Education Inequality and Development:
New Evidence from Semiparametric Panel Data, 1955-2010

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Abstract

A growing literature examines the effects of education inequality on economic development assuming a linear process. However, an emerging theme in the empirical growth literature has been the appearance of significant non-linearities in empirical growth regressions. This paper reviews the linearity assumption underlying the majority research on the issue and conducts a nonparametric and semiparametric investigation on the relation between education inequality and development using unbalanced panel data. We identify a robust non-linear link between Human capital inequality and economic development.

Keywords: Human capital inequality, Economic Growth, non-linearity, Unbalanced panel data.

1. Introduction

The World Bank's World Development Report 2006 titled "Equity and Development" moved for the first time beyond the question of income distribution, to emphasizing on inequalities in opportunity, such as health and education. This report supported that the distribution of opportunities is key to development.

A recent but fast growing literature examines the effects of human capital inequality on economic performance assuming a linear process. However, to our knowledge, no study has attempted to analyze this impact using nonparametric and semiparametric models. This article reviews the linearity assumption underlying the research on the issue and conducts a nonparametric and semiparametric investigation on the relation between human capital inequality and economic development using unbalanced panel data. We identify a robust non-linear link between Human capital inequality and economic development and also test the robustness of the results with different measures of human capital inequality, such as Gini, Theil, GE (0.5) and Atkinson indices of education.

2. Literature Review

The relation between human capital inequality and economic performance can be approached from two perspectives. First, it can be supported by the theoretical link between human capital and growth in which human capital inequality is one variable, among others (quantity, quality, and efficiency of human capital), that may impact economic growth. In fact, some researches start from the failure of empirical studies to support the theoretical implication of a strong causal link from human capital to growth. Therein, the distribution of human capital is considered as an omitted variable. Inclusion of the distribution of education should deliver more reliable estimates of the social return to education. Second, it can be approached by the theoretical link between Inequality and growth in which human capital inequality is a dimension, among others (Income, health inequalities) used in the measurement of multidimensional inequalities. Besides the distribution of land and wealth, the distribution of human capital, therefore, builds part of the initial asset distribution (e.g. Birdsall and Londoño, 1997; Castelló and Doménech, 2002; Bowman, 2007; Digdowiseiso, 2009; Castelló, 2010).

Despite significant investment in human capital accumulation, level of economic development in many developing countries have not reached expectations (Holsinger 2005; Pritchett 2001); several scholars have suggested that this may be due to levels of inequality in the distribution of education (Holsinger 2005; Lopez et al., 1998; Thomas et al., 2001; Dessus 2001). Inequality in human capital severely restrains the positive effect of education on both social and economic development. It is interesting to note that not only the average schooling years but also distribution of population in terms of different educational attainment levels varies widely across economies and across time. We find many countries that, in spite of having the same average years of schooling, significantly differ in indices of educational inequality i.e. although both Cambodia and Tunisia have similar average years of schooling for their population, Tunisia's population is vastly more diverse in terms of its individuals' educational attainment levels than Cambodia[1].

Some empirical studies analyzed the relationship between human capital inequality and economic growth using cross-countries data, time series data, panel data or intra-country data. The organization of the paper is as follows. The next Section describes the data and presents the econometric model to be estimated. Section IV displays empirical results about the influence of human capital inequality on economic performance. Finally, Section V provides concluding remarks.

3. Data and model specification

We report in this section the description and data sources of all the variables used in the model. The Gini index of education is obtained from Benaabdelaali et al. (2011) supplemented with several human capital inequality measures (Theil, Generalized Entropy and Atkinson -See Annex-). These variables are calculated using information on attainment levels and the average schooling years of the total population aged 15 years and above, taken from the latest version (v1.2) of Barro and Lee (2010). The real GDP per capita, investment (investment share of real GDP per capita), government size (government expenditure share of real GDP per capita) and trade openness (percentage share of exports plus imports in GDP per capita) are sourced from the Penn World Tables version 7.1. We also include the growth rate of the population as a control variable since it has been one of the determinants in the conventional Solow growth model. Government size (kg) is used to proxy an institutional indicator and to test if a larger government size was likely to harm growth, as shown in Iradian (2003, 2005). Trade openness (trade) is included in our analysis as it has always been seen as an important catalyst for economic growth.

The nonparametric panel data model with fixed effects is:

$$y_{it} = g(z_{it}) + u_i + \varepsilon_{it} \qquad t = 1,2,\ldots,m_i; \quad i = 1,2,\ldots n. \qquad (1)$$

Where the z_{it} is a vector of dimension p and $g(\cdot)$ is an unspecified function. Each country i has m_i observations. Individual effects u_i are fixed effects which are correlated with z with an unknown correlation structure.

The error term ε_{it} is assumed to be i.i.d. with finite variance and mean-independent of z_{it}, namely, $E(\varepsilon_{it} \mid z_{it}) = 0$.

[1] In year 2000, the average years of schooling for Tunisia and Cambodia are respectively 5.82 and 5.79. However, in terms of education inequality, Tunisia remains unequal in comparison to Cambodia. In fact Gini, Theil, GE(0.5) and Atkinson indices of education of Tunisia are respectively equal to 0.50, 0.50, 0.79 and 0.36 while, on the other hand, the indices of Cambodia are respectively 0.26, 0.13, 0.14 and 0.09.

The semiparametric counterpart of Model (1) with control variable is:

$$y_{it} = g(z_{it}) + x'_{it}\beta + u_i + \varepsilon_{it} \quad t = 1,2,\ldots,m_i; \quad i = 1,2,\ldots n. \qquad (2)$$

Where ε_{it} is also assumed to be mean-independent of x_{it}. When $g(\cdot)$ is parametric quadratic or cubic polynomial functions of z_{it}, (1) and (2) become parametric unbalanced panel data models with fixed effects.

Models (1) and (2) are estimated by the iterative procedure modified from Henderson et al. (2008) for unbalanced panel data.

4. Empirical results

4.1 Benchmark model and data

Let $y_{i,t} = \ln(gdppc_{it})$

$gdppc_{it}$ is the real GDP per capita and $y_{i,t}$ is the logarithm of real GDP per capita.

$$y_{it} = \beta HC\_inequality_{it} + x'_{it}\gamma + u_i + \varepsilon_{it} \quad t = 1,2,\ldots,m_i; \quad i = 1,2,\ldots n. \qquad (3)$$

The coefficient for human capital inequality is statistically significant and negative in sign for all different measures of human capital inequality, indicating that higher educational inequality leads to lower economic performance. The estimated coefficients for logarithm of population growth rate (lnpopgrowth), openness of the economy (Trade), government expenditure as a ratio of GDP (govexpenditure), and investment-GDP ratio (investment) are all statistically significant and have the expected sign.

The possibility of a nonlinear relationship between economic development and human capital inequality is explored first by including quadratic, cubic human capital inequality terms into the equation (3).

$$y_{it} = \beta_1 HC\_inequality_{it} + \beta_2 HC\_inequality_{it}^2 + x'_{it}\gamma + u_i + \varepsilon_{it} \qquad (4)$$

$$y_{it} = \beta_1 HC\_inequality_{it} + \beta_2 HC\_inequality_{it}^2 + \beta_3 HC\_inequality_{it}^3 + x'_{it}\gamma + u_i + \varepsilon_{it} \qquad (5)$$

Columns (1,2,4,5,7,8,10,11) of Table 2 report the parametric estimation results. Note that a cubic polynomial function is still significant although the coefficient estimates in quadratic form is also significant. This impels us to examine a nonparametric and semiparametric approach on the relation between human capital inequality and economic performance.

4.2 Non-linear model specification and estimation

Let $y_{i,t} = \ln(gdppc_{it})$ and $z_{it} = Gini_{it}$ or $z_{it} = Theil_{it}$ or $z_{it} = GE(0.5)_{it}$ or $z_{it} = A(1)_{it}$.

$$y_{it} = g(z_{it}) + u_i + \varepsilon_{it} \quad t = 1,2,\ldots,m_i; \quad i = 1,2,\ldots n. \qquad (1)$$

$$y_{it} = g(z_{it}) + x'_{it}\beta + u_i + \varepsilon_{it} \quad t = 1,2,\ldots,m_i; \quad i = 1,2,\ldots n. \qquad (2)$$

Columns (3,6,9,12) of Table reports the coefficient estimation for the control variables in the parametric part of Model (2). Except investment share of real GDP per capita, the coefficient estimates of all other control variables are statistically significant and have the expected sign.

Figures 1 and 2 illustrate the nonparametric estimation of g(・) in Models (1) and (2), respectively, where lower and upper bounds of 95% confidence intervals are also drafted. The two curves of g(・) in Figures 1 and 2 look similar, implying that the control variables, though having an overall impact, play little role in the estimation of nonlinear shape of g(・).

Table n°2: Parametric and semiparametric estimation of fixed effects panel data

Dependent Variable - Logarithm of real GDP per capita

Explanatory variables	Parametric model		Semiparametric model	Parametric model		Semiparametric model	Parametric model		Semiparametric model	Parametric model		Semiparametric model
	Quadratic	Cubic		Quadratic	Cubic		Quadratic	Cubic		Quadratic	Cubic	
	(1)[a]	(2)[a]	(3)[a]	(4)[b]	(5)[b]	(6)[b]	(7)[c]	(8)[c]	(9)[c]	(10)[d]	(11)[d]	(12)[d]
constant	9.973	10.392	-	7.753	8.513	-	8.352	9.087	-	9.688	9.343	-
	(36.78)***	(35.16)***		(31.61)***	(34.58)***		(33.97)***	(36.78)***		(34.77)***	(32.10)***	
hc-inequality	-5.728	-8.625	-	-1.179	-2.356	-	-1.253	-2.586	-	-9.218	-4.006	-
	(16.62)***	(9.60)***		(16.12)***	(17.93)***		(17.35)***	(17.63)***		(14.27)***	(2.69)***	
hc-inequality^2	3.441	9.423	-	0.275	1.232	-	0.282	1.382	-	12.112	-10.749	-
	(11.45)***	(5.41)***		(11.15)***	(13.20)***		(11.88)***	(12.68)***		(10.82)***	(1.79)*	
hc-inequality^3	-	-3.681	-	-	-0.199	-	-	-0.244	-	-	29.245	-
		(3.49)***			(10.60)***			(10.32)***			(3.88)***	
lnpopgrowth	0.080	0.089	0.275	-0.275	-0.105	0.3558	-0.133	0.016	0.417	0.157	0.144	0.406
	(0.94)	(1.05)	(1.67)*	(3.12)***	(1.21)	(2.20)**	(1.53)	(0.19)	(2.59)***	(1.73)*	(1.59)	(2.24)**
govexpenditure	-0.009	-0.008	-0.024	-0.010	-0.012	-0.024	-0.012	-0.009	-0.024	-0.005	-0.005	-0.025
	(3.05)***	(2.63)***	(4.60)***	(3.17)***	(3.62)***	(4.47)***	(3.69)***	(3.02)***	(4.65)***	(1.44)	(1.50)	(4.32)***
investment	0.005	0.005	0.002	0.004	0.004	0.002	0.004	0.003	0.002	0.005	0.005	0.005
	(3.75)***	(3.76)***	(0.70)	(2.43)**	(2.58)***	(0.65)	(2.67)***	(2.53)**	(0.65)	(3.29)***	(3.09)***	(1.59)
trade	0.004	0.004	0.001	0.006	0.005	0.001	0.005	0.004	0.002	0.005	0.005	0.003
	(11.47)***	(11.04)***	(2.33)**	(14.89)***	(13.43)***	(2.33)**	(13.88)***	(12.44)***	(2.67)***	(13.88)***	(14.09)***	(4.57)***
Observations	1474	1474	1474	1474	1474	1474	1474	1474	1474	1474	1474	1474
Countries	144	144	144	144	144	144	144	144	144	144	144	144
Within R squared	0.46	0.47	-	0.37	0.42	-	0.41	0.46	-	0.36	0.37	-

Absolute value of t-statistics in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%

[a] hc-inequality measured by the Gini index of education.

[b] hc-inequality measured by the Theil index of education.

[c] hc-inequality measured by the GE(0.5) (general entropy class inequality measure with an inequality aversion parameter α equal to 0.5)

[d] hc-inequality measured by the A(1) (atkinson class inequality measure with an inequality aversion parameter ε equal to 1).

Figure.1. Nonparametric curves

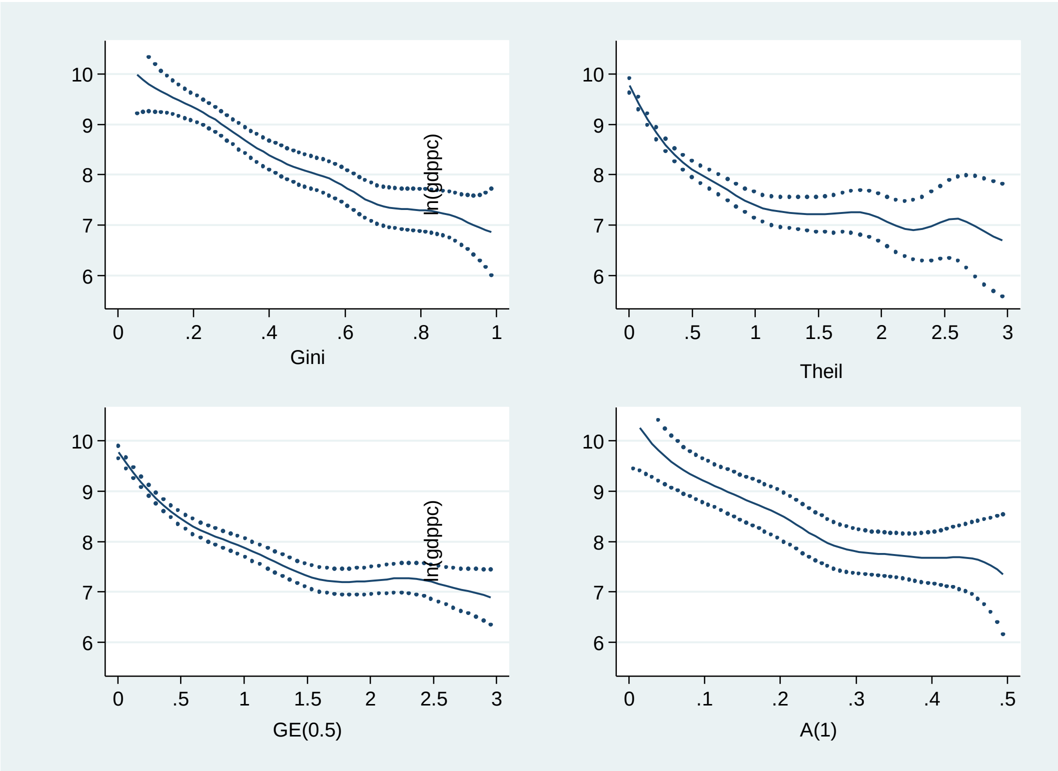
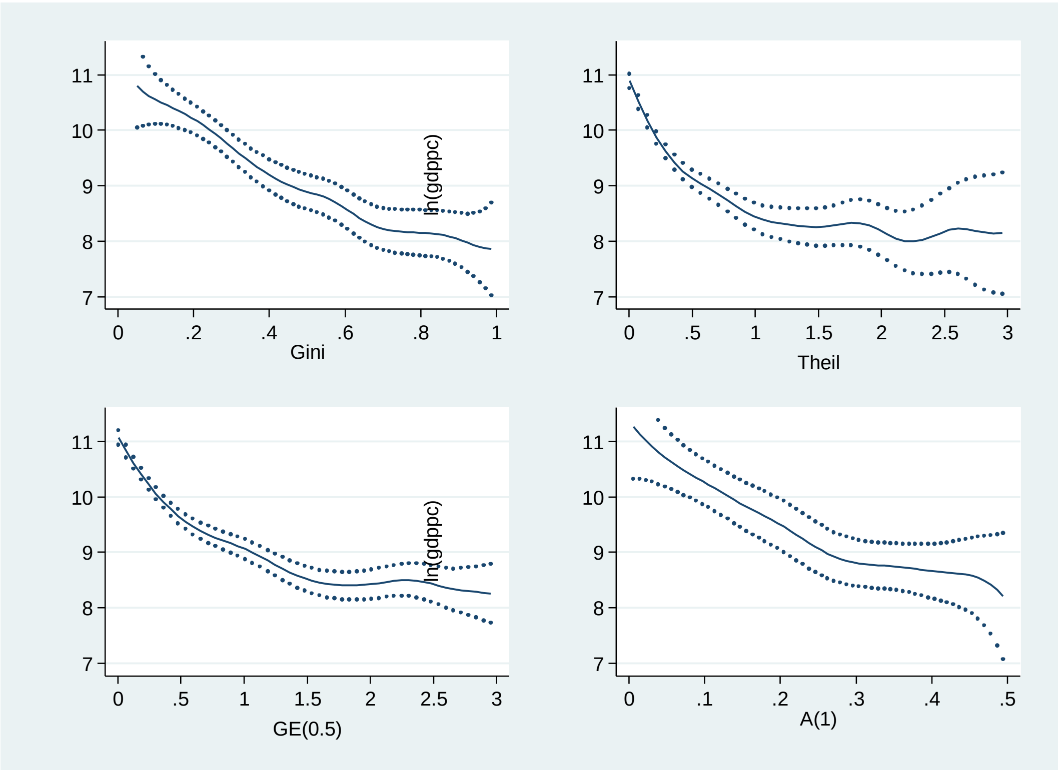


Figure.2. Semiparametric curves



5. Conclusions

This paper uses nonparametric and semiparametric unbalanced panel data models with fixed effects to study the validity of the human capital inequality and development relationship. We identify a robust non-linear link between Human capital inequality and economic development and also test the robustness of the results with different measures of human capital inequality, such as Gini, Theil, GE (0.5) and Atkinson indices of education. This result is robust whether or not the control variables are included in the model.

References

Castelló, A. (2010a). Channels Through Which Human Capital Inequality Influences Economic Growth. Journal of Human Capital, 4(4): 394–450.

Castelló, A. (2010b). Inequality and Growth in Advanced Economies: An Empirical Investigation. Journal of Economic Inequality, 8(3): 293–321.

Castelló, A., & Doménech, R. (2002). Human Capital Inequality and Economic Growth: Some New Evidence The Economic Journal, 112(478): 187–200.

Güngör, N.D. (2010). "Education, Human Capital Inequality and Economic Growth: Evidence from Turkey" Regional and Sectoral Economic Studies, 10(2): 53–71.

Henderson, D.J., Carroll, R.J., & Li, Q. (2008). Nonparametric estimation and testing of fixed effects panel data models. Journal of Econometrics 144, 257–275.

Park, J. (2006). Dispersion of Human Capital and Economic Growth. Journal of Macroeconomics, 28 : 520–539.

Rodríguez-Pose, A, & Tselios, V. (2010). "Inequalities in Income and Education and Regional Economic Growth in Western Europe." The Annals of Regional Science, 44(2): 349–375.

Thomas, V., Wang Y., & Fan, X. (2001). " Measuring Education Inequality: Gini Coefficients of Education." Policy Research Working Paper, N°. 2525, World Bank Institute.

Thomas, V., Wang Y., & Fan, X. (2003). "Measuring education inequality: Gini coefficients of education for 140 countries (1960–2000)." Journal of Education Planning and Administration, 17(1): 5–33.

World Bank, The (2006): World Development Report 2006: Equity and Development. New York: Oxford University Press.