself
Statistical	1	0	I can learn how to use Excel, so it helps me to count and analyse the data quickly
Technology Video	1	0	Watching the videos at home is more enjoyable because it stimulates my curiosity

5. Discussion and Conclusion

The aim of the current study was to explore student's perceptions toward flipped classroom. The result suggests that the students, in general, have positive perceptions towards flipped classroom approach. They perceived pre-class activity as useful phase in their learning experiences. Specifically, they felt that the use of videos can enhance their learning in their own learning environments. Long, Logan, and Waugh (2016) have similar findings regarding the use of video in flipped classroom.

The students also have positive attitudes toward in-class activity. They perceived that peer instruction in the beginning face-to-face meeting motivated them in learning statistics. This is also the case for group discussion. Instructor role in guiding and tutoring students has positive impact to students' learning as well. These findings are the evidence of what Sams and Bergmann (2012) suggest about flipped classroom. Flipped classroom optimize the use of time for learning in class time. Since students had learned basic knowledge about domain specific contents in pre-class activity, the instructor has more time to guide students in learning more advanced and engaging materials.

However, the students also have negative perceptions as well when the flipped classroom was not accompanied with adequate infrastructure, such as internet connection. The internet connection is critical requirement for students to access all materials. Time management also has important role in conducting flipped classroom. It was the case of the current study. The students regarded that they did not have enough time in solving all problems to be presented in face-to-face meeting. This finding in line with Prober and Khan (2013) findings, but in contrast with Lai and Hwang's (2016) selfregulated flipped classroom results. In their self-regulated flipped classroom, student uses selfregulated monitoring system track their learning strategies.

The findings of the current study, albeit anecdotal, suggest that flipped classroom has the promise in orchestrating active learning environments without losing time in covering basic learning materials. Engaging students with multimedia in pre-class activity provide learning environment in which they can learn essential course material to prepare them for in-class time. Therefore, the instructor can focus to deepen students' knowledge and understanding when the students come to class with active and engaging activities. This learning approach may serve a significant promise for successful implementation in Statistics course for non-mathematics students who consider Statistics as, referring Cobb's (2007) phrase, "tyranny of the computable."

Admittedly, much more research is needed in supporting the current study with regard to the effectiveness of flipped classroom from student's perspective. The current study shows student's perceptions toward flipped classroom approach, but more studies are still needed in investigating the approach's impact on student's learning.

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Analysis of a vaccination mathematical model of an infectious measles disease

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Abstract
Analysis of a vaccination Mathematical model of an infectious Measles disease was carried out. SVEIR epidemic model was investigated and incidence rate was considered. Its formulation and analytical study showed two equilibrium points (disease free equilibrium (DFE) and endemic equilibrium (EE)). Model proved positivity of solutions and obtained the basic reproduction number for determining whether disease dies out completely or not. The local stability of disease-free equilibrium was proved, and determined by the basic reproduction number. DFE and EE were shown to be Globally Asymptotically Stable (GAS) which resulted to a new model equation. Numerical simulations were carried out.

Keywords
Deterministic; Equilibrium; SVEIR; Number; Stability

1. Introduction

Over the past decades, mathematical models have been developed and implemented to study the spread of infectious diseases since the early 20th century in the field of mathematical epidemiology. Most of the models in mathematical epidemiology are compartmental models, with the population being divided into compartments with the assumptions about the nature and time rate of transfer from one compartment to another. Many infectious diseases are spread by direct contact between susceptible and infective. Here we develop and analyze a vaccination model for infectious diseases. This tool is used to study the mechanisms by which diseases spread, to predict the future course of an outbreak and to evaluate strategies to control an epidemic.

Bernoulli, et al (2004) despite the availability of the measles vaccine since 1963, the infectious disease is still endemic in many parts of the world including developing and developed nations. It was eliminated from the U.S. in 2000 but due to importation, secondary transmissions have been occurring since then. Ochoche et al (2014) discussed an SVEIR mathematical model of measles with vaccination and two phases of infectiousness. Even though vaccination was considered in their model, but global stability was not shown. We thereby introduce improvement by analyzing the global stability of the endemic equilibrium using Lyapunov function.

In this paper, we extend the model presented by Shulgin et al. (2003 and 2005) and Ghoshet al (2004), by incorporating the effect of vaccination on the infectious diseases and assuming a generalized logistic model governing the growth of carrier population. In addition, we use more realistic standard mass action type interaction for direct contact between susceptibles and infectives instead of simple mass action. The model is analyzed qualitatively to determine the stability of its associated equilibria and the optimal vaccine coverage level needed to control effectively or eradicate the disease. The numerical simulation study at the end of this paper helps us actualize this aim.

2.1 Assumptions of the model were made.

2.2 Flow Diagram of the Model

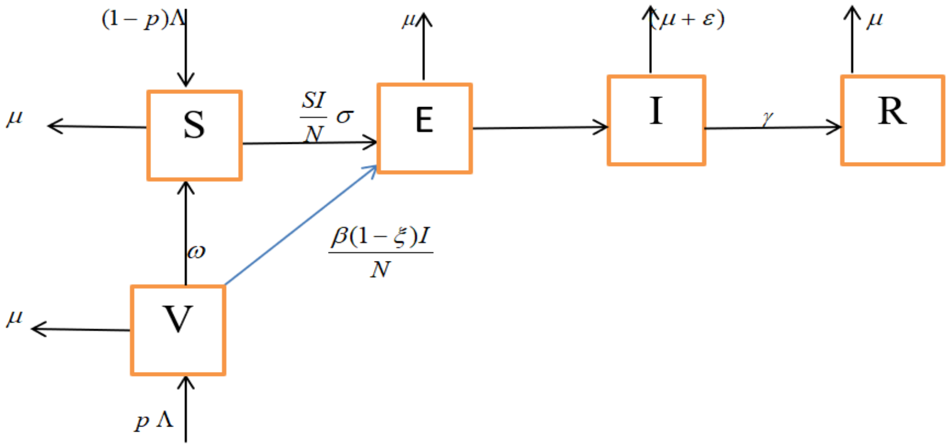

Fig. 2.1: Schematic Diagram of the Model

$N(t) = S(t) + V(t) + E(t) + I(t) + R(t)$

Using the Assumptions, flow diagram, the symbols and parameters, we write the proposed model as:

$$\left.\begin{aligned}
\frac{dS}{dt} &= (1-p)\Lambda + \omega\Lambda - \frac{\beta I}{N}S - \mu S \\
\frac{dV}{dt} &= p\Lambda - \frac{\beta(1-\xi)VI}{N} - (\mu+\omega)V \\
\frac{dE}{dt} &= \frac{\beta IS}{N} + \frac{\beta(1-\xi)VI}{N} - (\mu+\sigma)E \\
\frac{dI}{dt} &= \sigma E - (\mu+\varepsilon+\gamma)I \\
\frac{dR}{dt} &= \gamma I - \mu R \\
where\ \lambda &= \frac{\beta I}{N}\ which\ is\ the\ s\tan dard\ \ force\ \ of\ \ \inf\ ection
\end{aligned}\right\} \tag{2.1}$$

3.1 Analysis of basic Properties of the Model

3.1.1 Boundedness of Solutions

The model will be analyzed in a biologically feasible region as follows. We first show that the system is dissipative (that is, all feasible solutions are uniformly-bounded) in a proper subset $D \subset \Re_{+}^{5}$

Theorem 3.1: Consider the closed set,

$D = \left\{ (S,V,E,I,R)\varepsilon\Re_{+}^{5} : S+V+E+I+R \leq \frac{\Lambda}{\mu} \right\}$, D is positively invariant.

3.1.2 Positivity of Solutions

For the model equation to be epidemiologically meaningful, it is important to prove that all its state variables are non-negative for all time.

Theorem 3.2: Let the initial data be $S(0), V(0), E(0), I(0), R(0)$ .Then the set of solutions $\Omega = \{S(t), V(t), E(t), I(t), R(t)\}$ of the model are positive for all time $t > 0$.

Proof: Let $t_1 = Sup\{S(t) > 0, V(t) > 0, E(t) > 0, I(t) > 0, R(t > 0)\}$

$t_1 > 0$. It follows, from the second equation of (2.1),

$$\frac{dV}{dt} = p\Lambda - \lambda(1-\xi)V - (\mu+\omega)V \Rightarrow \frac{dV}{dt} + [\lambda(1-\xi) + (\mu+\omega)]V = p\Lambda \tag{3.1}$$

(3.1) is a linear differential equation, hence we shall solve by finding the integrating factor given as;

$$\text{Integrating factor} = \exp\left[\int_0^t (\lambda(1-\xi) + (\mu+\omega))dt\right] = \exp[\lambda(1-\xi) + (\mu+\omega)]\int_0^t \lambda(\tau)d\tau$$

$$\therefore \frac{d}{dt}\left\{V(t)\exp\left[(\mu+\omega) + \lambda(1-\xi)\int_0^t \lambda(\tau)d\tau\right]\right\} = p\Lambda \exp\left[(\mu+\omega) + (1-\xi)\int_0^t \lambda(\tau)d\tau\right] \quad (3.2)$$

Now, if we integrate both sides of (3.2) from 0 to t1, we shall obtain

$$V(t)\exp\left[(\mu+\omega) + (1-\xi)\int_0^t \lambda(\tau)d\tau\right] = \int_0^t p\Lambda \exp\left[(\mu+\omega + (1-\xi)\int_0^t \lambda(\tau)d\tau\right]$$

$$\therefore V(t)\exp\left[(\mu+\omega)t + (1-\xi)\int_0^t \lambda(\tau)d\tau\right] = p\Lambda\left[\frac{\exp\left[(\mu+\omega)t_1 + (1-\xi)\int_0^{t_1} \lambda(t)dt_1\right]}{(\mu+\omega) + \frac{d}{dt}(1-\xi\int_0^{t_1} \lambda(t_1)dt_1)}\right] + V(0)$$

$$\therefore \quad V(t) = p\Lambda\left[\frac{\exp\left[(\mu+\omega)t_1 + (1-\xi)\int_0^{t_1} \lambda(t)dt_1\right]}{(\mu+\omega) + \frac{d}{dt}(1-\xi\int_0^{t_1} \lambda(t_1)dt_1)}\right] \bullet \exp\left\{-\left[(\mu+\omega)t + (1-\xi)\int_0^t \lambda(\tau)d\tau\right]\right\} + V(0) \bullet \exp\left\{-\left[(\mu+\omega)t + (1-\xi)\int_0^t \lambda(\tau)d\tau\right]\right\}$$

$$V(t) = \frac{p\Lambda}{(\mu+\omega) + \frac{d}{dt}(1-\xi\int_0^{t_1} \lambda(t_1)dt_1)} + V(0) \bullet \exp\left\{-\left[(\mu+\omega)t + (1-\xi)\int_0^t \lambda(\tau)d\tau\right]\right\}$$

Recall that recall $\lambda = \frac{\beta I}{N}$

Hence, we shall observe that at t1 = 0, V (0) is always positive since exponential of a number is always positive.

$\Rightarrow V(t) > V(t_1) > V(0)$ Since $\sup V(0) > 0$

Hence $V(t) > 0$ *always*

Similarly, the same proof shows that: $S(t) > 0, E(t) > 0, I(t) > 0, R(t) > 0$: which concludes that S(t); V (t); E(t); I(t); R(t)) of the model are all positive for all time t >0.

3.2 Steady State of the Model

At the steady state, the model equation (2.1) is set to zero that is:

$$\frac{dS}{dt} = \frac{dV}{dt} = \frac{dE}{dt} = \frac{dI}{dt} = \frac{dR}{dt} = 0$$

3.3 Disease Free Equilibrium (DFE) ξ_0

At the disease free equilibrium, the disease compartments $E^* = I^* = 0$ .Then equation (3.4) is at steady state and the disease-free (DF) equilibrium is now:

$$\xi_0(S^*, V^*, 0, 0, 0) = \xi_0\left(\frac{(1-p+\omega)\Lambda}{(\lambda+\mu)}, \frac{\Lambda p}{[\lambda(1-\xi)-(\mu+\omega)]}, 0, 0, 0\right) \quad (3.5)$$

3.4 Local Stability of the disease free equilibrium

Theorem 3.3: The disease-free equilibrium of the model (2.1) is locally asymptotically stable.

Proof:

We establish that for the model equation (2.1), the disease free equilibrium is locally asymptotically stable if the basic reproduction number is less than unity, $(R_0 < 1)$, and unstable if the reproduction number is greater than unity, $(R_0 > 1)$.

3.5 Global Asymptotic Stability (GAS) of the Disease-free Equilibrium (DFE) ξ_0.

Theorem 3.4: Consider the model equation (2.1) with the DFE given by ξ_0. The DFE ξ_0 is Globally Asymptotically Stable in D whenever $R_0 < 1$.

3.6 Global Asymptotic Stability of Endemic Equilibrium (EE)

Here, the global asymptotic stability property of the endemic equilibrium of the model equation
(2.1) is given for special case where the rate at which the vaccine wanes is zero, that is, $\omega = 0$.

This results to a new model equation as shown below;

$$\left.\begin{aligned}
\frac{dS}{dt} &= (1-p)\Lambda - \frac{\beta I}{N}S - \mu S \\
\frac{dV}{dt} &= p\Lambda - \frac{\beta(1-\xi)VI}{N} - (\mu+\omega)V \\
\frac{dE}{dt} &= \frac{\beta IS}{N} + \frac{\beta(1-\xi)VI}{N} - (\mu+\sigma)E \\
\frac{dI}{dt} &= \sigma E - (\mu+\varepsilon+\gamma)I \\
\frac{dR}{dt} &= \gamma I - \mu R \\
where\ \lambda &= \frac{\beta I}{N}\ which\ is\ the\ standard\ force\ of\ infection
\end{aligned}\right\} \quad (3.16)$$

In this section, we present computer simulation results for the model equation by using MATLAB 7.9.

We shall consider the following values for the parameters involved in the model.

A graph of Individuals with time

3.7 The Simulation Graphs

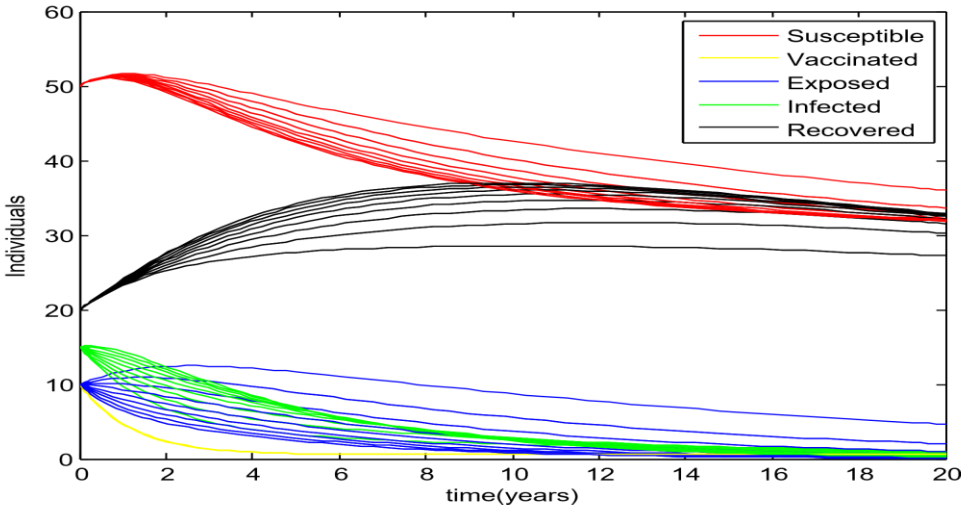

Fig 4.1: A graph of individuals with time when beta (contact rate) is 0.5

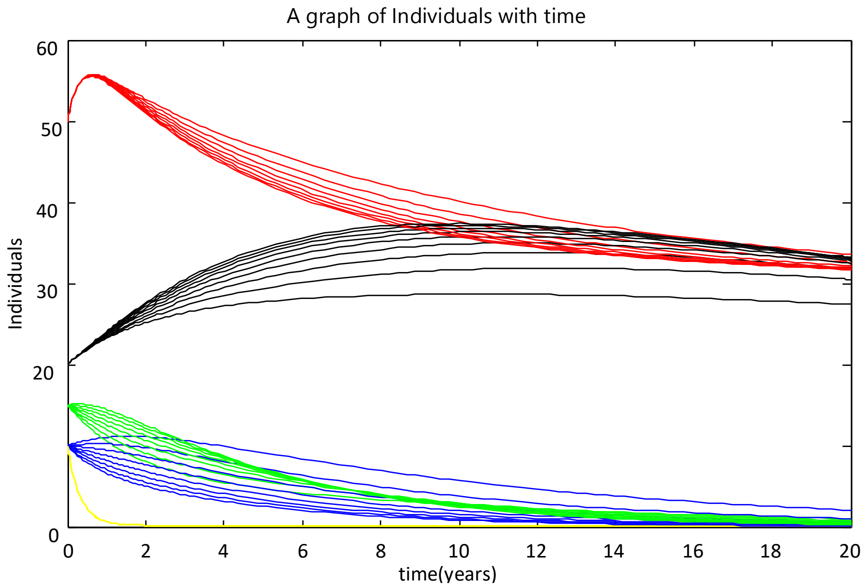

Fig 4.2: A graph of individuals with time when the contact rate (beta) is Increased to 1.0

4.1 Discussion

Figure 4.2 shows the variation of all the classes with time. When the contact rate β was increased, we can see a sharp fall in the susceptible and the vaccinated compartment whereby the vaccinated individuals later maintained an equilibrium point as time goes on. The infectious individuals reduced as a lot of individuals recovered from the disease. The population raises, drops and then maintains a stable increase. From the Figures, we could see that as far as the vaccination is effective and does not wane, the infected class kept on reducing until the disease is totally eradicated.

4.2 Summary and Conclusion

We formulated a flow diagram for our model and a non-linear autonomous differential equation. The local stability of the disease free equilibrium was found. The model strongly indicated that the spread of a disease largely depend on the contact rates with infected individuals within a population. proposed an epidemic model to defend the propagation of an infectious disease, which takes the vaccination strategy into account. We formulated the Mathematical Model and showed that DFE and EE were GAS.

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Comics for investing statistical knowledge

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Abstract

Statistical fallacy occurrence in society is unavoidable. Therefore, Badan Pusat Statistik (BPS) ambitiously provides people with a comprehensive statistical understanding package. BPS does not promote statistical products only, but also the formation and possible utilization of those products. Comics for conceiving statistical philosophy with spirit "Understanding Statistics from The Root" is adopted by BPS currently. Language employed in comics is so simple and easy understood that could attract the reluctant users. This strategy aims to arouse people's interest for learning statistics of their own volition. Comics for understanding seasonal adjustment figures is composed in line with BPS plans to produce seasonally adjusted gross domestic product as official statistics. Comics are disseminated through BPS' Bureaucratic Reform Facebook account. Facebook is effective to reach users broadly. This paper will reveal if the collaboration of comics and social media could form a new statistical literacy system, which is important for sustainable statistical literacy.

Keywords

statistical fallacy, statistical philosophy, seasonal adjustment, Facebook, statistical literacy

1. Introduction

Statistical literacy is part of the responsibilities of National Statistical Office (NSO). NSO should promote actively its statistical products to users in order to raise public awareness. Gal (2002) proposed two primary interrelated components of statistical literacy namely knowledge and disposition components. Knowledge deals with people's ability to interpret and critically evaluate statistical information, data-related arguments, or stochastic phenomena. Disposition deals with the people's ability to discuss or communicate their reactions to such statistical information.

For BPS, promoting statistics is not only exposing the variant of outputs, but also the formation and possible utilization of those products. Therefore, BPS is ambitiously providing people with a comprehensive statistical understanding package. BPS is being so pushful on this matter because the prospect occurrence of statistical fallacy is unavoidable. BPS used to conduct seminar, training, workshop, and e-learning for intern and extern users. Later, BPS conducted an initiative, exploiting comics for arousing people's interest to learn statistics of their own volition. Conceiving statistics philosophically by taking a spirit "Understanding Statistics from The Root" is the main objectives. BPS created seasonal adjustment comics as initial work. It is aligned with BPS' plan to produce seasonally adjusted gross domestic product (GDP) in the future. EUROSTAT mentioned in its guideline if seasonal adjustment is important for analysing the current economic development and revealing the "news", because large seasonal movements can blur other movements. It offers benefits in time series analysis such as short term forecasting and month to month series comparation. BPS utilized Bureaucratic Reform Facebook account to disseminate seasonal adjustment comics. As part of social media, Facebook could reach many people quickly with minimum cost. Meanwhile, Bureaucratic Reform Program is believed to have a power of enforcement especially for intern BPS.

2. Methodology

a. Comics for Statistical Literacy

A lot of researchers have been conducted studies about involving comics in education long time ago. Gruenberg (1944) through his writing "The Comics as a Social Force" showed the use of the comics' technique for fairly clear educational or social purpose. Sones (1944) also emphasized that comics employ a language that apparently is almost universally understood. Most research deduced that comics could be an effective tool of literacy (Marianthi et al., 2008).

Comics integrate visual and verbal communication simultaneously (Combs, 2003). Baker (2011) revealed that comics not only attract reluctant readers, but they are being used to teach advanced themes in literature and visual literacy. This reality brings out a notion from BPS if comics could be a breakthrough strategy of statistical literacy. Statistics could be easily understood using a sequence of story and fun visualization. BPS utilized comics to educate public about seasonal adjustment figures. BPS want to make sure, users understand what seasonal adjustment figures are, how to conduct seasonal adjustment, what the differences with other figures are, and when to use them.

In general, constructing comics consists of two phases, the story-boarding and the illustration. The story-boarding is done by arranging story sequence on interest topic. Meanwhile, the illustration is conducted by depicting the story made (on the board) by drawing the characters, arranging the speech, and presenting the background pictures. Since the comics is for promoting statistics, then it is called scientific comics. Story board is also known as comic's framework. It could be presented in general on detail ways. If the cartoonists do not have statistics background, then it is better to arrange it in detail ways.

b. Comics Dissemination Method

Social media seems become a basic need of people that should be fulfilled. Raut and Patil (2016) declared that social media is built on the idea of how people know and interact with each other. It provides power to share, make the world more open and connected with each other. Viral social marketing is one of strongest aspects of social media (Gosselin and Poitras, 2008). Because, it could reach out to many more people, more quickly and with minimal costs, compared to other forms of marketing technique.

BPS approved the positive side of the social media as mentioned above and would like to take advantages from those. BPS also agrees that as media of literacy, it should be able to increase awareness of the many forms of media messages encountered in our everyday lives (European Commission, 2007). Based on this reason, BPS hired a popular social media, Facebook, then integrated it with BPS' Bureaucratic Reform program as statistical promotion media.

Bureaucratic Reform Program aims to create government's professional bureaucracy, with adaptive characteristics, integrated, high performed, free and clean from corruption, collusion and nepotism, capable serving the public, neutral, prosperous, and dedicated (BPS, 2015). This program is proved to have power of enforcement and covered 8 specific areas, including implementation of good governance system and improving the quality of public services. This area is aligned with the responsibility of BPS on statistical literacy as mentioned in the missions of organization and the law on statistics. BPS quite sure if this program would be powerful means of promoting statistics.

3. Results

a. Seasonal Adjustment Comics

Seasonal adjustment comics story board should be created by statisticians who mastered the sense of analysis. Before depicting the story board, the cartoonists should find the characters that would be involved in the comics. In order to provide a good speech, cartoonists are allowed to transform the words used in the story board without changing the meaning. The words employed for comic's speech should be as simple as possible and commonly used in daily life. The BPS' seasonal adjustment comics are presented as follows:

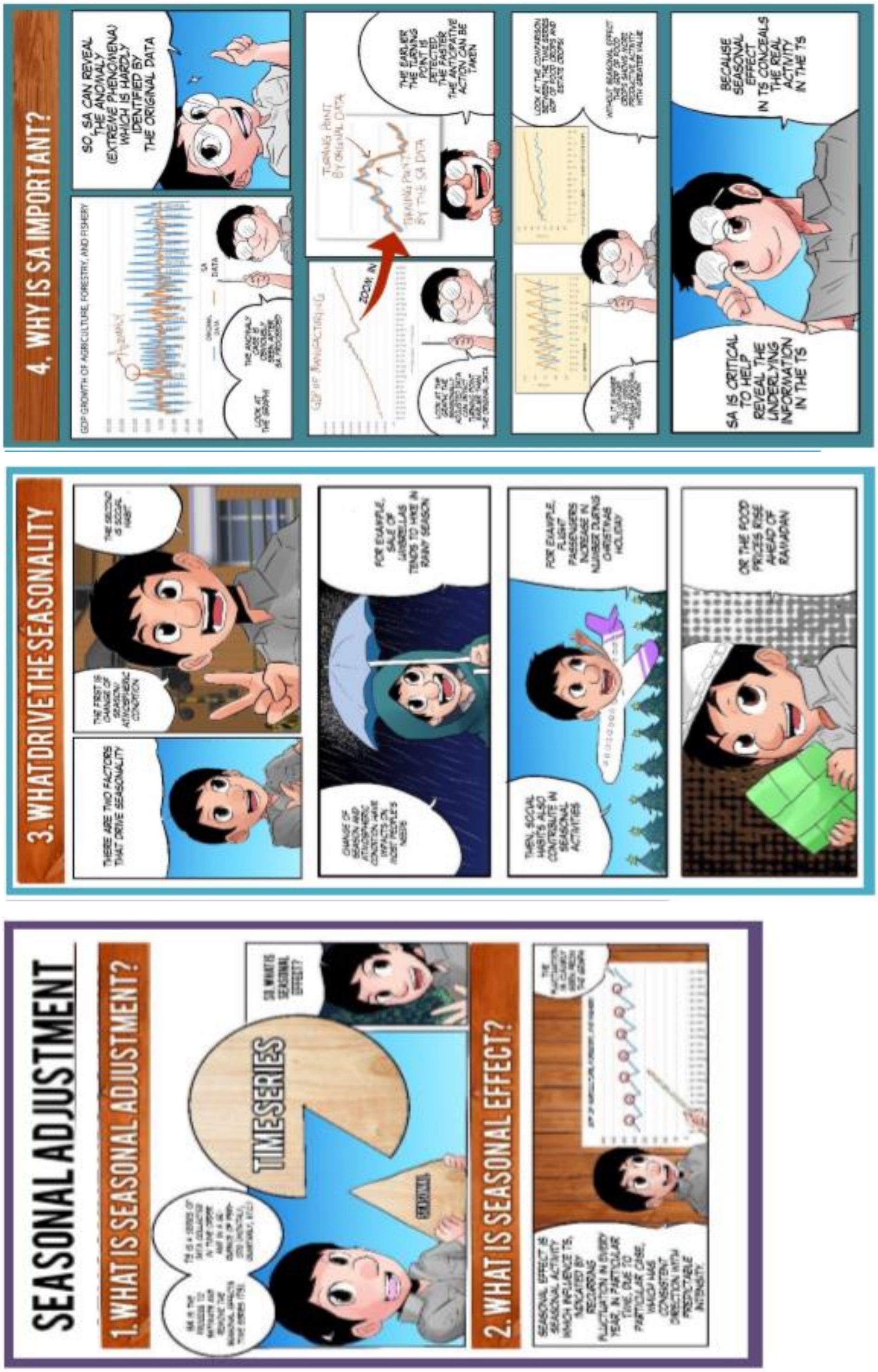

Figure 1. Comics Part 1, Part 2, Part 3, Part 4

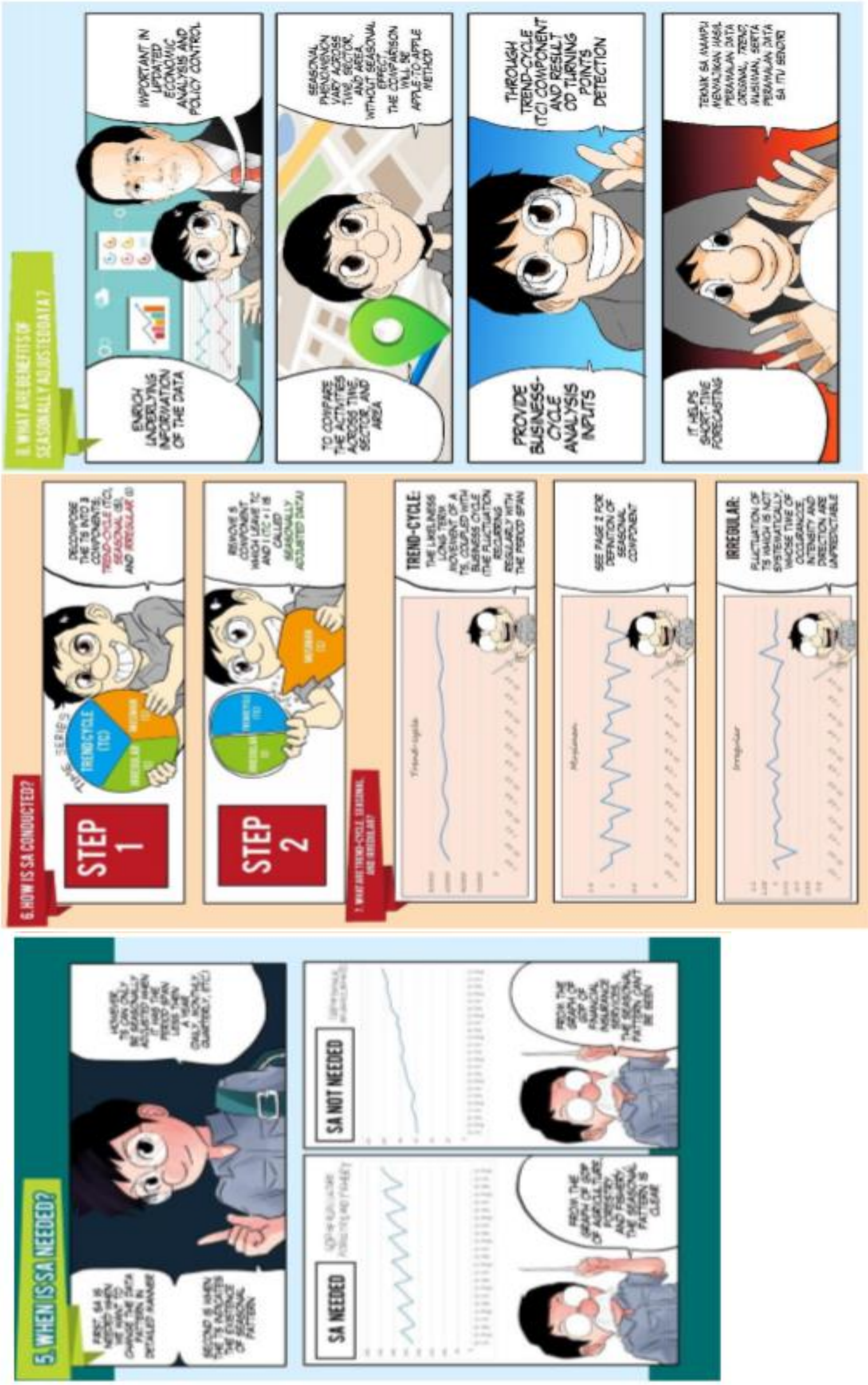

Figure 2. Comics Part 5, Part 6, Part 7, Part 8

b. People Reached - Statistics of Users

To assess the effectiveness level in reaching people, BPS monitored the comics statistics of users after 2 weeks uploading. Comics could reach out more than 5500 users within 2 weeks. It means, there are at least 5500 people who have known about seasonal adjustment comics. In case they are interested in getting in-depth understanding about seasonal adjustment, they could open the comic's post on the Facebook anytime. Among those number, there are 320 people who gave post click to observe full parts of comics and more than 40 people re-shared the comics post. This statistics keep increasing over the time.

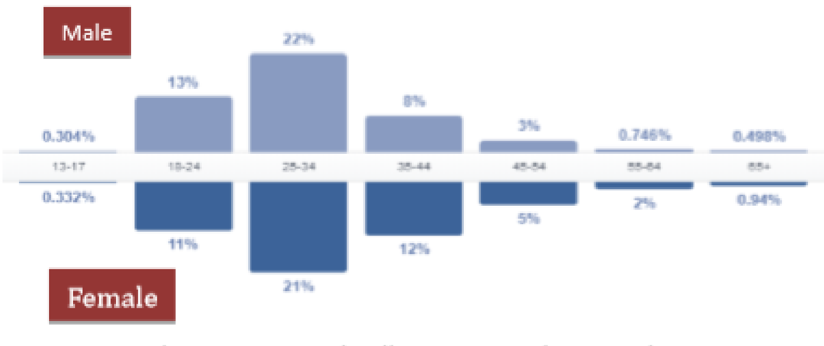

Figure 3. Seasonal Adjustment Comics Users by Age

Facebook revealed through figure 3 that the highest interest on seasonal adjustment comics came from people aged 25-34 years old with the prevalence of about 43 percent. The second highest interest was about 24 percent shown by 18-24 years old people. Those statistics express obviously if seasonal adjustment comics met its best target of users, they are aged 18-44 years old, with relatively equal in prevalence between male and female.

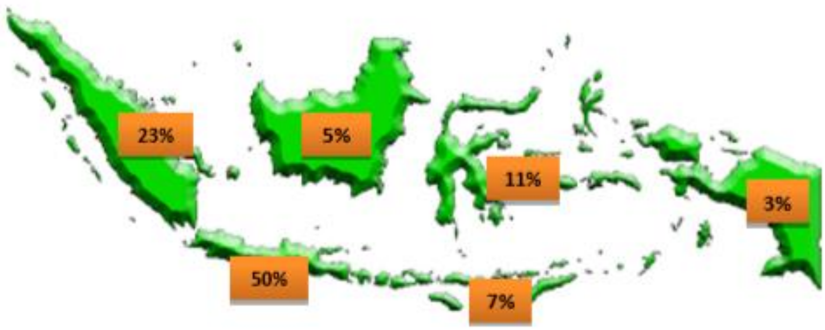

Figure 4. Seasonal Adjustment Comics Users All Over Indonesia

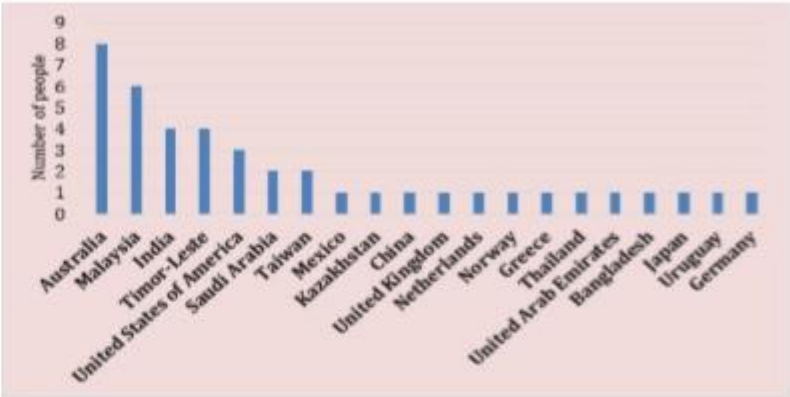

Figure 5. Seasonal Adjustment Comics Users by Country

Figure 4 shows the success of seasonal adjustment comics in reaching people all over Indonesia. Most of the users are from Java Island with prevalence of about 50 percent. Java is leading in development compared to other regions, including internet, digital communication and other information system infrastructure. Hence, no wonder if Java is ranking the highest access on comics through Facebook. Seasonal adjustment comics originally were designed for Indonesian public. BPS was amazed when the comics could reach wider society more than just Indonesian. The are 42 people from overseas who take part as users of BPS' comics (Figure 5).

4. Discussion and Conclusion

Statistical training and workshop are the most common form of statistical literacy implemented by BPS. As they are conducted by face to face meeting, the partcipants are limited in number and social background. The more participants covered, the more space and budget needed. Making leaflets, booklets, and banners in large number for promoting statistical activities and products are also costly. Then, BPS started considering comics engaged with social media to complement its usual literacy methods.

Seasonal adjustment comics created by BPS proved to have contribution in increasing public awareness and interest on statistics. This fact could be indicated from positive responses delivered by users. Some of them stated: "understanding statistics becomes easier through comics, "learning statistics using comics is more interesting than reading statistics textbook" and "comics are helpful for understanding new statistical terms".

Seasonal adjustment comics in collaboration with the social media were also proven as an effective statistics promotion method. More than 5000 people have been reached within two weeks and more than 7000 within two months. Comic was also re-shared by more than 70 people after a two month review. BPS never know how many people connected with the re-sharing actors. It means, seasonal adjustment comics have reached more than 7000 people actually.

Social media does not have limitation in reaching and connecting people. Therefore, comics and social media absolutly could be collaborated for developing broadly statistical literacy system. It would be much cheaper, faster and easier compared to practicing traditional literacy system entirely. Comics engaged with social media would never replace traditional literacy system but would support it to reach many more users with varied background and age. Absolutely, this breakthrough would contribute to sustainable statistical literacy system in the world.

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The poverty reduction through social-economic factors in Indonesia

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Abstract

Poverty is a macro problem that concerns the welfare of a country. Various programs were applied by the government to reduce poverty in Indonesia. This study aims to explain the effect of several social economic factors on poverty in Indonesia using multiple linear regression analysis and Klassen's typology to see the patterns of poverty. The independent variables used to represent economic social factors such as Human Development Index (HDI), Farmer Terms of Trade (FTT), economic growth, and unemployment rate, while the dependent variable used is the number of poor in 2017. Based on this research, it can be concluded that the overall independent variables have a significant effected the number of poor in Indonesia. Partially, only the HDI, FTT, and economic growth variables significantly affected the number of poor. Based on analysis of Klaseen's typology, Riau and Bali was a province that has high HDI, FTT, and economic growth values and poor population relatively low.

Keywords

economic growth, farmer terms of trade, human development index, unemployment rate, the patterns of poverty

1. Introduction

Poverty is a macro problem that has always been the topic of discussion all the time. It's is because the problem of poverty can bring another economic, social, and political issues. Based on Indonesia's Ministry of National Development Planning, Indonesia has made significant progress in reducing poverty since the 1970s. Based on data from the Statistic's Indonesia, the percentage of poor in Indonesia in September 2017 was 10.12 percent with a population of 26.58 million. The government has also carried out various policies to reduce poverty in Indonesia, which is the first goal of the 17 Sustainable Development Goals, known as the Sustainable Development Goals (SDGs) agreed upon by more than 150 heads of state in the World at the Sustainable Development Summit in 2015 which took place in United Nations Headquarters, New York (United Nations, 2015).

The number of poor is influenced by various social-economic factors, such as Farmer Terms of Trade (FTT) which is a picture of the welfare of farmers because in Indonesia the main jobs of the community are in the agriculture, forestry, and fisheries sectors. Based on data from Statistic's Indonesia, in August 2017 it was noted that 29.8 percent of the population aged 15 years and over in Indonesia worked in that sector. This means that the welfare of farmers can play a role in poverty in Indonesia. Another factor is based on Fosu's research (2011), economic growth also has a role in poverty. In addition, based on the research of Zuhdiyati and Kaluge (2017), the benchmark for people's welfare that can contribute to poverty is unemployment and Human Development Index (HDI). HDI is a measure of the development of a country that will reflect the welfare of a country. Therefore, this research is carried out using several variables, they are FTT, Economic Growth, HDI, and Unemployment Rate to examine the effect of these variables on poverty in Indonesia.

2. Methodology

This study used quantitative methods to examine the effect of Farmer Terms of Trade (FTT), Economic Growth, Human Development Index (HDI), and open unemployment rates on poverty in Indonesia. The analysis method used multiple linear regression statistical analysis. In addition, analysis was also carried out using Klassen's typology to find out the characteristics of the provinces in Indonesia which were described by FTT, economic growth, HDI, and the unemployment rate in determining the pattern of poverty in the region. This analysis is done by dividing provinces in Indonesia based on the comparison of poverty rates, FTT, economic growth, HDI, and Unemployment rate with the Indonesian average.

Based on Statistic's Indonesia, poverty is seen as an economic inability to meet basic food and non-food needs measured in terms of expenditure. So, poor are residents who have an average per capita expenditure per month below the poverty line. Meanwhile, HDI is an indicator that explains how residents can access the results of development in obtaining income, health, education, and so on. HDI is formed by 3 basic dimensions, they are longevity and healthy life, knowledge, and decent living standards. The unemployment rate is the percentage of the number of unemployed people in the workforce in Indonesia and economic growth is an indicator to measure economic progress as a result of national development.

Processing data in this study using Microsoft Excel 2016 and SPSS Statistics 22 software. The data used is secondary data from Statistic's Indonesia (Badan Pusat Statistik).

3. Result

The following are the results of multiple linear regression tests:

$y = \beta 0 + \beta 1 x 1 + \beta 2 x 2 + \beta 3 x 3 + \beta 4 x 4$

y : Number of Poor (Million People)

β_0 : Constant

$\beta 1, \beta 2, \beta 3, \beta 4$: Regression coefficient

x_1 : Human Development Index (HDI) %

x_2 : Farmer Terms of Trade (FTT)

x_3 : Logarithm of Natural Gross Domestic Product (Ln_GDP)

x_4 : Unemployment Rate (%)

obtained the following output:

Table 1. Model Summary

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.777[a]	.603	.547	.78261

a. Predictors: (Constant), Unemployment, FTT, HDI, ln_GDP

Source: Output SPSS 22.0

Based on table 1, the R-Square number is 0.603. This shows that there is a strong relationship between FTT, economic growth (ln_GDP), HDI and the Unemployment Rate towards the number of poor. Furthermore, Adjusted R Square shows the number 0.547, meaning the percentage of the contribution of the independent variable (FTT, GDP, HDI and unemployment rate) to the dependent variable (the number of poor) is 54.7 percent. It can be said, the variation of the independent variables used in the model is able to explain as much as 54.7 percent variation of dependent variables, while the remaining 45.3 percent is explained by other variables outside the research model.

Table 2. ANOVA

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
(Constant)	-8.189	3.945		-2.076	.047	-16.270	-.108
HDI	-.088	.038	-.314	-2.306	.029	-.167	-.010
FTT	.061	.030	.251	2.049	.050	.000	.122
ln_GDP	.779	.139	.780	5.602	.000	.494	1.063
Unemployment	-.043	.078	-.068	-.544	.591	-.203	.118

a. Dependent Variable: NumberOfPoverty

Source: Output SPSS 22.0

Based on the ANOVA output above, it is obtained sig F of 0,000. This shows that with a 5 percent significance level it can be concluded that FTT, GDP, HDI and Unemployment Rate together affect the number of poor in Indonesia in 2017.

Partial testing results of the regression coefficient (t-test) show that only HDI has a significant negative effect on the poverty rate in Indonesia at the 5 percent level. it means when the other independent variables remain and HDI increases by 1 percent, the number of poor people will decrease by 0.088 million. Meanwhile, FTT and economic growth have a significant positive effect on the poverty rate in Indonesia at a significant level of 5 percent. This shows that the increasing GDP does not guarantee welfare that is evenly distributed in all levels of society. The increase in FTT also does not necessarily reduce the number of poor due to the narrowness of agricultural land due to the phenomenon of rural farmers' migration to the city. So that whatever the proceeds of the sale cannot lift them out of poverty. The regression equation for poverty in Indonesia in 2017 can be written as follows:

$$y = -8.189 - 0.088x_1 + 0.061x_2 + 0.779x_3 - 0.043x_4$$

The number of poor predicted (y) for each province in Indonesia can be seen in the predicted poverty column, while the standard residual column is a standardized residual value. if the value is getting closer to 0, the regression model is getting better at making predictions, on the contrary, getting away from 0 or more than 1 or -1, the regression model is not good at making predictions.

Table 3. Residual Output

Province	Predicted Y	Residuals	Standard Residuals
ACEH	0,126	0,725	0,990
SUMATERA UTARA	1,574	-0,184	-0,251
SUMATERA BARAT	0,451	-0,089	-0,122
RIAU	1,764	-1,259	-1,720
JAMBI	0,921	-0,638	-0,872
SUMATERA SELATAN	1,156	-0,070	-0,095
BENGKULU	-0,445	0,754	1,030
LAMPUNG	1,716	-0,608	-0,831
KEP. BANGKA BELITUNG	-0,479	0,554	0,757
KEP. RIAU	0,256	-0,129	-0,177
DKI JAKARTA	1,525	-1,134	-1,549
JAWA BARAT	2,804	1,167	1,594
JAWA TENGAH	2,359	1,966	2,685
DI YOGYAKARTA	-0,223	0,701	0,957
JAWA TIMUR	2,979	1,532	2,093
BANTEN	1,353	-0,666	-0,910
BALI	0,767	-0,589	-0,804
NUSA TENGGARA BARAT	1,255	-0,484	-0,662
NUSA TENGGARA TIMUR	1,026	0,117	0,159
KALIMANTAN BARAT	0,867	-0,479	-0,654
KALIMANTAN TENGAH	0,383	-0,245	-0,334
KALIMANTAN SELATAN	0,441	-0,247	-0,337
KALIMANTAN TIMUR	0,946	-0,726	-0,992
SULAWESI UTARA	-0,244	0,441	0,602
SULAWESI TENGAH	0,424	-0,004	-0,005
SULAWESI SELATAN	1,343	-0,524	-0,715
SULAWESI TENGGARA	0,133	0,190	0,259
GORONTALO	0,015	0,189	0,257
SULAWESI BARAT	0,726	-0,577	-0,788
MALUKU	-0,448	0,768	1,050
MALUKU UTARA	-0,362	0,439	0,600
PAPUA BARAT	0,625	-0,405	-0,553
PAPUA	1,391	-0,487	-0,665

Source : Microsoft Office Excel 2016

Based on the residual output it can be concluded that the regression model for North Sumatra, West Sumatra, Jambi, South Sumatra, Lampung, Bangka Belitung Island, Riau Island, Banten, Bali, West Nusa Tenggara, East Nusa Tenggara, West Kalimantan, Central Kalimantan, South Kalimantan, North Sulawesi, Central Sulawesi, South Sulawesi, Southeast Sulawesi, Gorontalo, West Sulawesi, North Maluku, West Papua, and Papua both in predict the number of poor with NTP, GDP, HDI, and unemployment rate as the independent variable.

Poverty Pattern by Province in Indonesia, 2017

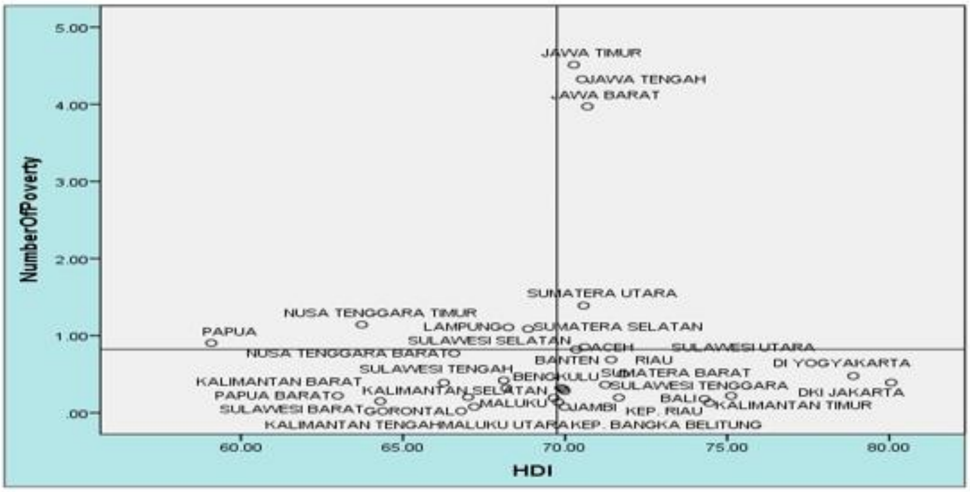

Figure 2. Poverty and HDI patterns for the Indonesia average in 2017

Figure 2. Shows that the provinces of Riau, West Sumatra, Jambi, North Sulawesi, Bangka Belitung Islands, Riau Islands, DKI Jakarta, Bali, East Kalimantan, and DI Yogyakarta have low numbers of poor and high HDI.

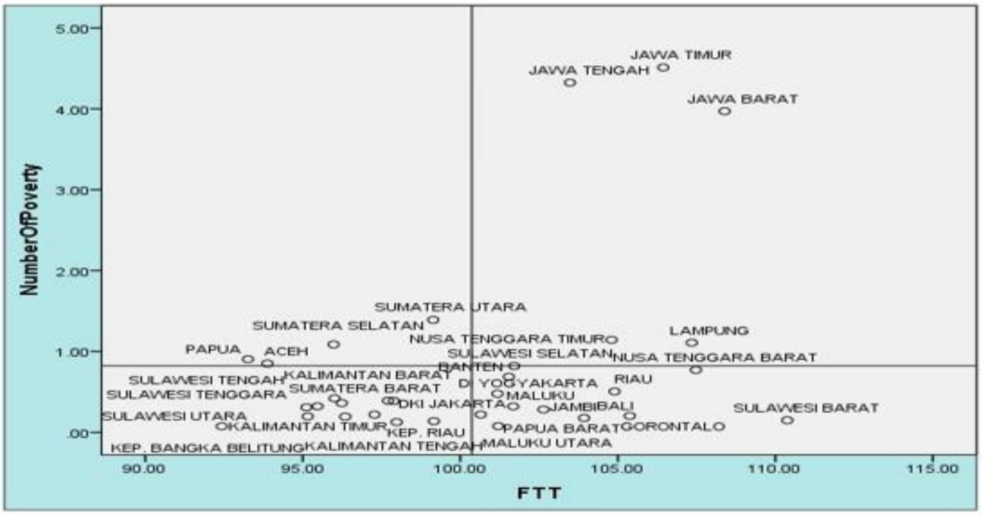

Figure.3 Poverty Patterns and FTTs for the Indonesia average in 2017

Based on Figure 3. it can be seen that provinces in Yogyakarta, Riau, Maluku, Jambi, Bali, West Papua, Gorontalo, North Maluku and West Sulawesi which are in quadrant IV have a low number of poor people and high farmer exchange rates. Based on Figure 4, The provinces of North Sumatra, South

Sumatra, Riau, Riau Island, DKI Jakarta, Bali, East Kalimantan, South Kalimantan and South Sulawesi have low numbers of poor and high economic growth.

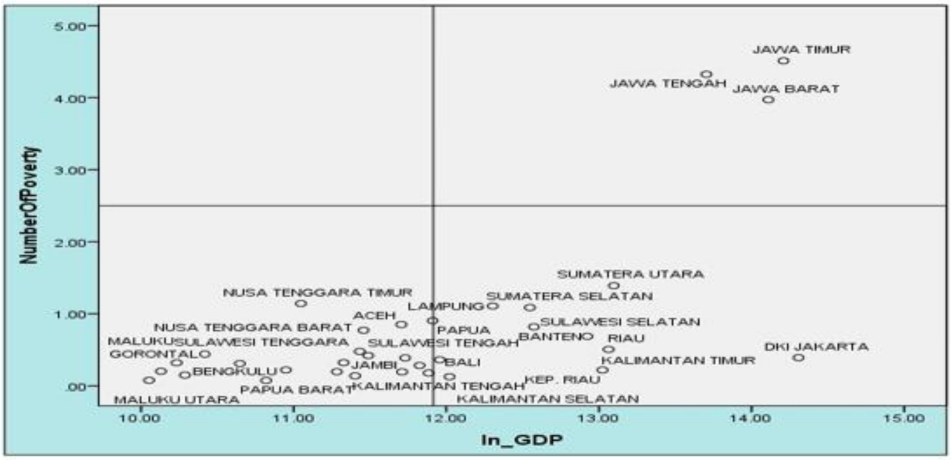

Figure 4. Pattern of Poverty and Economic Growth towards the Indonesia average in 2017

4. Discussion and Conclusion

Based on this study, it can be seen that the phenomenon of poverty in this case the diversity of the number of poor can be explained by the independent variable of 54.70 percent while the rest is explained by other variables outside the model. In addition, based on multiple linear regression analysis it was found that the overall independent variables significantly influence the number of poor in Indonesia in 2017. Individually (partial) which affects the number of poor people is HDI, FTT, and Economic Growth. Based on the poverty pattern of Riau and Bali provinces, it is a province that has high HDI, FTT, and economic growth values and a relatively low poor population.

Especially for the government can do more policies to increase the value of HDI in each province, for example in terms of education, improving health, and decent living standards for the community. For further research, it is better to use more independent variables related to poverty so that they can better explain the diversity of poverty in Indonesia.

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The need for a new conceptual statistical framework for macro-prudential purposes

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Abstract

The System of National Accounts provides "a comprehensive conceptual and accounting framework for compiling and reporting macroeconomic statistics for analysing and evaluating the performance of an economy"[2]. It was established as a response to the Great Depression in the 1930-ies. The financial crisis during the first decade of the 21-th century also highlighted significant weaknesses of the statistical system and led to a number of new statistical initiatives. This article provides a brief overview about the current macro-economic statistical system and the related initiatives over time. It highlights the shortcomings of the current residency based statistical framework and proposes the development of a new satellite financial account that provides a consolidated, national view of the financial positions of the entities that have their ultimate owner in one territory/country. In its final conclusion the author urges the statistical community not to let the opportunity that was created by financial crisis go without renewing the conceptual framework of our macro statistics.

Keywords

System of National Accounts (SNA); residency and nationality based or consolidated statistics; financial crisis; interconnectedness

1. Introduction

The System of National Accounts was established as a response to the Great Depression in the 1930-ies. The financial crisis during the first decade of the 21-th century also highlighted significant weaknesses of the statistical system and led to a number of new statistical initiatives. Nonetheless, these developments were mostly limited to the increase of the coverage of already existing statistics rather than the development of new statistical framework. **What is the problem, why to develop a new framework?** Since the System of National Accounts is collected and compiled on a residency basis, it provides only limited insight to the true nature of the economic developments and the financial risks in our internationally connected world. **What could be**

[1] European Central Bank, Micro-Prudential Supervision IV, SSM Risk Analysis Division. This paper is written in the private capacity of the author and should not be reported as representing the views of the European Central Bank (ECB). The author had been Head of Statistics in the Central Bank of Hungary from 2009 - 2014.

[2] Reference 1

the solution? A satellite financial account should be developed that provides a consolidated, national view of the financial positions of the entities that have their ultimate owner in one territory/country.

2. Methodology

This article provides a brief overview about the current macro-economic statistical system and the related initiatives over time. The impact of the difference between a residency and nationality based statistical concept will be illustrated with Euro Area data compiled by the author. Finally a proposal is made for the way forward.

3. Quick overview of the current macro-economic statistical system and the ongoing initiatives

The first full System of National Accounts (SNA) guidance was published in 1953 by the United Nations Statistical Committee in response to "the need for international statistical standards for the compilation and updating of comparable statistics in support of a large array of policy needs."[3]. The broad objective of the SNA was (and still is) "to provide a comprehensive conceptual and accounting framework for compiling and reporting macroeconomic statistics for analysing and evaluating the performance of an economy."[2] The SNA provides an overview of economic production and its distribution among consumers, businesses, government and foreign nations. It also shows income distribution aspect of these processes and provides an overview of the financial position of the different economic sectors. At that time, it was the statistical response to the unprecedented downturn in the great depression during the 1930s and subsequently to the effects of the Second World War. The basic architecture of the SNA remained stable since that date[4]. According to David Stocton, this stability could be explained by the fact that the structure of the SNA and the sectors defined by the system are in line with the structures used in economic theory[5] and also because it had been developed parallel to macro-economic modelling and the Keynesian revolution of economic thinking.[6] During the past 50 years, the SNA became the most widely used statistics by monetary policy. Although in recent times, policy makers maintain and use several ten thousands time series: "much of the macroeconomic analysis and forecasting work is organised around national income and

[3] Reference 1.

[4] The guidance has been expanded and updated regularly and have also been complemented by the Balance of Payment and International Investment Position Manual (Reference 2) and the Government Finance Manual (Reference 3)

[5] Reference 4

[6] Reference 5

product accounts and the flow of funds[7] accounts"[8] . One of the corner stone of the SNA is its focus on economic activity of institutional unites (legal entities and natural persons) that are actually resident in the observed territory. The system covers the activity and financial position of these entities within the boundaries of this territory and also their interaction with the rest of the world on an immediate counterparty basis.[9]

The 2007-2009 financial crisis highlighted significant weaknesses of the statistical system. The G20 Countries initiated a project that aimed to identify and rectify the major financial and economic information gaps. The outcome was the so called G 20 Data Gaps Initiative (DGI) [10] that included 20 recommendations to be implemented in its first phase from 2010 to 2015. After fulfilling the first mandate, additional 20 initiatives have been launched in 2015[11].

If we investigate these initiatives further, we will find that most of the recommendations focused on the implementation of already existing statistical frameworks where the ongoing collection needed some enhancement. On the other hand, the recommendations also covered areas where the conceptual/statistical framework needed development[12].

The financial crisis of the first decade of the 21st century was rooted in the interconnectedness of the global economy. It had led to renewed interest in information that could serve as a basis of macro-prudential analysis. The Statisticians of the European Central Bank has organised a conference in 2010 with high level participations from policy makers from all over the world titled "What Did the Financial Crisis Change?"[13]. One of the main conclusions of the conference was that central bank statistics that had been established to support the monetary policy of the central banks from now on should also provide statistical support to the macro-prudential authorities, e.g. Systemic Risk Boards, that were established as a response to the crisis. The speakers

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[7] Flow of funds of the US corresponds to the Financial Accounts in the European statistical terminology.

[8] Reference 4

[9] "The concept of residence in the SNA is not based on nationality or legal criteria. An institutional unit is said to be a resident unit of a country when it has a centre of predominant economic interest in the economic territory of that country; that is, when it engages for an extended period (one year or more being taken as a practical guideline) in economic activities on this territory." Reference 6

[10] Reference 7

[11] Reference 7. These initiatives can be grouped into the following categories: Monitoring and reporting progress on this initiative (I.1 and II.1), Monitoring risk in the financial sector (I.2-7 and II.2-7 , International network connections (I.8-14), Sectoral and other financial and economic datasets (I.15-19), Vulnerabilities, interconnections and spill-overs (II.8-18), Communication in official statistics (I.20 and II.19-20).

[12] Reference 7. These were the following: Tail risk (I.3), Aggregate Leverage and Maturity Mismatches (I.4), Structured products (I.6), Data for Global Systemically Important Financial Institutions (G-SIFIs) (1.8-9 and II.4), Financial and Nonfinancial Corporations crossborder exposures (I.13-14), Distributional Information (I.16-II.9), Shadow Banking (II.5)

[13] Reference 8

stressed their appreciation of the current statistical system, however also highlighted that the current statistical system is not focused on financial risks, interconnectedness and spill overs[14].

Almost all of the participants highlighted the shortcomings of the current residency based macro statistical system due to its limited ability to provide full information on the cross border exposures of the multinational enterprises.

As a response to the DG 20 data GAAP initiative I.13, the Interagency Group on Economic and Financial Statistics (IAG) investigated the issue of monitoring and measuring cross-border, including foreign exchange, derivatives, and exposures of nonfinancial and financial corporations, with the intention of promoting reporting guidance and the dissemination of data. IAG also issued a reference document titled "Consolidation and corporate groups: an overview of methodological and practical issues"[15]. The paper acknowledges the usefulness of the current residency based statistics, however reminds the readers that "the globalisation of activities implies that a growing part of corporates' domestic activities is now governed by parent companies located abroad, rather than by the (resident) reporting institutional units, which are just affiliates of these parent companies. Symmetrically, residents' actions are increasingly influencing the actions of other 'controlled' agents located in other sectors and/or countries". According to the reference document, a "nationality based approach" should complement the current residency based statistics, as originally proposed by Cecchetti, Fender and McGuire[16]. The residential based statistics summarises the financial position of all economic units that is resident in a country regardless of the nationality of the owners and fails to capture the activity of the subsidiaries that belong to these entities. On the contrary, the proposed nationality-based approach is envisaged to display information only on domestically controlled entities, but it is expected to provide full consolidated view of these entities, also reflecting the activity of affiliates and eliminating all intragroup balances. The paper also emphasises that residency and nationality based statistics are complementary and should be reconciled to each other. The final conclusion of the reference document is that while the compilation of nationality based statistics would be useful, it is impossible "to reconcile aggregated data compiled on a residency basis and those constructed under the corporate group approach (one would have to

[14] Reference 8. The participant agreed in the need for wider application of harmonised statistical standards, more focus on financial risks (liquidity, foreign currency and solvency), more granular information instruments that are key for the understanding of the interconnectedness of the market like, derivatives, securities, securitization vehicles, information on the distribution of main macro aggregates, information on residential and commercial real estate price indexes that played important role in the 2007-2009 financial crisis , and also for more information on the financial sector outside of activity of traditional credit institution (shadow banking).

[15] Reference 9

[16] Reference 10

split a corporate group into the various subgroups residing in each of the relevant countries). That means that further research needs to be done to facilitate the comparison between the existing business accounting, supervisory and statistical standards and practices, and to combine them in an analytically useful way."[17] By publishing this reference document the DG-20 initiative was considered fulfilled. In the second set of G 20 data initiatives, we can find the continuation of this effort aiming to improve data on cross border exposures of non-bank corporations (II.14) as follows: "The IAG to improve the consistency and dissemination of data on non-bank corporations' cross-border exposures, including those through foreign affiliates and intra-group funding, to better analyse the risks and vulnerabilities arising from such exposures including foreign currency mismatches."[18] The ultimate goal was to investigate the possibility of regular collection of data under a conceptual framework developed in DGI-13[17].

As a follow up of his initiative, Bruno Tissot summarised his proposal on how should one proceed to collect meaningful data to assess consolidated risk exposures as follows: "First, one has to classify economic units by sector and nationality…. Second, one should define the concept of control between two economic units; …Third, one should try to look at information aggregated at the "corporate group" level. …. But a key issue is that the SNA framework, by design, makes it difficult in practice to present *on* a consolidated basis the financial positions of (cross-border) corporate groups, since this would require the re-allocation of institutional units that are residents in various economic territories and captured by different statistical systems."[19] [20]

The European Committee on Monetary, Financial and Balance of Payments Statistics (CMFB) dedicated a two-day workshop to the impact of globalisation on macro statistics in 2008 July. Participants acknowledged that "globalisation has led to tighter integration of economies worldwide"[21]. It was also recognised that activity of the Multinational Enterprises (MNEs) are global and they contribute to very significant portion of the overall GDP of developed economies, however their operation can all cause significant disruption of the statistical data[22]. The need for ownership / nationality based concept as a complementary measure and the collection and dissemination of consolidated MNE data was widely recognised by the participants.

[17] Reference 9

[18] Reference 7

[19] Reference 11

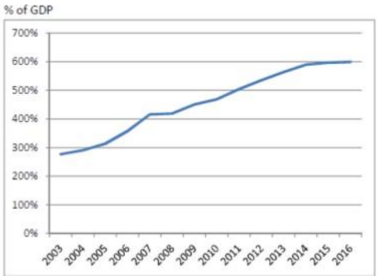
[20] Another important element is the maturity breakdown: original maturity in SNA, residual when risk-based.

[21] Reference 12

[22] Examples mentioned were sudden relocations of different subsidiaries, transfer pricing, offshoring, contract manufacturing, management of intellectual properties within the group, tax optimisation.

The concept of consolidation is already applied by the SNA. Special Purpose Entities (SPEs)[23], that are resident in the same economy like as their parent, should not be treated a separate institutional unit but should be consolidated with their parent. On the other hand SPEs resident in an economy other than their parent are treated as separate institutional unit by the official statistics. The main reason of this inconsistency is to avoid practical data exchange problems. Please find below the development of the total assets of SPEs compared to GDP in The Netherlands as an illustration of the significance of this issue.

Figure 1 – Total assets of SPEs compared to GDP in Netherland[24]



4. The difference between a residency and nationality based statistical concept based on the example of the Euro Area

In the following we make an effort to illustrate the magnitude of the differences between the residential and nationality based consolidated information with respect to the Euro Area.

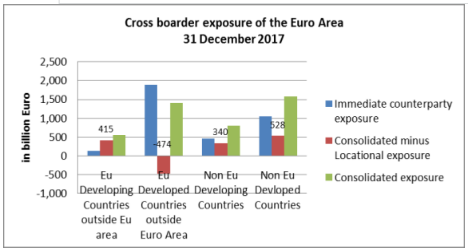
Table 1 and Chart 1 and 2 - Cross Border exposure of the Euro Area by group of countries[24]

	Immediate counterparty exposure	Consolidated minus Locational exposure	Consolidated exposure	Immediate counterparty exposure	Consolidated minus Locational exposure	Consolidated exposure	Immediate counterparty exposure 2017/2014	Consolidated cross border exposure 2017/2014
in billion Euro	31-Dec-17			31-Dec-14			%	%
Eu Developing Countries outside Eu area	130	415	545	115	395	511	113%	107%
Eu Developed Countries outside Euro Area	1,884	-474	1,410	2,220	-926	1,294	85%	109%
Non Eu Developing Countries	464	340	804	416	307	723	111%	111%
Non Eu Devloped Countries	1,054	528	1,582	966	600	1,565	109%	101%
Total Exposure	3,532	808	4,340	3,718	376	4,093	95%	106%

[23] "SPEs are defined as having no employees and no non-financial assets; having little physical presence beyond a "brass plate"; always related to another cooperation" Reference 13 [24] Source: The Nederlandsche Bank 2018 Reference 13

[24] The coverage of the BIS data collection is, however, not stable neither in respect of reporting countries nor for banks, so the data in the table and chart below should be interpreted with care. However the differences between the locational and consolidated cross border exposures and their development are striking.

Source: Own estimate based on the Locational and Consolidated total exposure staistics of the BIS



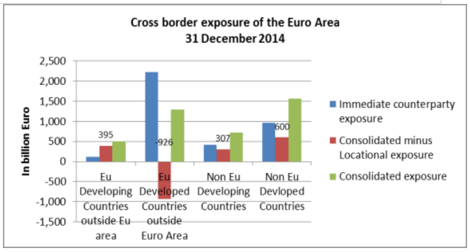
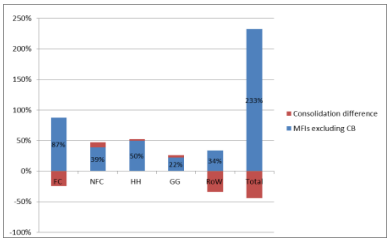


Table 1 illustrates the major differences between exposures on immediate counterparty basis and the consolidated view that includes all exposures of the domestically owned entities including the exposures of subsidiaries, and excluding intragroup balances. Interestingly the immediate counterparty exposure to EU Developed countries outside the Euro area is higher compared to the consolidated exposure. This can be explained by the high number of banking subsidiaries in these countries that have further subsidiaries on other territories. The decrease of this difference from 926 to 474 billion Euro from 2014 to 2017 could be mainly explained by the relocation of banks from the UK as a preparation for the Brexit. In the following the differences between the debt instruments held by the Monetary Financial Institution excluding Central Banks will be presented according to the residential view of the SNA and in a consolidated national view by the issuer of the debt instruments for the Euro Area at the end of 2017.

Table 2 and Chart 3 Debt instrument held by the Monetary Financial Institution excluding Central Banks by the issuer sector of the debt instruments at 31 December2017 compared to GDP[25]

Debt instruments held per GDP in 2017	FC	NFC	HH	GG	RoW	Total
MFIs excluding CB	87%	39%	50%	22%	34%	233%
Consolidation difference	-25%	9%	2%	4%	-34%	-44%
Consolidated Banking Data - Gross carrying amount	63%	47%	52%	26%	0%	188%

[25] Source: Own estimate based on the Euro Area National and Financial Accounts, Eurosystem aggregated BS, Consolidated Banking Data of domestic banking groups and stand-alone banks in the Euro Area. Due to methodological differences and inconsistencies between the data source the results. The following abbreviations are used in the table and the chart FC: Financial Corporates, NFC: Non-Financial Corporates, HH: Households, GG: General Government, RoW: Rest of the World



Contrary to our expectations, the consolidated debt balance held by Monetary Financial Institution excluding Central Banks decreases compared to the residency based view due to the significant impact of eliminating of the intra group balances and by the exclusion of instruments not ultimately held domestically. On the other hand, a significant increase in the debt issued by non-financial corporations, households and general government can be observed.

5. Conclusion

The financial crises highlighted several weaknesses of the current statistical system and resulted in high numbers of new statistical initiatives all over the world. Existing initiatives have been enhanced, several new data collection procedures including the collection of granular information have started or have been expanded. The need for a renewed National Accounts System that shows a consolidated, national view of the financial positions of the entities that have their ultimate owner in one territory/country has been widely acknowledged. This new satellite financial account could also serve as a reference data to the many newly collected granular information. The statistical community and the decision makers are recommended to take the necessary steps to move forward[26]. Consolidated information of the major financial and non-financial multinational entities are widely available and the creation of experimental consolidated national account would be feasible. The statistical community should not let the opportunity that was created by financial crisis go without renewing the conceptual framework of our macro statistics.

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[26] The ambitious goal of creating new world wide statistics based on consolidated / national view was diminished to the goal of publishing additional sectoral breakdowns in the International Banking Statistics (BIS) , including non-bank counterparties, to enhance the security statistics with measures of currency mismatches and funding risks (BIS) and to implement a revised Report for
Other Financial Corporations, including items on cross-border exposures by 2018 according to the First Progress Report of the
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"Information and communication technology satellite account exercise opportunities and risk from alternative methods". Case study: Palestine

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Abstract

The importance of the Information and Communication Technology (ICT) sector in the Palestinian economy and the global economy arose from the fact that it involves in many economic activities such as manufacturing, trade (whole sale and retail), telecommunication services and media. The urgent need to study Information and Communication Technology satellite accounts (ICTSA) appeared recently due to the rapid global development in the field of information and communication technology, which led to the development in the culture and civilization of the community and thus raising the level of science and knowledge. The advantage of a satellite account is the ability to isolate the ICT supply and demand in various industries, it allows the component of supply and use tables (SUT) to be examined with greater flexibility than the frame work of the national accounts typically allows. [1] So gaining data about its impact on economy in terms of expenditure and production is necessary, which in turn serves decision makers, researchers, and those interested in the development of the information sector. It worth's mentioning that ICTSA in Palestinian Central Bureau of Statistics (PCBS) is still in the study phase and not published yet.

Keywords

PCBS; data sources; SUT; OECD.

1. Introduction

As the primary provider of official statistics for Palestine, PCBS is striving to implement the Palestinian Information and Communication Technology Satellite Account (ICTSA) to provide accurate and reliable indicators on the status of ICT expenditure in Palestine to ensure the credibility of official statistics and to serve decision makers, researchers, and those interested in the development of the information and communication sector. The absence of recommended guidelines and framework about ICTSA consider as a fundamental obstacle that had appeared, so depending on the recommendations of the Organization for Economic Co-operation and Development (OECD), experiences of other countries and the System of National Accounts (SNA, 2008) were adopted.

2. Information and Communication Technology Satellite Account Methodology

- The aim of this exercise is to isolate ICT activities in the supply- use table of which form the basis of ICTSA. Total Supply in economy consists of total output and import of goods and services, while total Use in economy consists of intermediate consumption, final consumption expenditure, gross fixed capital formation (GFCF) in addition to export of goods and services. But due to the lack of available data about ICT from financial, governmental, and Nonprofit Institution Serving Household (NPISH) sectors, ICTSA as a studying experience in PCBS is implemented only for the non-financial and the household sectors for the year 2017.
- Referring to the recommendations, definitions, and classifications of the OECD that form the basis of the recommended ICT products (goods and services) and activities, these products and activities are classified according to Central Product Classification (CPC) and International Standard Industrial Classification of All Economic Activities (ISIC, Rev.4). In PCBS economic surveys, ICT activities and related activities are classified according to the (ISIC, Rev.4).
- Imports and export data are traditionally classified according to Harmonized System (HS). Data for ICT products had been chosen according to the product classification as described in CPC.
- Data are available for these indicators of ICT activities:
  - ➢ Output
  - ➢ Intermediate consumption
  - ➢ Value added
  - ➢ Compensation of employees
  - ➢ Imports and exports of ICT goods and services
  - ➢ Household final consumption (HFC)
  - ➢ Gross fixed capital formation (GFCF)
  - ➢ Gross Domestic Product (GDP) based on production approach (also known as value added approach) is the summation of value added, that is total differences between gross output value of resident producing unit (measured at producer price) and value of intermediate consumption (measured at purchaser's price).

Data of these indicators is considered as a strong and reliable for ICT goods, while it's weak for ICT services due to these reasons:

1. Import and export ICT services data for the year 2017are preliminary estimates taken from balance of payment.
2. Data for household expenditure for ICT goods and services in Palestine are preliminary data.

3. Data of informal ICT sector are not covered in PCBS surveys.

- ICT specific industries with available ISIC Rev.4 codes are as in the table below:

Table (1): ICT economic activity with compatible ISIC Rev.4 code according to OECD recommendations [2]

ICT Specific Activity	ISIC Rev.4
ICT manufacturing	2610
Telecommunication services	6110,6120,6130,6190
Computer programming, consultancy and related activities	6201,6202,6209
Data processing, hosting and related activities, web portals	6311,6312
Content and media	5811,5812,5813,5819,5911,5912,5920,6010,6020
ICT Related Activity	
ICT trade (Whole sale and retail)	4651,4652,4741,4742
Repair of computers and communication equipment	9511,9512

2.1 Primary data sources

ICT satellite accounts rely on many data sources and variety of data collection and compilation methods in order to cover the recommended sectors. The total data sources are as follows:

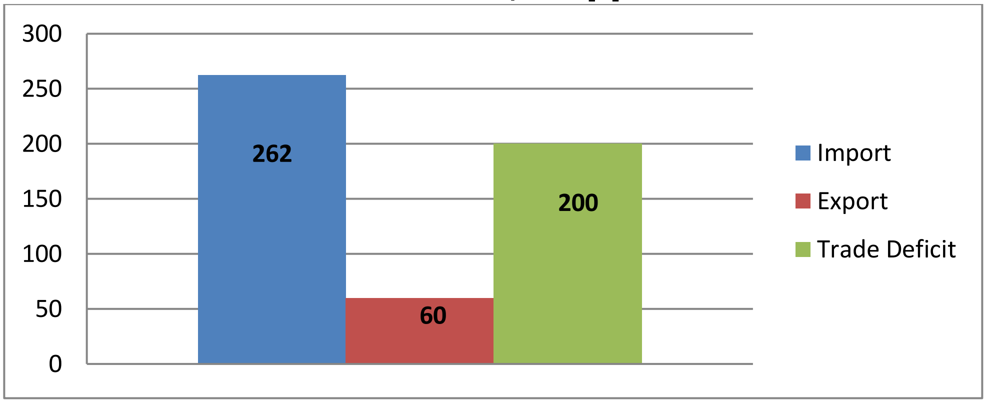
- Import and export data are from administrative records through coordination between institutions in order to build a partnership to enhance the value of official statistics.
- Main economic indicators are from economic surveys series that implemented annually by PCBS.
- HFC are from household expenditure and consumption survey for the year 2017.
- Census 2017.

3. Main Result

3.1 Import and export of ICT products

Import and export data for ICT products are from administrative records, it measures the trade transaction volume between Palestine and the whole world including Israel, in the other hand, data for ICT import and export services are estimated values for the year 2017. Palestine imported a total of USD 262 million of ICT products and services which constitute 4.5% of the total imports of Palestine, while exported of ICT products and services was USD 60 million which constitute 5.6% of total export. ICT trade deficit was USD 200 million in 2017 as in the figure below:

Fig (1): Import, export and trade deficit of ICT products and services in Palestine*, 2017[3]



* Data excluded those parts of Jerusalem which were annexed by Israeli Occupation in 1967.

3.2 Main economic indicators for ICT activities

Economic surveys series implemented annually by PCBS for the enterprises of the private sector. The results of economic surveys show the data of the main economic indicators of ICT specific and related activities for the year 2017 were as in the table below:

Table 2: Main economic indicators for ICT specific and related activities in Palestine*, 2017 [4]

(Value in 1000 USD)

ICT Specific Activity	Output	Intermediate Consumption	Compensation of Employees	Value Added	GFCF
ICT manufacturing	11,829	6,766	1,078	5,063	0
Telecommunication services	585,564	120,330	115,081	465,233	96,629
Computer programming, consultancy and related activities	36,703	2,942	13,813	33,761	417
Data processing, hosting and related activities, web portals	3,071	450	1,407	2,621	0
Content and media	21,357	5,593	13,230	15,764	377
ICT trade (Whole sale and retail)	89,907	19,949	873	69,958	16,655
Repair of computers and communication equipment	13,801	4,274	2,751	9,527	0
Total	**762,232**	**160,304**	**148,233**	**601,927**	**114,078**

*Data excluded those parts of Jerusalem which were annexed by Israeli Occupation in 1967.

- Total ICT output of the ICT sector at current prices was USD 762 million in 2017, telecommunication services constitute 77% of the total ICT output.
- Total value added for ICT specific and related activities for the year 2017 was USD 602 million, it constitutes 4.2 of the total GDP at the current prices, in which GDP at current prices for the year 2017 in Palestine was USD 14,498.1 million.
- Total ICT expenditure (Computer consulting services, and Advertising, and Post, telegraph, telephone and fax+ Internet subscription) for enterprises in non financial sector was USD 145 million, which constitute 3.1% of total intermediate consumption and 19% of total ICT output. ICT intermediate consumption, and intermediate consumption and share of ICT intermediate consumption for enterprises in all economic activities for the year 2017 were as in the table below:

Table 3: Total ICT Intermediate Consumption in All Economic Activities in Palestine*, 2017[4]

(Value in USD 1000)

Economic Activities	Used SIC Division	Intermediate Consumption	ICT Intermediate Consumption	Share of ICT Intermediate Consumption (%)
Industry	05-39	2,805,932	23,075	0.8
Construction	43-41	348,890	2,737	0.8
Trade	45-47	736,877	49,537	6.7
Transport and Storage	49-53	76,784	2,922	3.8
Communication and Information	58-63	130,065	36,044	27.7
Services	(55-56), (68-96)	581,332	31,051	5.3
Total		**4,679,880**	**145,366**	**45.2**

* Data excluded those parts of Jerusalem which were annexed by Israeli Occupation in 1967.

3.3 House hold final consumption on ICT products and services in Palestine

In 2017, preliminary data show that the household final consumption on ICT products and services was USD million 618.9 in Palestine (excluded those parts of Jerusalem which were annexed by Israeli Occupation in 1967) [5].

4. Constraints and Risk

The main constraints and risk associated with ICT satellite accounts in Palestine are:

- No recommended guidelines and framework.

- Lack of administrative records about governmental and NPISH sectors.
- Difficulties in estimating output from household ICT services (informal sector).
- Obstacles in estimating data especially that associated with e-commerce.

5. Recommendations

- Get benefit from the experiences of other countries in ICTSA due to the lack of updated published reports.
- Improvement of data within ICT framework with ensuring the quality.
- Obtaining data for the expenditure of ICT from governmental, NPISH and financial sectors in order to compile ICTSA for Palestine for the year 2017.
- Further investigation and more details about labor/employment, and productivity in the ICT specific and related activities.

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Use of national account data in international comparisons of indicators dynamics and structure GDP (At the production stage)

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Abstract
The system of national accounts (SNA) is an international standard and is the key to economic analysis. It plays an important role in the development and monitoring of economic policies of the countries. Standardization of indicators in SNA allows international comparisons. The article makes an international comparison of the dynamics, structure of GDP and the influence of factors on GDP at the production stage, using data from the national accounts of Ukraine and Poland for 2014-2016. On this basis were drawn conclusions about the efficiency of the use of intermediate consumption, the level of tax burden and the impact of defining factors on GDP.

Keywords
International comparisons, GDP, Dynamics, Structure

1. Introduction

International comparisons of dynamics, GDP structure and the influence of GDP factors at the production stage require relevant data from time series of indicators for individual countries. An important source of such data is of national accounts, where they are made as of today. SNA is used to represent to international organizations national accounts data that meet the standard, internationally accepted concepts, definitions and classifications. National accounts data are widely used for international comparisons of such key aggregates as GDP or GDP per head, as well as for comparisons of structural statistical indicators such as the ratio of investment volumes, taxes, or public expenditure to GDP. As underlined in in SNA 2008, the results of such comparisons are used by economists and other analysts to assess the effectiveness of the economy of the country compared to countries of similar levels of economic development. They can influence public and political opinion about the relative effectiveness of economic programs. In addition, databases, which include country sets of national accounts, can be used for econometric analysis, in which time series of data and cross-classification data are combined, which provides a wider range of observations for the assessment of functional interconnections [3, p.5].

The objectives of this research are international comparisons of indicators:
1) the shares of GDP and intermediate consumption in the output.
2) the efficiency of production.
3) the tax burden.
4) defining factors GDP.

The fulfilment of these tasks will help to understand at which level these economies was at the time of the survey, to analyse their dynamics, structure and impacts factors on GDP.

2. Methodology

In order to solve these tasks, the data of the production accounts and the generation of income account of the national accounts of Ukraine and Poland were used. The statistical agencies of Poland and Ukraine use the European system of national accounts [6]. The production account occupies a special place in the SNA because it is the first account among other accounts of current operations. It does not cover all operations related to the production process, but reflects only the result of the production of goods and services (output) and use of goods and services in the production of this output (intermediate consumption). Production account at the level of the country's economy as a whole is shown below (Table 1).

Table 1.

Production account

Uses	Resources
Intermediate consumption	Output at basic prices
Gross domestic product at market prices	Net taxes on products and imports
	Gross output at market prices
Total	Total

Source: [6, p.231]

The resource part of the consolidated account comprises the output of goods and services and taxes less subsidies on products and imports. The use section shows the intermediate consumption of goods and services. Balancing item is Gross Domestic Product. At the level of sectors and types of economic activity, the balancing item in the production account is the gross value added. The generation of income account also linked to the production process (Table 2). It shows how GDP is distributed between labor (wages), capital (operating surplus or mixed income) and public administration (taxes on production and imports less subsidies in so far as they are included in the assessment output).

Table 2.

Generation of income account

Uses	Resources
Compensation of employee	Gross domestic product at market prices
Net taxes on products and imports	
Operating surplus or mixed income	
Total	Total

Source: [6, p.233]

The resource part includes the gross domestic product at market prices. The use includes primary income from production and shows the distribution of GDP to pay wage earners, taxes and subsidies on production and imports and operating surplus or mixed income (balancing item).

There is a problem of converting data in national currencies into one currency, comparing indexes of national accounts, in absolute terms because neither market nor fixed exchange rates reflect the relative internal purchasing power of different currencies. Converting GDP or other statistical data into one currency using exchange rates, the prices at which goods and services are valued in higher income countries are generally higher than in countries with a relatively low income [3, p.5]. This leads to exaggeration of the differences between their real incomes. Therefore, data calculated using exchange rates cannot be used for international comparisons of indexes of national accounts in absolute terms. In international practice, this problem is solved by purchasing power parity (PPP), which is an index of currency conversion. It is necessary in order to equal the prices of a general basket of goods and services in two countries under consideration. But PPPs are mainly used for GDP recalculations. The ICP is a worldwide statistical initiative led by the World Bank under the auspices of the United Nations Statistical Commission, with the main objective of providing comparable price and volume measures of gross domestic product (GDP) and its expenditure aggregates among countries within and across regions. Through a partnership with international, regional, sub-regional and national agencies, the ICP collects and compares price data and GDP expenditures to estimate and publish purchasing power parities (PPPs) of the world's economies [4]. In 2018, the ICP celebrates the 50th anniversary of its inception in 1968 as a joint venture of the United Nations and the University of Pennsylvania, under the leadership of Irving Kravis, Robert Summers and Alan Heston. The program has come a long way since then and has evolved into the largest statistical partnership in the world with the participation of about 200 countries, 20 global, regional and sub-regional agencies, and renowned experts. In recognition of the ICP's relevance and impact, the United Nations

Statistical Commission (UNSC) instituted the program as a permanent element of the global statistical work program in 2016[5].

Due to the fact that, a problem of converting data in national currencies into one currency, comparing indexes of national accounts, in absolute terms, only the relative indicators were used to solving the problems of our research.

The structure of production in Ukraine and Poland was calculated as the share of GDP and intermediate consumption in the output according to national accounts data in market prices for 2014 and 2016. The choice of these years was based on the desire to show how the results of economic reforms affected the structural economy of Ukraine compared to similar changes in the Polish economy.

Efficiency of production was calculated using the coefficient of coordination, as the ratio of GDP to intermediate consumption. The level of tax burden was also calculated using the coefficient of coordination, as the ratio of the product tax balance to GDP.

For the assessment of the impact of factors on GDP we formulate the hypothesis that the gross value added at the level of the institutional unit or branch of economy (VA) are influenced by the following factors: labor costs (we use the indicator of income formation - wages of hired workers - W), productivity (output divided by unit labor costs -P) and the share of gross value added in output (dVA).

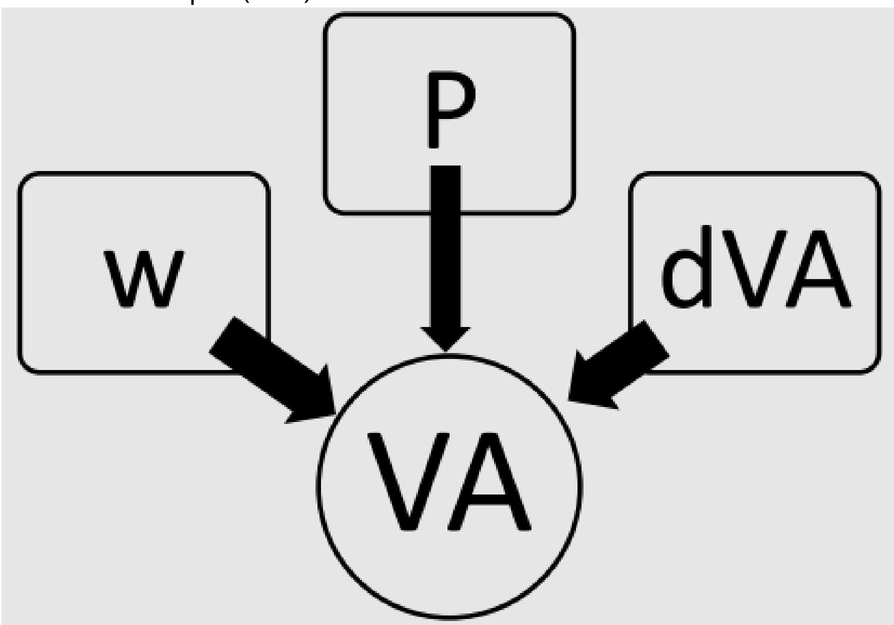

Figure 1. Model of the relationship of factors Gross Value Added

International comparisons of performance at a level lower than the country level, such as industry level, are problematic. PPPs are calculated on the basis of data of the use of GDP. Thus, there are no PPPs for individual industries contributing to GDP. Therefore, we assume that labor productivity at the sectoral level will be calculated as the ratio of the output to the payment of wage earners.

Gross Value Added (VA) can be presented as a product of:

labor costs (wages of wage earners - W), labor productivity (output per unit labor costs -P), and the share of gross value added in gross output (dVA):

$VA = \Sigma W \; x \; P \; x \; dVA$

A comparison of the two VA's values in the reporting and baseline periods can be performed in absolute and relative terms. Analysis is performed using the method of chain substitutions, the feature of which is that the left first in a chain of factors should always be the primary sign and the following two factors that stand next to it. As a result of multiplication, the product must represent a real economic value.

Growth VA in absolute terms will look like:

$\Delta VA = \Sigma VA_1 - \Sigma VA_0 = \Sigma W_1 P_1 dVA_1 - \Sigma W_0 P_0 dVA_0$ – total change of VA in absolute terms.

The influence of each of the factors is defined as:

$\Delta VA = \Delta VA\,(W) + \Delta VA(P) + \Delta VA\,(dVA)$,

where $\Delta VA(W) = \Sigma W_1 P_0 dVA_0 - \Sigma W_0 P_0 dVA_0$ – change of VA due to changes in labor costs;

$\Delta VA(P) = \Sigma W_1 P_1 dVA_0 - \Sigma W_1 P_0 dVA_0$ – change of VA due to labor productivity;

$\Delta VA(dVA) = \Sigma W_1 P_1 dVA_1 - \Sigma W_1 P_1 dVA_0$ – hange VA at the expense of VA's share in the output.

Change of VA in relative terms will look like:

$$IVA = \frac{\Sigma W1 \mathrm{x} P1 \mathrm{x} dVA1}{\Sigma W0 \mathrm{x} P0 \mathrm{x} dVA0} = IW \mathrm{\,x\,} IP \mathrm{\,x\,} IdVA$$

total change of VA in relative terms.

The influence of each of the factors is defined as:

$$IVA(P) = \frac{\Sigma W1 \mathrm{x} P1 \mathrm{x} dVA0}{\Sigma W1 \mathrm{x} P0 \mathrm{x} dVA0}$$

-VA changing due to changes in labor costs;

$$IVA(P) = \frac{\Sigma W1 \mathrm{x} P1 \mathrm{x} dVA0}{\Sigma W1 \mathrm{x} P0 \mathrm{x} dVA0}$$

-VA changing due to changes in labor productivity;

$$IVA(dVA) = \frac{\Sigma W1 \mathrm{x} P1 \mathrm{x} dVA1}{\Sigma W1 \mathrm{x} P1 \mathrm{x} dVA0}$$

-change of VA due to changes in VA's share of a particular sector (industry, type of activity) in the total output.

3. Result

International comparisons of indicators of dynamics, structure and influence of factors on GDP at the production stage are made on the basis of data of national accounts of Ukraine and Poland in 2014 and 2016.

Table 3.

Comparison of the structure and efficiency of production of Ukraine and Poland in 2014 and 2016, percentage

Indicator	2014		2016	
	Ukraine	Poland	Ukraine	Poland
Output at market prices	100,0	100,0	100,0	100,0
Intermediate consumption	55,4	52,6	56,0	52,8
GDP at market prices	44,6	47,4	44,0	47,2
The level of tax burden on the final product	12,9	10,2	15,2	11,6
Level of efficiency of using the intermediate consumption	80,5	90,2	78,6	89,5

Source: own calculations based on data [1, 2]

The share of GDP in gross output in Ukraine is smaller than in Poland (by 3.2 percentage points in 2016 and in 2014 by 2.8 percentage points), which indicates that the level of efficiency of intermediate consumption in Ukraine is lower. The share of the value of products consumed during this period in the process of production in Ukraine increased faster than in Poland.

Comparison of the efficiency of using intermediate consumption of the two countries by sector of the economy in 2016 indicates a higher level of use of intermediate consumption in the sectors of nonfinancial corporations, general government and households in Poland, but in the sectors of financial corporations and non-profit organizations serving households this indicator is much higher in Ukraine. The indicator of the tax burden on the final product in Ukraine is higher in comparison with Poland in size and in 2 years this gap has increased from 2.7 to 3.6 pp, which indicates the over burdensome taxation of factors of production of the tax system of Ukraine compared with the Polish for business development. The tax burden should be optimal, which would allow the opportunity to invest in expansion of production and stimulation of investment processes.

Analyzing the influence of individual factors on the dynamics of GDP of Ukraine and Poland, we can draw the following conclusions.

Table 4.
Indexes of the influence of individual factors on the dynamics of GDP of Ukraine and Poland for 2015-2016.

Country	IVA	Due to		
		IVA(w)	IVA(p)	IVA(dVA)
Ukraine	1,197633136	1,128163054	1,060723762	1,000805383
Poland	1,027551659	1,075122219	0,965605598	0,989796817

Source: own calculations based on data [1, 2]

Regarding indicators of gross value added changes due to changes in labor costs in 2016 relative to 2015 should be noted greater impact of this factor in Ukraine versus Poland (difference of index by 5.3 percentage points in favor of Ukraine). This suggests that the expansion of GDP growth in Ukraine is more strongly influenced by the extensive factor of the rate of economic growth compared with Poland. In assessing the impact of labor productivity indicators on the dynamics of gross value added (intensive factor), it can be noted that the situation in Ukraine is better than in Poland. While there is a negative indicator in Poland (96.6%), in Ukraine, it has a tendency to increase (106.1%). Analysing the indicators of the share of gross value added in the volume of output (intensive factor), it can be said that the effect of this factor negatively affected the dynamics of gross value added in Poland, and in Ukraine it has practically not changed.

Thus, comparing the overall impact of factors on the dynamics of GDP in two countries, we note that in Ukraine compared with Poland, the GDP dynamics are heavily influenced by intensive factors than extensive ones.

4. Discussion and Conclusion

Thus, the paper shows how national accounts data can be used for international comparisons of various indicators of the economic development of different countries.

From our point of view, it is necessary to take into account the scale and specificity of the development of economies of compared countries. Otherwise, such comparisons will not be of practical value.

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Pension funds in Morocco: reforms and challenges

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Abstract

In Morocco, like in many countries, the sustainability of pension systems is questioned and a reform is important in response to alarming results of different actuarial reviews made on Moroccan pension plans. The problematic of financial balances of Moroccan retirement plans constitutes a threat of their future. The basis of this threat is the choice of a contribury pension scheme and the beginning of a demographic transition characterized by the decline of fertility and the increase in life expectancy.

This exploratory research aims to deepen understanding of the current situation of Moroccan pension system and to identify the strategic choices and the major axes of reform. The present research addresses the following main question: **"to what extent the parametric reform could reply to the financial sustainability of Moroccan pension schemes?"**

The methodology is based on the use of a reflection engaging in deeper our understanding of factors that surround the conduct of the reform, its quality and pertinence of its results for the specific economic and political interlocutors. Moreover, the diffusion of results to a wide audience and particular users in social and political contexts surrounding the issues of public policy. This case study examines the impact of the process of reflection on the reform policies of the civil pension schemes managed by the Moroccan Pension Fund (CMR) with a particular focus on the period 2011-2060.

To do this, we proceed to the analysis of the current situation of the CMR and the study of its future financial health through demographic and financial projections. The data used include demographic and financial data Moroccan of High Commission plan, and direction Insurance and Social Welfare of Ministry of Economy and Finance.

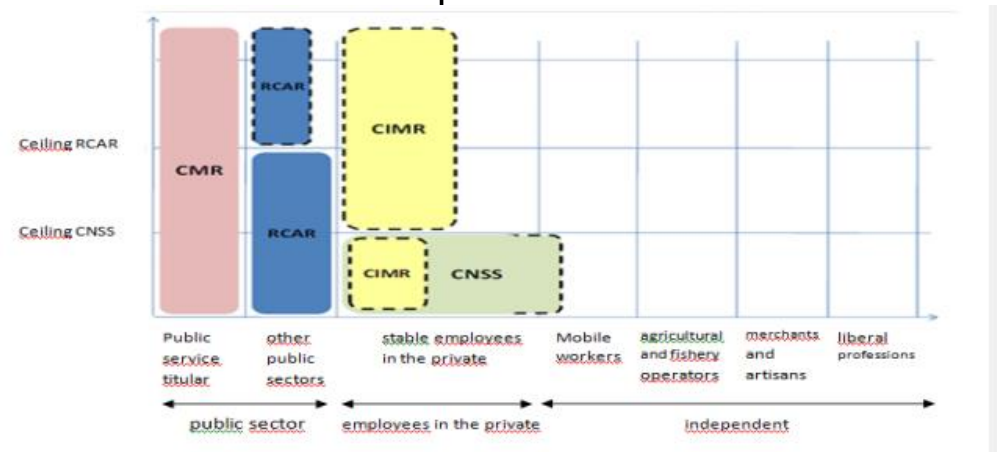
The evaluation indicates that on the basis of the found results, it appears that scenario of parametric reforms for the civil pensions scheme managed by the Moroccan Pension Fund (CMR), helped contribute to the delay of dates appearance of deficit and depletion of reserves. However, research actuarial balance over a very long period in relying solely on changing parameters of the system is a difficult mission.

Keywords
pension plans, pricing, operating parameters, actuarial equilibrium, parametric reforms

1. The pension sector stakes in Morocco

Face to the fragility of financial equilibrium and the low efficiency that characterize the pension system in Morocco, particularly in terms of the coverage of the active population, the Moroccan government realized an assessment mission on the situation of the pension plans in order to stop the constraints they know and propose reforms to improve efficiency and reduce the imbalances. The Retirement sector in Morocco, currently has four general plans (Moroccan Pension Fund "CMR", Collective Retirement Allowance Plan "RCAR", National Social Security Fund "CNSS" and Interprofessional Moroccan Pension Fund "CIMR").

Schema 1: Presentation of the current pension sector in Morocco

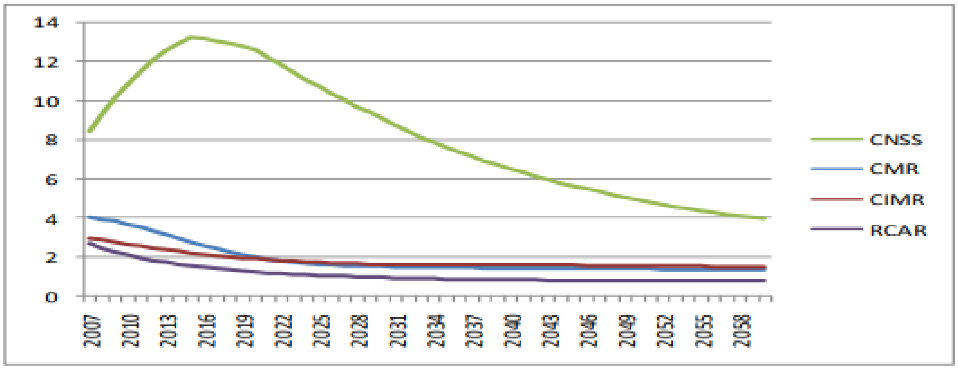


The concepts of balance and sustainability of these plans were not on the agenda at least at the moment of their creation. Also, as the demographic situation was very favorable during the first years of creation of pension plans (number of active much higher than retirees), the actuarial balance was not even checked or wanted by the managers of these regimes. Similarly, management methods, based on an annual balance logic without any concern of future obligations under these plans of their affiliates, have favored the absence of a culture of evaluation and verification the long-term equilibrium. In this context, the surpluses in pension plans were used for purposes other than those relating to the missions of these regimes instead of being housed in specific reserves for retirement. Thus, and as an example, the contribution of the state in the CMR, as an employer, was limited for a long period (before 1996) to a balancing subsidy, which helped in the absence of any excess.

Thus, the problem of the balance of pension plans becomes more important from the early 90s, especially following the demographic changes that the Moroccan population started recording and the evolution outlook for this population in the future. The problem of the imbalance of pension plans is increasingly worrying.

However, for several years, Morocco has entered into what demographers call "demographic transition", with fecundity of around 2.19 in 2010, life expectancy at birth is approaching 73 years for men and 75 years for women and a natural growth rate of 1.32%, it is in rupture with the traditional demographic regime characterized by high levels of mortality and fertility. Future developments of the Moroccan population under the impact of changes in life expectancy and fertility rate will have a significant impact on the demography of the Moroccan pension system and its balanced budget.

Schema 2: Evolution of the demographic ratio of Moroccan pension funds (2007-2060)



This rapid demographic transition, coupled with other socio-economic developments hinders the development of social protection. Indeed, demographically, except the CNSS regime, the population of active contributors remains low and mainly grows less quickly. However, retirees for all funds tend to increase at a faster pace than active contributors. In the public sector, this is explained by the stability of the staff of officials and agents with regard of public policy (limiting the weight of wage bill of the public sector in GDP and slowdown in recruitment in the public service). Therefore, the demographic ratio (number of contributors per retiree) deteriorates continuously, to varying degrees, for all plans except the CNSS. This state is accentuated, and will be more accentuated, by improving the life expectancy of the population at retirement age (60 years). The structural degradation of equilibrium of the plans coupled with the deterioration of demographic indicators have a negative impact on the country's macroeconomic situation. Indeed, as shown by several studies including that of the HCP, this degradation will involve a reduction in savings and therefore an investment retraction. The HCP has estimated that the last aggregate will increase from 35% of GDP to 25% in 2050.

2. Simulation of the parametric reform in the case of the Moroccan Pension Fund

The reform of pension systems has the character of a global issue because of three major factors: the change in the demographic structure, the lengthening of life expectancy and insufficient steering instruments often oriented on the short term. In the late 1980s, the pension plans managed by distribution had already started to show signs of weakness affecting their financial equilibrium and their viability and sustainability. Furthermore, it should be noted that in the area of retirement, there is no universal model applicable to all contexts, regardless of the specifics of each country. Each state has built its pension system based on its own economic and social history, its culture and its level of development. The pension issue has also been the subject of great interest to many international organizations. In this context, the World Bank has set up a matrix of reform of pension system based on four components:

- The link with the balance of public accounts;
- The impact on economic growth;
- The contribution to the fight against poverty;
- The political dimension of reform.

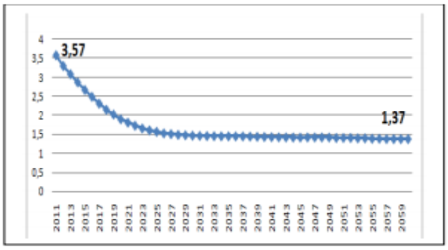
The equilibrium of the civil pension scheme managed by the Moroccan pension fund will be assessed in two stages: first, in the status quo i.e. without introducing any changes to the operating parameters of this regime and in the second place, the approach taken to achieve an actuarial balance in the context of a parametric reform. it should be noted that the simulation work of equilibrium of civil pension scheme are made by the actuarial piloting software of pension plans "ATLAS" developed in the direction of Insurance and Social Welfare. The evolution of the civil pension scheme is simulated on the basis of following assumptions:

- The base year = 2011, the projection horizon = 2060
- The rate of evolution of the numbers of active contributors: replacement of retirements
- The evolution of wages rate is equal to 4.5%, Discount rate is 4.55%
- The inflation rate is assumed to be 2% over the projection period.
- Investment return rate is 4.5%
- The mortality table is the TD 88-90

3. Simulation in the context of the status quo

These assessments were carried out in open group: in this scheme, the system receives new affiliations with the assumption of replacing retirements. The amounts of commitments and future contributions are discounted to the date of establishment of the actuarial balance sheet. The results of this simulation as part of the status quo show a deterioration of the demographic report will increase from 3.57 to assets retired in 2011 to $ 2060 from the neighborhoods of 1, which means that the pension of a retiree will currently funded theoretically by the contributions of a single asset.

Evolution of demographic report (2011-2060) on status quo

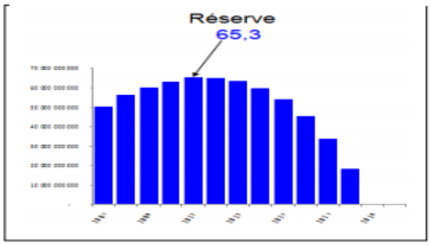


Actuarial commitment and coverage rates (2011-2060) on status

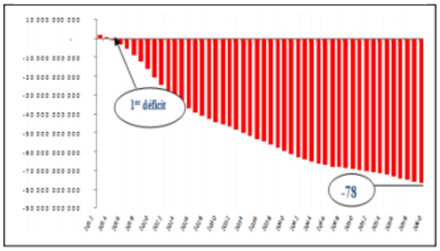
Milliarde de Dh	Régime fermé	Régime ouvert
Affiliés actifs cotisants	390,6	982,1
Retraités	100,5	100,5
Veufs / Veuves	21,9	21,9
Orphelins	1,9	1,9
Total Engagements	**517,4**	**1 108,90**
Cotisations escomptées	-	299,9
Fonds et réserves	50,1	50,1
Total Ressources	59,5	359,4
Taux de couverture (régime fermé) / **Taux de préfinancement** (régime ouvert)	**11,50%**	**32,41%**

Financially, the actuarial study of the scheme reveals the appearance of the first deficit in 2014, the financial balance reaches -78 Billion dirhams in 2060. The fund made possible reserves, however, to support the financing of deficits Register until 2022, when the money runs out and the scheme would be insolvent.

Depletion of reserves (2011-2060) on status quo



Actuarial commitment and coverage rates (2011-2060) on status



To meet the requirements of the principle of scaled premium, the rate of contribution to civil pension scheme is currently set at 20% will guarantee the balance until 2014. In this case the rate that would contribute in 2011 and up 2060 would be approximately 60.3%. Similarly, it appears from the actuarial balance sheet as total plan liabilities amounted to 1066 billion dirhams, the resources of the scheme totaled about them at 445.52 billion dirhams constituted the majority of future contributions. Thus the balance sheet results in an estimated deficit of 620.48 billion dirhams.

Contribution rates of equilibrium (2011-2060) on status quo

Balance sheet of CMR (2011-2060) on status quo

Montant en milliard de DH	Engagements	Cotisations futures	Fonds de réserves	Soldes
Retraités et bénéficiaires	-172			-172
Actifs	-894	371,40		-894
Total	**-1066**	**371,40**	**74,12**	**-620,48**

4. Simulation after introduction of parametric reforms

This parametric reform is to maintain the institutional organization and the system of funding mechanisms. Indeed, without compromising the structure of the system. This way of reform is to harmonize the parameters with the economic and demographic situation of the country and to restore the financial equilibrium of the pension plan. However the success of the parametric reform depends on economic aggregates, employment and productivity growth. Without sustained growth of the economy, parametric reforms cannot guarantee a favorable financial position to the regime.

In this context, this parametric reform measures include a bouquet to implement. The simulation will be run with the same approach in the status quo. The parametric reform proposed for the Civil Pension CMR, could be structured as follows:

- Legal age of retirement: the retirement age will be gradually increased to 63 years;
- Basis of calculation of rights: the rights of liquidation plate must be at least the average wage of 8 years. This measure will be phased in, as is the case in other pension plans in force in Morocco: CNSS (last 8 years) and RCAR (salary career);
- Annuity rate: the annuity calculation of the pension will be reduced to 2% per year of activity for the future rights instead of 2.5% currently;
- Contribution rate: an increase in the contribution rate to 28%.

The combined effect of the proposed measures should result in an extension of the horizon of appearance of deficit of nearly five years. From the simulations, it appears an improvement to the actuarial balance sheet level with a deficit of 305.607 billion dirham down from the status quo or the deficit was $ 620.48. Also, an improvement in the contribution rate from 60.3% in the status quo to 46.7% for the moderate scenario. The first deficit meanwhile will be recognized in 2019 and the depletion of reserves in 2026. However, despite the importance of the adopted changes, the actuarial balance will be guaranteed only over a period of 5 years. This is what motivated us proceeded to develop a second scenario we call aggressive.

5. Conclusion

It is internationally recognized that social welfare is at a critical crossroads in its evolution and a broad objective debate involving all partners (State, Employers and unions) is required to override it, to give it more importance and clarity. This situation, in the absence of appropriate measures, will only get worse over time and jeopardize the rights acquired by the beneficiaries. In this regard, the work done in the context of this article can be grouped into two categories of results: the results in the status quo and the results after the establishment of new parameters. The simulations carried out in this direction to the Civil Pension managed by CMR and according to its current operation (status quo) show the following results:

- The balance of the scheme is questioned (1 deficit in 2014 and the depletion of reserves is planned for 2022);
- The contribution rate necessary to ensure balance throughout the projection period must be located dice 2011 up to 60,3%.

However, the simulation results of the balance of the WRC civil pension scheme on the basis of parametric reforms show a clear improvement of the indicators of the plan:

- The year of occurrence of the first deficit is postponed to 2019 (moderate scenario) and the exhaustion of reserves in 2026 (moderate scenario) and 2036 (moderate scenario);
- The gain in terms of commitment is 51% (moderate scenario) and 81% (moderate scenario).

Also, on the basis of the results given above, it appears that the parametric reform scenario proposed for the civil pension scheme has helped contribute to the delay of onset dates deficit and depletion of reserves and the decrease in amortization payment rate over the entire projection period. However, and despite the importance of the reform measures introduced to the scheme in question, it must be stated that this reform did not solve the problem of the sustainability of this scheme to the extent that its balance remains threatened the dice '2028.

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The demographic dividend and development benefits prospects: A case of Uganda

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Abstract

Using the DemDiv Model, we projected the demographic prospects for Uganda to reap the demographic dividend. Model results showed that maintaining the development path that was observed over the past nine years (2009/10 – 2017/18), the country's GDP will to increase to USD 81 billion in 2040, which falls far below the national development target. Therefore, the country needs to implement strong reforms in the economy and enhance the quality of the human capital to achieve the development targets. Introducing economic reforms without associated improvements in the quality of human capital would increase Uganda's GDP from the 2017 level of USD 27.9 billion to USD 495 billion in 2040. The associated GDP per capita would be USD 6,735. However, the modelling has shown that Uganda's economy would grow faster if the combined model that concurrently prioritizes job-oriented economic reforms and investments in human capital are implemented, starting in 2018. Under this approach, Uganda can attain the vision 2040 target of being a higher middle income country (GDP per capita of USD 9,500) in 2040.

Keywords

Generalized cross validation; High-dimension data; Multicollinearity; Rank regression; Robust ridge regression; Spare model

1. Introduction

The demographic dividend is an opportunity for economic growth, development, and improved well-being that arises as a result of changes in population age structure. When fertility rates decline significantly, the share of the working-age population increases in relation to previous years(1).

Countries that have harnessed their populations to achieve a Demographic Divided have mainly enhanced human capital and accelerated the Demographic Transition through rapid fertility reduction. They have focused on reducing fertility; skilled the youth; fostered a healthy and productive workforce; provided gainful employment; invested in supporting economic drivers of economic growth. A third of the economic growth in "East Asia Tiger" nations: Republic of South Korea, Taiwan & Singapore was due to taking advantage of the demographic window of opportunity and making the right investments(1).

Uganda Vision 2040 recognizes the rapid population growth, young age structure and consequent high child dependency burden as the threats to the achievement of socio-economic development. However, the vision underscores that harnessing the Demographic Dividend is instrumental in facilitating socio-economic transformation(2).

The Vision 2040 acknowledges the progress Uganda has made over the years in improving the population and development situation. Harnessing the Demographic Dividend is central for achieving Uganda Vision 2040, which is set to be achieved within a six medium-term National Development Plans medium(2).

The second National Development Plan covering the period 2015/16 – 2019/20 also adopted harnessing or reaping the benefits of the Demographic Dividend as one of the key strategies to promote productivity, employment and inclusive growth in the country by 2020. This means that the country has to invest in its human capital as one of the key fundamentals that have to be strengthened in order to exploit the identified opportunities to produce a healthy, skilled and productive population that effectively contributes to socio-economic transformation(2).

The demographic dividend benefits prospects that Uganda is looking forward to include to changing its population pyramid from the current broad based bottom to the youth bulge, which is in line with high productivity and lower dependency.

Uganda like many countries embarked on various initiatives to operationalize the Demographic Dividend as a central framework for accelerating socio-economic development in line with the African Union's Agenda 2063. The motivation for pursuit of the Demographic Dividend is based on the experiences from the East Asian countries which were at the same level of development with Uganda in early 1960s, but have since transformed into first world economies. Currently their experiences are what Uganda envisages to emulate in the coming twenty three years.

Uganda's Demographic Dividend agenda started with the review of the 1994 International Conference on Population and Development – Plan of Action (ICPD-PoA). Countries had been implementing the International Conference on Population and Development, and progress was monitored every five years. The 2013 Africa Region conference recommended for countries to focus on harnessing the Demographic Dividend through addressing population age structure. In the case of Uganda, it was realised that the population was growing at a fast rate (3.2%), and it was recommended to not only reduce the growth rate but also ensure change in age structure.

Uganda Vision 2040 underscores that harnessing the Demographic Dividend is instrumental in facilitating socio-economic transformation. The second National Development Plan (NDP II) covering the period 2015/16 – 2019/20 also adopted harnessing or reaping the benefits of the Demographic Dividend as one of the key strategies to promote productivity, employment and inclusive growth in the country by 2020. However, the rapid population growth, young age structure and consequent high child dependency burden are potential threats to the realising of the Demographic Dividend and associated socio-economic development.

2. Data and Methods

We model Uganda's Demographic Dividend projected development prospects using the Dem-Div Model with 2011 as the base-year. The Dem-Div Model has two inter-related components namely the demographic component and the economic component. The demographic component projects the population, its age-sex structure and characteristics. This information is fed into the economic component which projects total production as a function of the labour force, capital formation and total factor productivity.

Base year information

The input indicators for the model are categorised into five groups namely Health and Family Planning, Education, Economic competitiveness, Economy related information and Population size and structure as listed in Table 1.

Table 1: Input Information into the Dem-Div Model

Sector	Input Indicators
Health and Family Planning	1. Contraceptive Prevalence Rate (Modern methods) for currently married women 2. Postpartum Insusceptibility (PPI) in Months 3. Sterility (% of All Women 45-49 who are childless) 4. % of females aged 15– 49 years who are Married (including those in consensual unions) 5. Total Fertility Rate 6. % Births at Risk (avoidable risk only) 7. Infant Mortality Rate 8. Under-5 Mortality Rate 9. Maternal Mortality Ratio 10. Contraceptive Effectiveness Rate for Modern Methods 11. Contraceptive Effectiveness Rate for Traditional Methods 12. Female Life Expectancy at Birth 13. Life Expectancy Difference (Females – Males)
Education	14. Expected Years of Schooling for females 15. Expected Years of Schooling for males

Sector	Input Indicators
	16. Mean years of schooling for females aged 25 years and above 17. Mean years of schooling for males aged 25 years and above 18. Mean years of schooling for persons (both sexes) aged 25 years and above
Global Economic competitiveness Indicators	19. Imports as a %age of GDP 20. Public Institutions 21. Labour Market Flexibility 22. Financial Market Efficiency 23. ICT Use
Economy	24. Capital Formation per capita 25. Initial Employment (18–64 Years) 26. Initial Employment Growth Rate (18–64 Years) 27. Gross Domestic Product per Capita (USD) 28. Ratio of Capital Stock to Population 18 – 64 Years 29. Initial GDP Growth Rate 30. Capital Stock Growth Rate
Population (used for Population projections)	31. Base period population by five year age groups and sex 32. Net Migration (Rates or absolute numbers)

3. Result

Under the **Business as Usual Scenario**, where the prevailing performance in both the economic and demographic environments was projected to continue, Uganda would achieve limited economic growth and development, and the per capita GDP would increase from USD 506 in 2011 to USD 927 in 2040. **The Economic Emphasis Scenario**, in which the country prioritises economic reforms and invests at the level articulated in Vision 2040 and enjoyed by the benchmark countries, projected that per capita GDP would increase to USD 6,084. This would be a sizable improvement from the 2010 income level, but still far short of the Vision 2040 target.

In the **Combined Economic and Demographic Emphasis Scenario (V2040)**, the country would prioritise economic, social and demographic reforms to achieve the socio-economic transformation envisaged in Vision 2040. This would result in the GDP per capita increasing to USD 9,567. This is in line with the Vision 2040 target and would move Uganda into the upper middle-income category.

There has been a delay in accelerating growth and therefore Uganda has not been able to double its GDP even with the introduction of new technologies and the expansion of the infrastructure. Over the past seven years, Uganda's economy has been growing but not as fast as initially projected. By 2017 the GDP per capita was USD 740, which is 24.5 % short of the projection for the same year.

If the progressive assumptions for the 2014 modelling are not changed, then the country would only achieve an estimated GDP per capita of USD 4,583 in 2040. This is 52% short of the Vision 2040 target of a GDP per capita of USD 9,500.

Population Size and Structure

The projection period for the current modelling is 2017 to 2040 and the results presented here refer to the year 2040 (the end year for the Vision 2040).

Given the current structure of population with nearly half of the population aged less than 15 years, the population will continue to grow rapidly for decades, irrespective of whichever development path the country takes. Under the Economy Scenario, the total population is projected to increase to 73.4 million in 2040, with an average annual growth rate of 2.9 % per annum. However, with a combination of economic reforms, fertility reduction and targeted human capital development, the population is expected to grow at a slightly slower rate (2.5 % per annum) giving a projected population of 67.5 million in 2040.

Table 2: Summary Results from the modelling by Scenario, Uganda 2040

Indicator	2040 Projection	
	Economy Scenario	**Combined Scenario**
Total Population (Millions)	73.4	67.5
Average Annual Population Growth Rate 2017 – 2040 (%)	2.9	2.5
Population aged less than 15 years (Millions)	43.0	42.7
Dependency Ratio (%)	71	58
Total Fertility Rate	3.79	2.48
Life Expectancy at Birth - Females	71.1	75.3
Working Age Population (Millions)	38.0	38.2
Share of Working Age Population (%)	51.8	56.6

Table 3: Summary Results from the modelling by Scenario, Uganda 2040

Indicator	2040 Projection	
	Economy Scenario	**Combined Scenario**
Employment (Millions)	22.4	22.5
Gap between Working age Population and Employment (Millions)	15.6	15.7
Gap as a %age of Working Age Population	41.0	41.0
Capital formation per Capita (USD)	1,525	2,210
GDP (USD Billions)	494.5	642.6
Implied Average Annual GDP Growth Rate 2017 – 2040 (%)	13.1%	14.4%
GDP per Capita (USD)	6,735	9,523

4. Discussion

Owing to the high population momentum that the Ugandan population has accumulated over time, it will take several decades before the country can experience significant impact of the effects of the current fertility decline on the number of people entering the working age range.

Under the combined interventions scenario, the net intrants into the labour market (new entrants less retiring population) is projected to increase from 800,000 in 2017 to one and quarter million in 2040 (Figure 5). These are the number of new jobs that the economy should create so as to properly utilise the existing labour force to increase total production. Currently, more than one third of the employed population aged 18-64 years are experiencing some form of labour under-utilisation.

The gap between the working-age population (aged 18-64 years) and the population that would be in employment is projected to increase from 7.9 million persons in 2017 to 15.7 million persons in 2040 under the combined scenario or 20.3 million persons under the Business as Usual scenario. However, the ratio of the gap to the eligible working age population declines, from 48.2 % in 2017 to 41.0 % in 2040 under the combined scenario. Thus, while the demographic bonus can be realized through the increase in the share of the working age population relative to dependent children, there is a need to create enough jobs for the ever increasing working age population. It is only when the working age population is meaningfully engaged in employment that the country can reap the full economic dividend.

Uganda’s economy has been steadily growing for the past ten years. The total GDP in constant 2009/10 prices increased from UGX 38.8 trillion in

2008/09 to UGX 61.4 trillion in 2016/17. Despite the steady growth in the economy, unemployment has remained high at 9.7 %, while the Composite Labour Under-utilization Rate is 35.1 %. Nearly 40 % of the working population are engaged in subsistence farming as their main activity.

Alongside the economic growth, Uganda's population also grew from 24.2 million in 2002 to an estimated 37.7 million in 2017. The rapid growth in the population was a result of high fertility and declining mortality, which in turn led to a young population with more than half of the population being below the age of 18 years,

Uganda's Vision 2040, seeks to transform the country from a 'predominantly peasant and low income country to a competitive, modern and prosperous upper middle income country' by 2040. The vision highlights the potential role of the Demographic Dividend in realising the envisaged socio-economic transformation. It advocates for reducing the dependency ratio by reducing fertility levels, keeping school-age children (particularly girls) in school, and improving the health service delivery system.

Maintaining the development path that was observed over the past nine years (2009/10 – 2017/18), the country's GDP will to increase to USD 81 billion in 2040, which falls far below the national development target. Therefore, the country needs to implement strong reforms in the economy and enhance the quality of the human capital to achieve the development targets. Introducing economic reforms without associated improvements in the quality of human capital would increase Uganda's GDP from the 2017 level of USD 27.9 billion to USD 495 billion in 2040. The associated GDP per capita would be USD 6,735. However, the modelling has shown that Uganda's economy would grow faster if the combined model that concurrently prioritizes job-oriented economic reforms and investments in human capital are implemented, starting in 2018. Under this approach, Uganda can attain the vision 2040 target of being a higher middle income country (GDP per capita of USD 9,500) in 2040.

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A closer look at the National Senior Certificate Mathematics Examination: An item response theory based approach

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Abstract
South Africa's examination system has been defined as a single national examination to facilitate fair and standard assessment in order to provide all learners fair access to higher education. However, no research has been done to investigate examinations item (question) discrimination and the spread of the item category difficulties for the different items across the different school types. The aim of this study is to demonstrate the use of Item Response Theory (IRT) in the analysis of the National Senior Certificate (NSC) Mathematics items in accordance with the models expectations. From the results, it was apparent that the discrimination estimates for the 13 items varied across the different school types and the between threshold parameter estimates reflected a considerable range of item category difficulties and learner abilities.

Keywords
Mathematics; Quintile; Item Response; Graded Response; Latent Trait.

1. Introduction

One of the most challenging tasks facing the Department of Basic Education is the development of fair, effective and quality assessment tools for the National Senior Certificate (NSC) to evaluate learner performance and cognitive abilities. Studies and reports (DBE, 2018; Hunt et al., 2011; Mji and Makgato, 2006; Sasman, 2011) often make use of means and overall pass rates as a measure of performance. However, one may be interested in the underlying latent constructs or latent variables which are thought to influence the observable indicators (Embretson and Reise, 2000). That is, ascertaining if the examination was adequately designed to measure the intended learner aspects (Geremew, 2014).

Item Response Theory (Birnbaum, 1968; Embretson and Reise, 2000) is used to design, analyse and score assessment in the form of a test or questionnaire, to measure the respondents abilities or other latent traits. It is commonly used to model the probability of a correct response to an item by relating certain item characteristics to learner characteristics (Hambleton et al., 1991; Reckase, 2009). IRT rests on the postulate that a learner's score in item i is influenced by both learner and item characteristics. IRT can be divided into two branches namely, unidimensional and multidimensional. In brief, unidimensional IRT requires the items to measure one latent construct with multidimensional IRT models describing more than one latent construct (Wilson and De Boeck, 2004). IRT can be used to model both dichotomous and polytomous items.

Our first approach, using the Quantile Regression approach, revealed that School Type and Education District where the school is located, are the significant factors associated with learner performance in Mathematics in the Western Cape (WC). However, many other concerns regarding the characteristics of the learners or the characteristics of the items (questions) that make up the examination where not answered. Item Response Theory (IRT) attempts to measure the latent construct, the appropriateness of the items and can provide useful analytics on item bias for the learners from different school types. This research introduces an IRT approach, specifically the Graded Response Model (GRM), and shows how it can be applied to the learner marks in the NSC Mathematics. The data for this research is from the Western Cape Education Department (WCED), for the year 2009. To our knowledge this is the first to simultaneously examine the appropriateness of the NSC Mathematics questions and the latent construct of the learners from the different school types by looking at the learner and item characteristics.

2. Methodology

We specifically use the Graded Response Model (GRM) which is appropriate for items whose response/scoring categories are ordered and items need not have an equal number of categories. For the GRM, each item i is described by one discrimination (slope) parameter, α_i, and $j = 1, \dots, m_i$ between category threshold parameters, β_{ij}, where $R_i = m_i + 1$ is the total number of scoring categories for item i. Basically, item i is treated as a series of $m_i = R_i - 1$ dichotomies. The GRM is an extension of the two-parameter logistic model (Geremew, 2014; Cagnone and Ricci, 2005; Samejima, 1969) for items with polytomous response categories, one discrimination parameter, and multiple between threshold parameters (Birnbaum, 1968). One goal of fitting the GRM is to determine the location of the threshold (β_{ij}) parameters on the latent trait scale. These threshold parameters represent the trait level a learner needs to score in or above threshold j with probability of 0.5. Samejima's (1969) GRM is given by the following equation:

$$P_{ir}(\theta) = P_{ir}^*(\theta) - P_{i(r+1)}^*(\theta)$$

where

$$P_{ir}^*(\theta\,) = \frac{e^{\alpha_i(\theta-\beta_{ij})}}{1+e^{\alpha_i(\theta-\beta_{ij})}}$$

are the m_i curves describing the probability of a learner scoring ($r = j = 1, \dots, m_i$) in or above category threshold j for an item i, conditional on the learners latent construct. IRT rests on the assumption of unidimensionality of the latent traits and local independence. Unidimensionality of the latent traits implies that the examination items collectively measure only one latent trait that influences the learner scores to, with other factors being treated as random errors (DeMars, 2010). The local independence assumption indicates that if the assumption of unidimensionality holds then a learner's score in one item will be independent of their score in another item.

3. Data

The South African school system is divided into public government schools and independent (private) schools, with the public government schools being subdivided into five categories referred to as 'National Quintiles' (NQ1, NQ2, NQ3, NQ4 and NQ5). Schools classified as Quintile 1 (NQ1) are known to be the 'poorest', with those in Quintile 5 (NQ5) being the 'least poor' government schools (WCED, 2018). The data used in this study is that of National Senior Certificate (NSC) Mathematics at individual learner level, question by question, collected by the Western Cape Education Department (WCED). The data used has record of six different school types (namely, NQ1, NQ2, NQ3, NQ4, NQ5 and Independent). The NSC Mathematics Paper 1 consisted of 13 items (questions). The 2009 NSC Mathematics Paper 1 tested on items which covered topics on "Algebra and Equations", "Patterns and Sequences", "Functions and Graphs", "Annuities and Equations" and "Linear Programming". The data was presented as the raw mark captured for each item at the individual learner level. These raw marks were then polytomously scored into R_i ordered scoring categories for the different items, taking into consideration the different item weights to be appropriate for the GRM analysis. These categories were created and coded as shown in Table 1. The polytomously scored items resulted in some items have different number of scoring categories.

Table 1: Creation of Graded Scoring Categories for the Different Items.

Graded score category	Exam score
1	0 - 10
2	10 - 20
3	20 - 30
4	30 - 40
5	40 - 50
6	50 - 60
7	60 - 70
8	70 - 80
9	80 - 90
10	90 - 100

The NSC Mathematics data was fitted to the GRM using the SAS Enterprise Guide 7.1 software. The objective was to analyse the Mathematics items by taking into consideration both the learner and item characteristics. The GRM approach is appropriate for items with ordered response categories and items need not have an equal number of categories (Embretson and Reise, 2000). To check the accuracy of the model, the item reliability fit statistics are considered, which indicates the ability of the examination to define a distinct grading of items along the measured variable, as a value between 0 and 1. Our results indicated item reliability values above 0.9 for all items, indicating a high reliability of the results. The GRM has the unidimensionality assumption, i.e. the correlation among the items can be explained by a single latent variable. This assumption can be checked by examining the eigenvalues and the magnitude of the discrimination parameters. A small discrimination estimate < 0.5 often suggests that the item in question is not a good measure of the latent construct (An and Yung, 2014). From the scree plots, we note that the first eigenvalue of the polytomous item correlation matrix is much larger than the others, suggesting that a unidimensional model is sensible for our data. We used the Cronbach's alpha coefficient of reliability or internal consistency of the latent construct. Our items measure the unidimensional latent variable very well since the Cronbach alpha coefficients are much higher than 0.7.

4. Analysis and Results

The NSC Mathematics 2009 Paper 1 consisted of 13 items, all which collectively assessed on five topics. We fitted the GRM, which considers the whole distribution range of the latent construct (ability) across grouping variables (e.g. School Type and Settlement Type). The AIC/BIC were used to assess the GRM fit with and without School Type and Settlement Type as covariates. The GRM with School Type was a better fit, smaller AIC/BIC, indicating that there is a difference in learner ability (latent construct) between the different school types.

In evaluating the item parameter estimates, we try to address the following questions: "How discriminating are the items for the learners from the different school types?" and "What is the spread of the item category threshold parameters for the items across the different school types?" The item discrimination parameters from the results range from 0.68 to 3.18, these were labelled by Baker (2015) as "moderate" and "very high" discriminations, respectively. The item discrimination estimates are nicely summarised and presented in Figure 1. From this figure we note that in general, all items discriminated very well for the learners in NQ5 and Independent schools. Item 12 (last question on "Calculus") has the lowest discrimination estimate for learners in all the different school types (public and Independent schools). Item 11 (second question on "Calculus"), item 1 ("Algebra and Equations") and item 10 (first question on "Calculus") have the largest discrimination parameter estimates for the learners in NQ1, NQ2, NQ3 and NQ4 schools. Whilst item 11 (second question on "Calculus"), item 6 (first question on "Functions and Graphs") and item 8 (last question on "Functions and Graphs") had the largest discrimination parameter estimates for the "not so poor" government schools NQ5 and Independent schools. Furthermore, it is observed that discrimination estimates for NQ5 and Independent schools were similar and grouped together in all items with the exception of items 1, 10 and 11, which discriminated less for learners in the Independent schools compared to those in NQ5 schools. Similar observations were made for the intervals for NQ1 to NQ4 schools.

The between category threshold parameters are ordered within each item. These threshold parameters, β_{ij}, are between -0.91 and 7.4 for NQ1 schools, -0.94 and 10.47 for NQ2 schools, -0.68 and 10.25 for NQ3 schools, -1.24 and 9.34 for NQ4, from -1.98 to 3.44 and -2.54 to 2.9 for NQ5 and INDEP schools, respectively. The discrimination and between threshold parameter estimates are nicely summarised by the OCC's, $P^*_{ij}(\theta)$, in Figure 2. For the GRM, the item discrimination and threshold parameter estimates determine the shape and the location of the Operating Characteristic Curves (OCC's). The discrimination parameter, α_i, dictate the shape (the higher the estimate, the steeper the curves) and the between category threshold parameters, β_{ij}, dictating the location of the OCC's (Embretson and Reise, 2000; Sharkness, 2014).

From the OCC's, it is apparent that for item 1, learners who went to NQ1 and NQ2 schools with an average ability score ($\theta = 0$) have a probability of 0.5 score above category 4 in the question of "Algebra and Equations: whilst those from NQ5 with the same ability score have at least 50% chance of scoring above category 7. For learners in NQ2 schools with a higher ability score of 2, the probability of scoring in or above category 7 is 0.5. For item 11 (second question on "Calculus"), the probability of scoring above category 2 for learners in NQ1, NQ2 and NQ3 for learners with an average ability score of 0 is approximately 0.2. This probability increases to more than 0.8 when ability scores are increased to 1 for the same learners in question to score in or above category 2. In contrast, learners from NQ5 and Independent schools with an ability level of 1 have a probability of 0.4 and 0.6, respectively, of scoring in or above category 9 in the same item. In general, the probability of scoring in the lower categories is common for learners in the "poor government schools". Some items have the OCC's clustered in particular areas. Specifically, the thresholds for item 2 (first item on "Patterns and Sequences") were able to differentiate between low and high trait learners, the OCC's for this item show a clear distinguish in the clustering of the lower between threshold categories (1, 2, 3, 4 and 5) and the upper between threshold categories (6, 7, 8 and 9), for all school types. Items 5, 6, 7, 8, 9 and 12 required ability scores above zero (average) for learners in the "poor" government schools. The OCC's for these items are located more to right of the ability scale. Items 5, 6, 8 and 12 are not able to provide much information about learners from poor government schools with average ability scores. From Figure 3, it is interesting to note that the OCC's shift to the left of the ability scale as you move from NQ1 to NQ5 and Independent schools. This means that higher ability levels are needed for leaners in the "poor" government schools (NQ1 - NQ4) to perform well when compare to learners in the NQ5 and Independent schools. Furthermore, moving from item 1 (first item) to item 13 (last item) it is interesting to observe the location of the OCC's on the ability scale for the different items.

Furthermore, from the Test Information Functions (TIF's) presented in Figure 3, it is observed that maximum information gained from NQ1, NQ2 and NQ3 schools was around the ability score of 2. For NQ4, maximum information was obtained from learners with an ability score of 1 and around 0 for learners who attended the NQ5 and Independent school types.

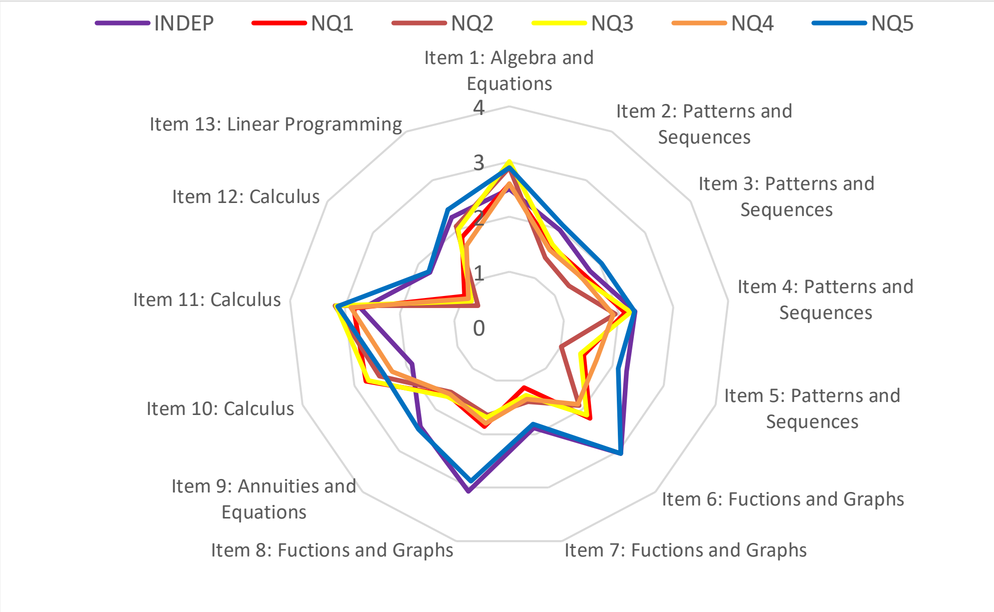

Figure 1: Item Discrimination Parameter Estimates by School Type

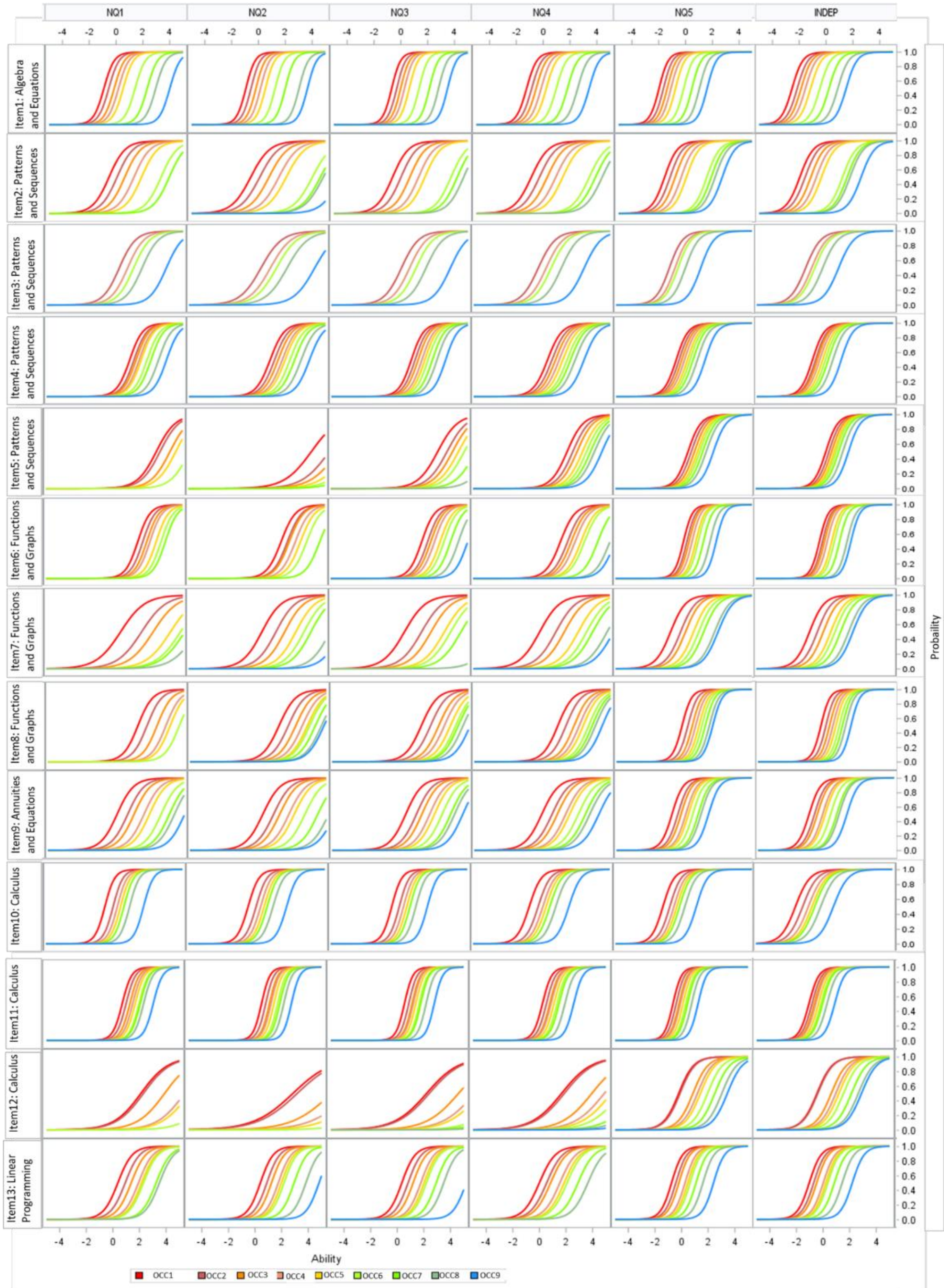

Figure 2: Operating Characteristic Curves for the 13 Items of the NSC Mathematics 2009 Paper 1 by School Type

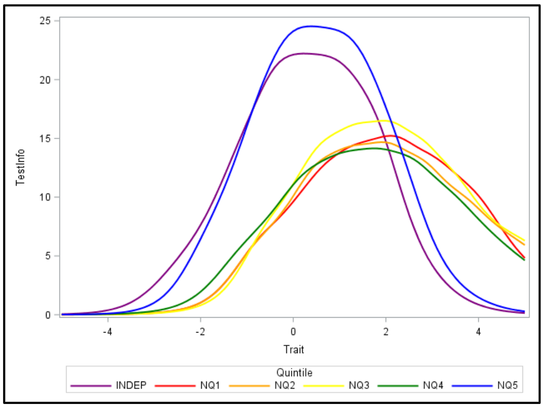

Figure 3: Test Information Curves for the Different School Types

5. Discussion and Conclusion

Government reports on NSC Mathematics provide information on how learners from the different provinces perform across the years in terms of means and variances of the learners marks (DBE, 2018). However, it is worth investigating where the achievements differ by school types. Past studies and reports on the NSC Mathematics often made use of means, pass rates or learner final marks as an outcome variable in a regression base procedure. To our knowledge, this is the first study to apply IRT to the grade 12 examination results, which took the characteristics of the items and the learners into account. Using the GRM approach, this analysis allowed us to model the relationship between learner ability score (latent construct) in Mathematics and the pattern of responses to the items. Each item was scored polytomously. Eigenvalues of the polychoric correlation matrix were performed for the different school types. It was evident that the interrelationship with items was explained by one latent variable. The reliability analysis further indicated that the Mathematics paper measured the single latent construct very well. The GRM was applied to the data using SAS 9.4.

We investigate the discrimination and difficulty of the NSC Mathematics items using the parameter estimates and the operation characteristic curves (OCC's) it provided. The obtained results showed that items 5 (last question on "Patterns and Sequences"), 6 (first question on "Functions and Graphs"), 7 (second question on "Functions and Graphs"), 8 (last question on "Functions and Graphs"), 9 ("Annuities and Equations") and 12 (last question on "Calculus") were amongst the most challenging items for learners in NQ1, NQ2, NQ3 and NQ4 schools. These items included the last question of Patterns and Sequences (item 5), all the questions on Functions and Graphs (items 6, 7 and 8) and the last question on Calculus (item 12). Items 5, 6, 8 and 12 gave the least information on learners with average ability from the lower Quintile schools, whilst most items gave much information on the average learner from the NQ5 and Independent schools. The examination tested for learners with ability around 2 for NQ1-NQ4 schools, whilst only ability of around 0 (average) for INDEP and NQ5 schools were tested. Lastly, we tested for equality of the discrimination parameters for the different school types. From our results it is apparent that the items did not discriminate equally for the different school types as some pairwise comparisons were rejected, more specifically the NQ5 and Independent vs the NQ1, NQ2 and NQ3 schools.

This approach has several advantages and can be applied IRT can also help develop effective outcome assessments (Embretson and Reise, 2000; Fraley et al., 2000; Kean and Reilly, 2014) for the National Senior Certificate. Furthermore, IRT can provide useful analytics about item bias for the different learners in the different school types. IRT has much potential to improve measurement in NSC Mathematics by accommodating for learners from the poor, the not so poor government schools and the Independent schools.

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Full end text reference list can be sent upon request.

Spatial-economic analysis of health facilities and factors associated to the demand and offer of health care for tuberculosis patients in Douala, Cameroon

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Abstract

Background: In 2016, there were an estimated 10.4 million new tuberculosis (TB) cases worldwide and 1.7 million TB deaths. Tuberculosis is a public health problem in Cameroon, especially in Douala, the economic capital and the first TB epidemiology's region, which counts for 11% of total population, but register almost 20% of the TB prevalence in Cameroon. In Cameroon, tuberculosis cases are diagnosed and treated within a nationwide network of 248 diagnostic and treatment centres (DTC). The DTC are suppose geographically distributed according to World health organization (WHO) recommendations, planning to bring DTC (offer) closer to patients (demand). The objective of this study was to analyse the spatial distribution of TB cases, in relation with the DTC and to identify the socio-economic factors linking the "demand" to the "offer".

Methods: The studied population includes confirmed TB patients, permanently resident (≥ 3 months) in Douala, between May, 1st 2011 and April, 30th 2012. During one year, a cohort of 2132 adults patients consecutively diagnosed with TB in any one of the twenty one (21) DTCs, who consented to participate to the study were interviewed; their residence and DTC were mapped using Geographic information system, by going to their home (In Douala, as others African cities, houses and streets are not addressed). The membership of each patient to a DTC (closest to his residence) was established. The "observed" number of patients attending the DTCs during the study period was compared to the "expected" number, using a bivariate analysis. Multivariate analysis using logistic regression and the analysis of variance were used to determine factors associated to the "demand" and "offer" of DTCs respectively.

Results: It emerges that, even if TB patients are concentrated around the DTCs, the majority of them (65%) goes far from their designated DTC, to seek for treatment. The decentralization policy advocated by the national tuberculosis program (NTP) is not always followed by the patients. Thus, the "expected" and the "observed" number of patients in DTCs were not correlated. Patients seeking treatment closer to their residence were mainly women and patients from large size household. Attendance of DTC was associated with their category and the quality of service.

Conclusion: Generally, the health system emphasizes its policy in bringing health facilities (HF) closer to population. In large cities, where several HF "compete", this criterion should be extended to the category of HF and the socio-economic characteristics of the target population.

Keywords

Health economics; spatial statistics; pulmonary tuberculosis

1. Introduction

Tuberculosis (TB) is contagious and airborne diseases. TB is one of the top 10 causes of death worldwide. In 2016, there were an estimated 10.4 million new (incident) TB cases worldwide, of which 1.7 million died. Tuberculosis is a public health problem in many African countries. In Cameroon, a total of 25,975 TB cases was notified in 2016, which was an incident rate of 203 (95% CI: (131-290) per 100,000 population (WHO, 2017). Douala, the economic capital of Cameroon, counts for 11% of total population, but register almost 20% of the TB prevalence in Cameroon in 2017 (NTP, 2018). Douala is the first TB epidemiology's region in Cameroon in term of the absolute number of TB cases. Since colonization, the Centre de Pneumophysiologie (CPP), part of Laquintinie Hospital, the largest hospital in the city of Douala, serves as reference center for TB diagnosis and care. To facilitate access to TB services and relieve the CPP, the National Program against Tuberculosis (NTP), in agreement with the local health authorities, decentralized TB services in 2002, Nowadays, twenty-five other health facilities (HF) of the city have been designated as Centers for Diagnosis and Treatment centers of Tuberculosis (DTC), including 11 public and 10 confessional HF. DTCs are geographically distributed according to WHO recommendations, foreseeing one DTC for 100,000 to 150,000 inhabitants. Before decentralization, more than 60% of TB patients in the city attended the LH. After decentralization, this influx was reduced to approximately 18% of total cases of reported TB patients (NTP, 2017).

The management of TB is standardized and free-of-charge in Cameroon. According to the logic of the health system, diagnosed TB patients should be distributed almost equitably, according to their residence, over all twenty-five decentralized DTCs, the CPP remaining the specialized center for complicated cases. However, according to the reports of the NTP, the notification of TB cases in the city of Douala varies greatly from one DTC to another. Allover, almost two thirds (2/3) of patients do not attend their designated DTC for diagnosis or treatment (Nana, 2013).

The objectives of this study were to describe the spatial distribution of TB patients and DTC in the city of Douala; analyze the level of supply of health care to the TB patients; and identify the socio-economic factors associated to the "demand" of DTCs.

2. Methodology

The study population comprises bacteriologically confirmed pulmonary TB (PTB+) cases, permanently (≥3 months) residing in Douala who were notified in any one of the functional DTCs (n = 21), between May, 1st 2011 and April, 30th 2012. During one year, each PTB+ patient consecutively diagnosed in any one of the DTCs was interviewed, his/her residence and DTC of health care were located using a GPS (Global positioning system) - by going to his home (in Douala, as others African cities, most houses and streets do not have proper addresses) – DTC attended and DTC expected to be attended DTC (i.e. closest to the patient's residence) were established for each patient. Corresponding data were represented on a Geo-referenced map using QGIS software version 1.6.

The distribution of DTCs and TB patients' residences in the city of Douala was decrypted to understand the spatial model of competition that lies behind the implementation of DTCs and the choice made by patients for attending a certain DTC. Patient's preferences with respect to DTCs were analyzed and compared with predictions of the health system in other to measure the matching of supply and demand for health care provided to TB patients in the city of Douala. R, version 3.5 (R core Team), software was used for statistics analysis.

For the analysis of the factors that determine the demand for health care, we considered a binary variable Y_1, whose modalities were Yes/No, depending on whether the patient makes use or not of the DTC closest to his/her home (designated DTC) for treatment. A logistic regression model was used to model the variable Y_1 as a function of the explanatory variables shown in Table 1. $Y_1 = 0$ if the patient did not use the DTC closest to his home for health care. Else, $Y_1 = 1$. From the supply side, to assess the determinants of attending a DTC by TB patients, the analysis of variance (ANOVA) was used: the discrete quantitative variable Y_2 representing the number of patients attending a DTC was the dependent variable, and the independent variables are presented in Table 2.

3. Result

During the study period, 2545 PTB+ patients permanently residing in Douala were notified: an incidence of approximately 85/100000 people. The residence of 2132 (84%) among them was mapped, their DTC of care was identified. The 16% of patients who did not participate in this study did not differ statistically from those who participated in what concerned their distribution by age and sex. Missing cases were distributed proportionally over the entire study area. 61.5% of diagnosed PTB+ patients were men and 38.5% women, the most affected age group was between 20 and 50 years old (78%). Figure 1 shows the residences of TB cases by health area (HA). According to the values recorded, the incidence of PTB+ cases varies greatly from one HA to another - between 3/100, 000 and 482/100, 000. Some HA recorded an incidence rate five times higher than the city average of 85/100,000. The HAs particularly affected by TB were those characterized by high population density (Nkongmondo, Sebenjongo and Bonadiwoto HA) and those that included spontaneous informal settlements of, relatively recent origin (Mabanda, Sodiko, Ndogpassi and Boko HA).

Figure 1. Spatial distribution of PTB+ patients and DTCs in Douala, 2011-12

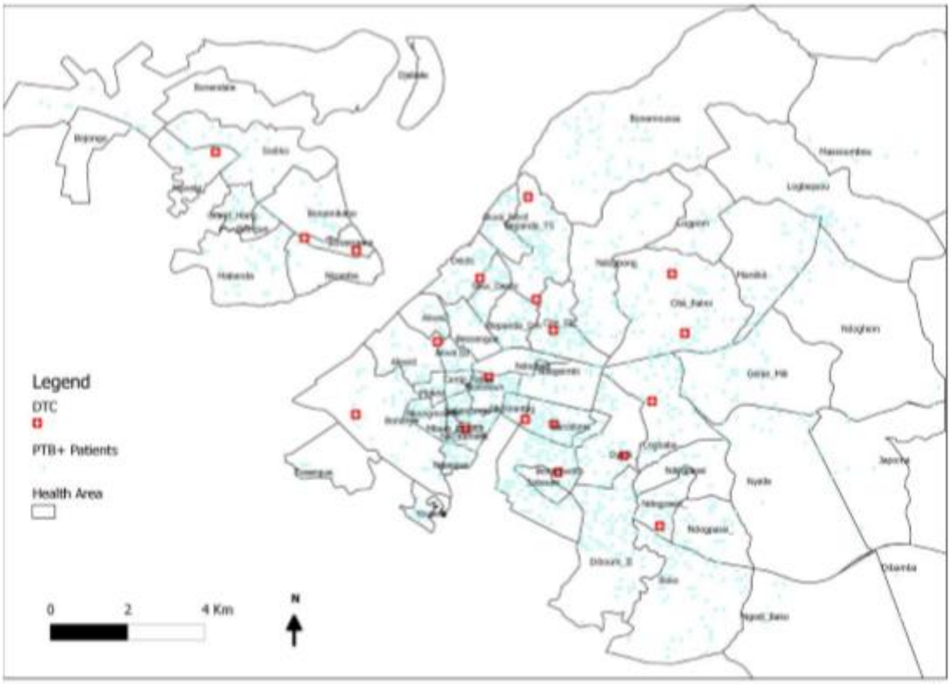

Figure 1 reveals that, at the peripheral areas of the city of Douala - Est and West entrance - DTCs are disposed on a straight line, in respect to the Hotelling model (1929). DTCs located in those area are the less popular (Figure 2). Further, more than 60% of TB patients living the peripheral neighborhoods didn't seek for health care in their designated DTCs. Paradoxically, the population density in these areas is the most important and HA with high TB incidence rate are found there (Nana, 2014). In the urban center of the city, the spatial distribution of DTC complies with the provision of circle model of Salop (1979). The number of patients registered in these CDTs (LH, Mbingo, Barcelone, ...) is generally above health system projections (Figure 2).

Figure 2. Attendance DTCs by TB patients, Douala, 2011-12 (source: NANA, 2013)

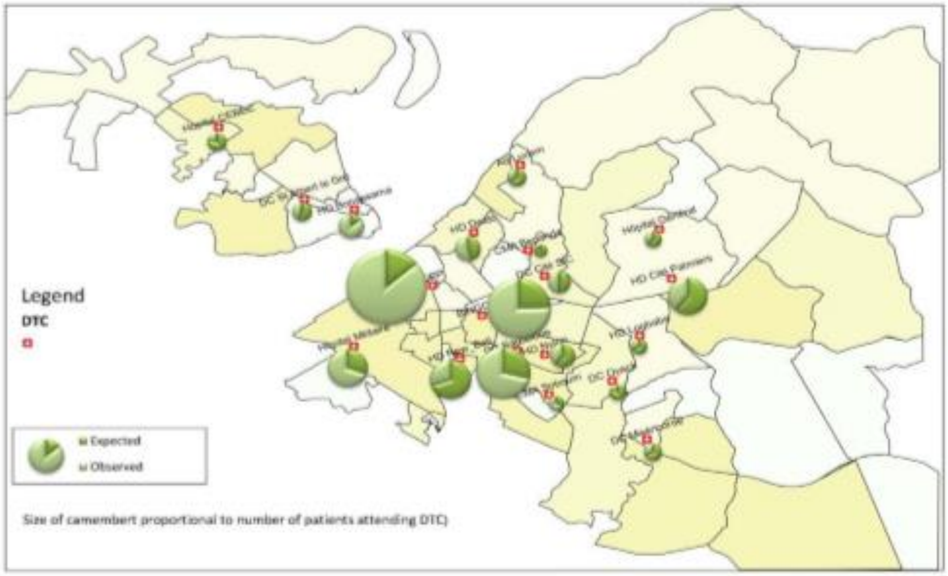

Figure 2 shows the attendance of different DTCs by TB patients, comparing the real attendance of each DTC to the expected (the total number of diagnosed TB patients living in the health areas (HA) assumed being covered by the DTC), DTC located in the urban center are more solicited than those in peripheral areas.

According to the result of the logistic regression model (Table 1), women unlike men tend to seek care in health facilities close to their home, particularly those who are heads of their households; this is also the case with TB patients originating from large household size (relatively poor). In contrast, patients living in couple only or those with a connection to pipe water (relatively rich) are more likely to seek treatment in DTCs far from their residence. This is the case, too, in older TB patients and those with a high level of education.

Table 1: Estimation of demand for health care (results of the logistic model)

Variables	Coefficients	z-statistics
Sex	-0.215*	-1.798
Age	0.0114**	1.974
Head of Household	-0.582***	-3.993
Education	0.323***	3.383
Marital status	0.517***	3.817
Family income	-0.351***	-4.745
Household size	-0.0452**	-2.142
Water connection	0.294**	-2.39
Constant	0.438	-1.112

Note: "*", "**" and "***" respectively indicate significance at the level of 10%, 5% and 1%.

The analysis of health care delivery for TB patients indicates that the influx in a health facility (HF) is significantly influenced by the category of the

HF. DTCs located in high category HF were more popular than others. The size of queue of patients before their treatment was negatively associated with the attendance of DTC (table 2).

Table 2: Estimation of supply health care (results from ANOVA)

	Degree of freedom	Sum of squares	mean square	Ficher	P.value
HF category	2	45155	22577	4.253	0.0360**
Waiting time	2	35167	17584	3.312	0.0664*
Residuals	14	74323	5309		

Note: "*" and"**" respectively indicate significance at the level of 10% et 5%.

4. Discussion and Conclusion

In the context of large cities such as Douala, where several DTC "compete", two models of spatial distribution are possible: a linear distribution, where DTCs are located in a straight line (Hotelling, 1929) or a circular distribution of DTCs around patients (Salop 1979). Those two models are implemented for DTCs distribution in Douala: linear and circular distribution in peripheral and urban center respectively. The circular model delivers best results. Patients are attracted to the city center because they consider DTC located there as perfect substitutes and will therefore be embarrassed for choice to be treated in one or another; whereas, in peripheral areas, distance from the place of residence of patients compared with DTC can generate not only additional costs but also queues caused by their high dispersion, which would avoid patients.

From the supply-side, the quality of care provided by health personnel can significantly influence the demand. This quality can be perceived by the reception, the availability of medical doctors and nurses or medicines of good quality. Under these conditions, poor quality reception of patients and the non-availability of conscious and qualified medical staff may discourage patients to return to a health facility. He/she might even advise his relatives and neighborhood against. Indeed, the patient, far from being a passive consumer, is always in the search for best quality of caregivers and health facility for the care of his illness (Nana, 2013). Good quality of health care in a HF should result in an important number of patients seeking a medical care in this HF, assuming that costs are the same for all HF located in the same geographic space, which is the case for TB health care in DTCs, and that, in case of good appreciation of a HF, the total number of patients attending the DTC of this HF will be equal or greater than the expected one. But the ratio between the number of patients seeking care in a DTC and the expected number of patients in the DTC (considered here as a measure of supply) varies significantly.

By focusing on the size of the population living in a geographic area to create a DTC, the health system didn't consider the daily migration of population in urban cities, to get to their workplace. It also conceives the health care offer to TB patients, as a market of pure and perfect competition, a form of market in which all hospitals produce an homogeneous “good” (health), consumers (patients) and the producers of the "good" (DTC) are informed, bear no transaction cost and have no inflation on the price. Then, each patient, aware of the homogeneity of supply would therefore not have to brave the distance, with the resulting price to be cured elsewhere if there is a DTC close to his residence. Then almost all patients who are taken care by each DTC should reside its immediate surroundings. Which is an ideal in economic theory (Ari Mwachofi, 2011), and far from the realty in Africa context. Figure 2 shows a situation almost opposite to this theory in the city of Douala: the supply of health care for TB patients in the city of Douala is not perceived as a perfectly competitive market. Many markets are characterized by monopolistic competition. The HF possesses market power, the power to set a price above marginal cost, although their economic profits remain zero. In Douala, patients consider different HF' label as imperfect substitutes.

Attitudes of TB patients in the city of Douala, facing the offer of health care delivery, are not in line with the predictions of the National TB program (NTP). Although the treatment of TB is free, there are opportunity costs and many other factors, beyond the geographic distance between the patient's residences to a DTC that influence his choice. These determinants of the demand side are sex, household size and household income (poverty). Characteristics that influence the supply side are mainly the category of health facility and the quality of services, including the patient waiting time before being received. This study will help to better understand the attitudes, knowledge and practices of TB patients in relation to the supply side of health care of TB in the city of Douala and evaluate the Cameroonian policy health system against TB.

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An analysis of Capital Gains statistics over the 5 years with an aim to formulate a profile of Taxpayers who have Capital Gains Tax liability

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Abstract

The absence of a capital gains tax has long been a structural weakness of the South African tax system, especially in view of the inequalities of income and wealth distribution and the sophistication of South Africa's financial markets (National Treasury, 2001:74). Capital gains was introduced in South Africa on 01 October 2001 and is not seen as a separate tax, rather it forms part of income tax. A capital gain is raised on proceeds that exceed its base cost on disposal of an asset and the gain is subject to tax.

The aim of this study will be to gain an understanding of capital gains tax in South Africa. The analysis involves using descriptive statistics try to develop a profile of the taxpayers who are paying capital gains. By means of developing a profile it would be possible to establish if there were a possible increase in the inclusion rate, which grouping of taxpayers would be the most effected. The data extracted covered the period from 01 March 2012 – 28 February 2017. Data fields of Taxpayer age, gender, geographical locations, taxable income groupings was used develop a profile of the taxpayers capital gain tax liability. An average of around 78% of assessments resulted in nil liability which is a significant proportion in relation the capital gain (average of 14%) that will actually result in tax being paid as tax is only paid on a capital gain.

This research paper highlights the importance of further research on capital gain by using models to forecast the approximate change in revenue should the inclusion rate be increased.

Keywords

Capital Gains Tax; descriptive statistics; income tax; liability

1. Introduction

The absence of a Capital Gains Tax (CGT) creates many distortions in the economy by encouraging taxpayers to convert otherwise taxable income into tax-free capital gains (National Treasury, 2000:4). The South African Revenue Service (SARS) has observed that sophisticated taxpayers have engaged in these conversion transactions, thereby eroding the corporate and individual income tax bases. This erosion reduces the efficiency and equity of the overall tax system. CGT is, therefore, a critical element of any income tax system as it protects the integrity of the personal and corporate income tax bases and can materially assist in improving tax morality. Capital gain tax is collected by the

SARS which is South Africa's tax collecting authority with a responsibility for administering the South African tax system and customs service.

Capital gains tax (CGT) is not a separate tax but forms part of income tax (SARS: 2017). According to Eighth Schedule to the Income Tax Act 58 of 1962 (the Act) section 26A provides that the taxable capital gain must be included in taxable income. The CGT provisions are contained in the Eighth Schedule was introduced in South Africa on 1 October 2001 and applies to disposal on or after this date. A capital gain is raised on proceeds that exceed its base cost on disposal of an asset and the gain is subject to tax.

The aim of this study will be to gain an understanding of the application of capital gains in South Africa by researching into:

- Using descriptive statistics try to develop a profile of the taxpayers who are paying capital gains. By developing a profile it would be possible to establish if there were a possible increase in the inclusion rate, which category of taxpayers would be the most effected.

This study aims to try answer the following question:

1. What are the age groupings of the majority of taxpayers who have a CGT liability? Are there specific groupings of taxpayers who are frequently having capital gains?
2. If majority of disposal of assets are based in a specific geographical location, it is possible some economic conditions that caused majority of taxpayers to dispose of property in that area crime, urban development. This study will aim to look at answer these types of questions by use of creating a profile form statistics extracted as it will determine should there be an increase in tax rate, which grouping of taxpayers would be affected?

2. Methodology

According to the Article published by the IMF (2018), the ability to collect taxes is central to a country's capacity to finance social services such as health and education, critical infrastructure such as electricity and roads, and other public goods. Countries can strengthen their capacity to collect tax revenue by pursuing reform strategies. A key reform strategy used by countries would be increasing tax rates. This investigation will involve analysing the statistics on capital gains assessments over a 5 years period to formulate **profile of the taxpayers** who have a capital gain tax liability. The profile will include age, gender, geographical distribution as well as income groupings. Based on this profile a pattern will established on which group of taxpayers would be affected should there be an increase in the inclusion rate.

2.1 Data source

The data is extracted for the period 01 March 2013 to 28 February 2017 which covers the Tax years 2013-2017. The data field has demographic information of the taxpayers who has declared capital gains/ loss / nil on their Income tax assessments. Examples of the data fields are age, gender, geographical locations, and taxable income groupings.

3. Result

This section will aim to address the main objectives of:

- Understanding the capital gain tax liability contribution to the total revenue collected from the assessments of Capital gains
- Formulating a profile of the Taxpayers who have a capital gains tax liability over a 5 years period

3.1 Capital gain tax Liability contribution to Total revenue collected by SARS

Capital gains tax is a relatively small but important source of government revenue (Clark, 2014:1). CGT liability as a percentage of Tax revenue, only contributes around an average of 1.1% over a 5 years period (figure 1). This would seem like a lesser contribution as compared to Personal Income tax contributing around (37%), Corporate Income Tax (18%) and Value-Added Tax (25%) (SARS Tax statistics: 2017:9). CGT is still a critical element of any income tax system as it protects the integrity of the personal and corporate income tax bases and can materially assist in improving tax morality (National Treasury, 2000:4).

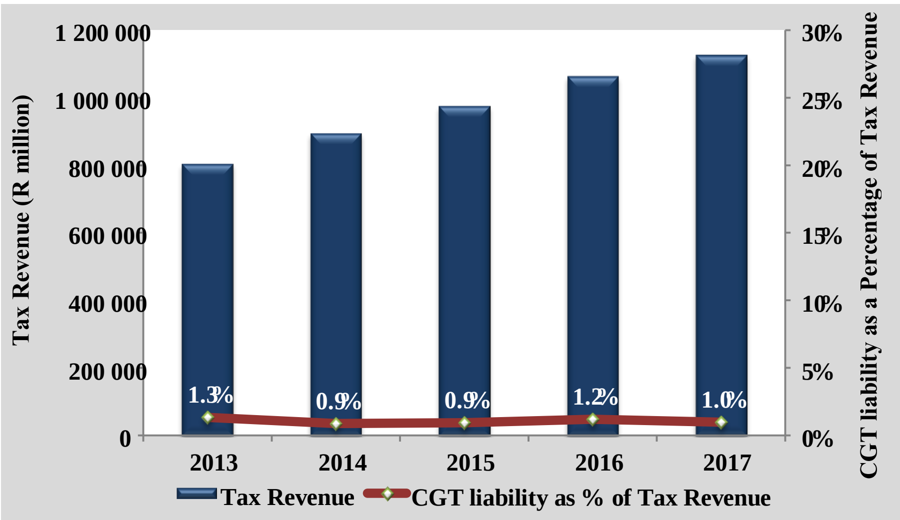

Figure 1: CGT liability as a percentage of Tax revenue, 2013 – 2017

CGT is one of the more complicated taxes as it requires an understanding of the many concepts in its calculations. A key concept which is crucial especially for analysis purposes is understanding the difference between "liability" (CGT calculated as per the Income Tax assessment) and "realised", referring to CGT paid by the taxpayer. The assessment can result in a positive (capital gain) negative (capital loss) or zero (nil liability). Tax is only paid on a capital gain. Data extracted over a 5 years period (2013-2017) shows the proportion of the capital gain/ loss / nil (figure 2). It is interesting to the note a significant proportion of assessments results in nil liability with an average of around 78%.

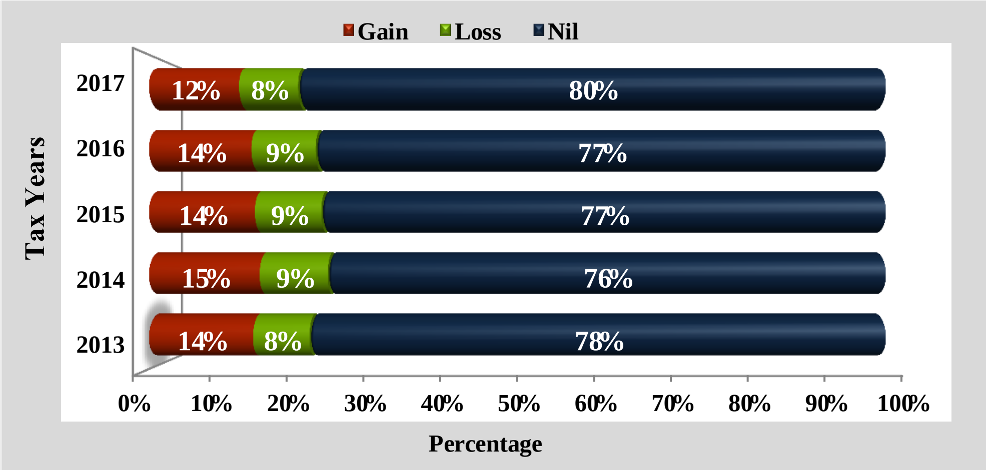

Figure 2: Proportion of Gain, Loss or Nil assessments for CGT, 2013 – 2017

3.2 Profile of Taxpayers with CGT Liability

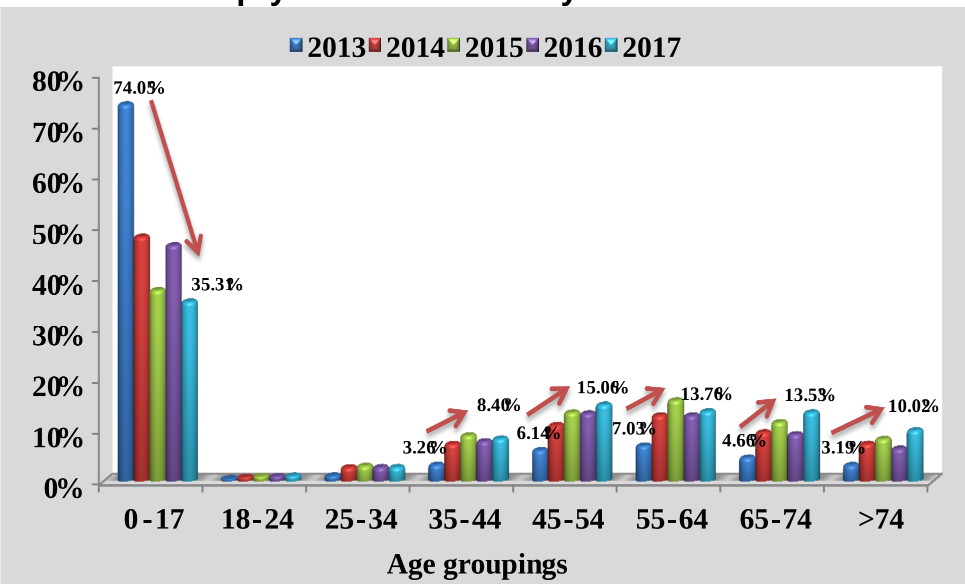

Figure 3: Groupings of Taxpayers based on assessed CGT per Age Groupings, 2013-2017

Taxpayers who have CGT liabilities grouped in the different age grouping over a 5 years period (01 March 2012 to 28 February 2017) is shown in figure 3. The following age groups have shown significant increases: 35-44years (3.26% to 8.40%), 45-54years (6.14% to 15.06%), 55-64years (7.03% to 13.76%), and older than 74 years (3.19% to 10.02%). In is interesting to note is the 017years age grouping shows a significant decrease over the 5years, 74.05% to 35.31%, though this age groupings is still the highest ranked in terms of the number of taxpayers who have capital gain liabilities. The 0-17years is likely to be minors who are Trust beneficiaries.

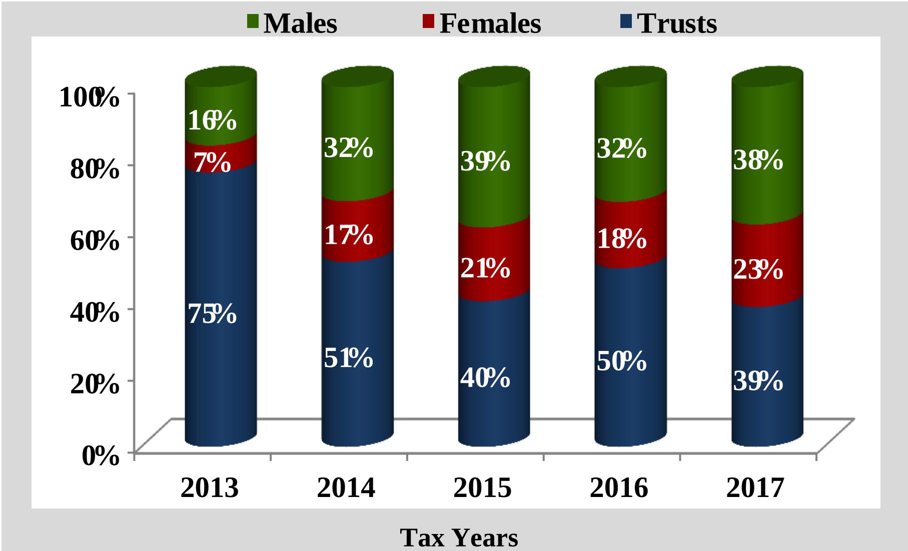

Figure 4: Groupings of Taxpayers based on assessed CGT per Gender Groupings, 2013 -2017

Similar to the analysis in figure 3, data was extracted over a 5 years period to establish the gender of taxpayers with CGT liabilities. In figures 4 it is evident a majority of taxpayer who have CGT liabilities belong to Trusts. An average of around 51% of the taxpayers with CGT liability, belong to Trusts. The reminders of taxpayers are with males, with an average of around 31.4% over 5 years and females, averaging around 17%.

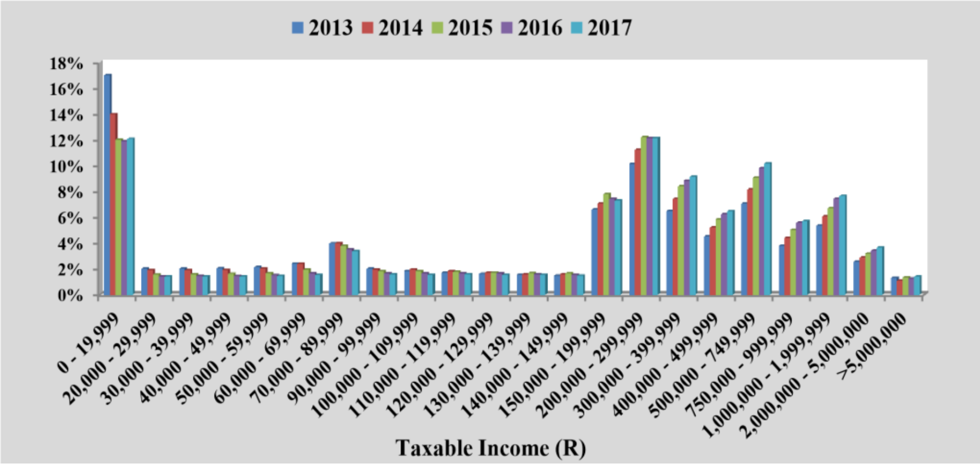

Figure 5: Groupings of Taxpayers based on assessed CGT per Taxable income Groupings, 2013 -2017

According to the Australian Taxation Office (2017), taxable income is the income that you have to pay tax on. It is the term used for the amount left after you have deducted all the expenses you are allowed to claim from your assessable income. Figure 5 shows taxpayers, who have CGT liabilities, grouped according to their taxable income. The taxable income groups that have the largest number of taxpayers with CGT liabilities are R0–R19 999 (average of 13%), followed by R200 000– R299 999(average of 12%) and R500 000-R749 999 (average of 9%). The difference between the taxable income groupings ranked first in comparison to the grouping ranked 3rd is significant with the highest rank being in the range of R0–R19 999 whilst the second ranked is R200 000–R299 999.

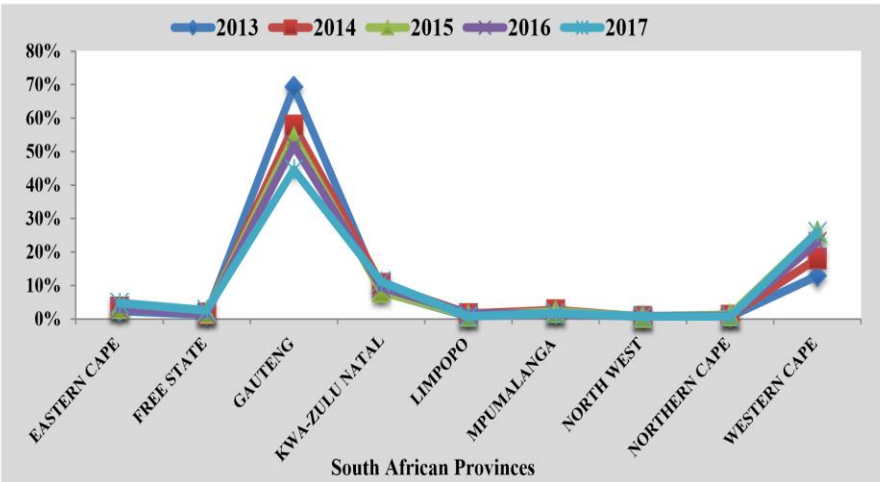

Figure 6: Groupings of Taxpayers based on assessed CGT per Province, 2013-2017

South Africa has nine provinces, which vary considerably in size with the smallest being Gauteng, but comprising of the largest share of the South African population, and the largest in size Northern Cape, but being the province with the smallest share of the South African population (Government of South Africa:2018)

Gauteng is ranked first with the highest number of tax payer who have CGT liabilities (41%). Ranked second is Western Cape (average of 27%) and Kwa-Zulu Natal, with an average of 14%. Gauteng is the economic center of South Africa and the continent, responsible for over 35% of the country's total gross domestic product.

4. Discussion and Conclusion

This study was undertaken to formulate a profile of taxpayers who have CGT liabilities. Based on the data extracted over a 5 years period it would seem evident majority the taxpayers belong to Trusts. Analysis on the geographical locations (provinces) showed majority of taxpayers are based in Gauteng which is South Africa's smallest province but has some of the most important sectors namely Financial and business services, logistics, manufacturing, property, telecommunications and trade. The largest number of taxpayers is R0–R19 999 (average of 13%), followed by R200 000– R299 999(average of 12%) and R500 000- R749 999 (average of 9%).

According to the Budget review (2001:74) CGT was introduced to:

1. Enhance the efficiency of the income tax system by reducing the incentive to convert ordinary income into tax-free capital gains.
2. Improve the equity of the tax system by ensuring taxpayers with similar income levels bear a similar burden of taxation, regardless of the form in which their income is received. To the extent that capital gains accrue primarily to upper income taxpayers, the progressivity of the income tax and, hence, vertical equity of the tax system is also enhanced.
3. Raise revenue directly through taxing capital gains and indirectly by protecting the integrity of the income tax base. It is estimated that once the tax is fully operational, it could raise about R1 to R2 billion a year directly. This provides scope to advance Government's overall tax reform strategy of broadening tax bases and reducing statutory tax rates.
4. Reduce distortions of real economic activity so that risk capital is allocated more efficiently, through the proposed capital loss offsetting rules.
5. Bring the South African tax regime into line with the many other countries that tax capital gains.

Considering one of the reasoning of introducing CGT from government is to raise revenue, and then it may not necessarily achieve that based on this analysis. Figure 2 shows that majority of declarations from taxpayer results in a nil (average of 78% of assessments) and its contribution to total tax revenue over a 5 years period ranges from around 1.03% (2013) and 1.01% (2017). Capital gain tax is only payable on a gain. Considering the administrative costs to implement this tax the question arises of whether the resources be better allocated to other taxes which will yield a high return and contribution to tax revenue

This study was able to build a profile of taxpayers who are currently liable for capital gains tax. This research paper highlights the importance of further research on capital gain by using models to forecast the approximate change in revenue should the inclusion rate be increased.

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