A Simulation of Rolling Sample Design Using Restaurant Web Data

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Abstract

Recently, the Bureau of Statistics (BOS) in Japan is planning to apply the rolling sample design to the Economic Census for Business Frame. When the rolling sample design is applied to the Economic Census for Business Frame, it will likely be implemented in sub-annual frequencies as the sub-annual data are necessary for the simulation of rolling sample design. Hosei University Japan Statistics Research Institute obtained the restaurant web data of six time periods from September 2014 to January 2016. This paper reports the result of the rolling sample simulation using the restaurant web data. With regard to restaurants in special wards, the rolling census can be expected to be effective.

Keywords: rolling sample; restaurant web data; economic census.

1. Introduction

Recently, the Bureau of Statistics (BOS) in Japan is planning to apply the rolling sample design to the Economic Census for Business Frame. The rolling sample design gives a single survey the flexibility to serve multiple purposes. Since the existing Economic Census for Business Frame is conducted in one time period every five years, many enumerators were necessary only on a temporary basis. However, it is getting difficult to hire stable, quality enumerators in sufficient quantities. The rolling census design is expected to level the number of enumerators and ensure stable quality enumerators.

To the best of my knowledge, the rolling sample has been applied to the population census or demographic surveys; for example, the French Census of Population and the American Community Survey (ACS), but has never been applied to economic census or industry surveys. Therefore, it is necessary to conduct a simulation of the rolling census in advance.

When the rolling sample design is applied to the Economic Census for Business Frame, it will likely be implemented in sub-annual frequencies as the sub-annual data are necessary for the simulation of rolling sample design. Hosei University Japan Statistics Research Institute obtained the restaurant web data of six time periods from September 2014 to January 2016. This paper reports the result of the rolling sample simulation using the restaurant web data.

2. Rolling Samples and Censuses

The concept of rolling samples and censuses were introduced by Leslie Kish. The definition of rolling sample is a combined (joint) design of k separate (non-overlapping) periodic samples, each a probability sample with fraction f=1/F of the entire population, so designed that the cumulation of the k periods yields rolling samples. A rolling sample design with k=F is called a “rolling census” (Kish (1981), Alexander (2002)).

There is a special circumstance in the background of the U.S. decennial census in which the rolling census was developed. The U.S. Census Bureau wrote that Leslie Kish introduced the concept of a rolling sample design in the context of the decennial census in 1981. During the time Kish was

conducting his research, the Census Bureau also recognized the need for more frequently updated data (U.S. Census Bureau(2014)).

Between the decennial censuses, the federal government's statistical programs provide relatively little information about the characteristics of the population below the national level. The need for more frequent information for smaller domains (or "communities") has long been recognized. The mid-year census was authorized for 1985, but it was never funded。The proposal to collect data in different states in different years did not gain acceptance. Kish's rolling sample proposal was definitely the controlling factor during this period. The Census Bureau developed a research proposal for continuous measurement as an alternative to the collection of detailed decennial census. "Continuous Measurement" was later renamed "American Community Survey (ACS)" (Alexander (2002)). Operational testing of the ACS began in 1995. After the development stage (1994-1999) and demonstration stage (2000-2004), the full implementation stage began in 2005.

Until 2005, the U.S. decennial census had two types of questionnaires: short form and long form. The short form part, which was required of all reporting households, was the main source of the population and housing numbers. The long form, required in one-in-six reporting households, was the main source of subnational data about the characteristics of U.S. population and housing (Alexander(2002)). Since the full implementation of ACS began, the long form of decennial census was replaced by ACS.

3. Restaurant Web Data

A restaurant guide website is a website people use to search online for restaurants when they eat out. Companies that operate the portal site are recruited by restaurants which send information from their management screen for advertisement purposes. This allows users to search and browse for free

There are three characteristics of restaurant web data. First, it is thought that coverage is high. It is common today for people to browse portal sites that handle eating and drinking information when they go out to dinner. There is a high possibility that the existence of a restaurant will not be recognized unless it is posted on the portal site. Therefore, most restaurants are posted on the portal site. However, restaurants such as box lunches, which are not eligible for eating out in the first place, are not listed too often because there is no value in being posted.

Second, the content of information is frequently confirmed by the user. If the content actually posted on the portal site is inaccurate the user will complain to the restaurant or portal site. Therefore, the information on the portal site is considered to be fairly accurate. In terms of the statistical survey method, this means "the frequency of profiling is high."

Third, there is information that is not present in the conventional Japanese Business Register, such as longitude / latitude information or the presence or absence of a parking lot. This information can be used for editing and imputing.

The restaurant web data, which Hosei University Japan Statistics Research Institute obtained, covers all Japan areas. Considering the calculation load, this paper focused on special wards of Tokyo prefecture.

4. The Number, Increase and Decrease of Restaurants

Table 1 shows the number, increase and decrease of restaurants by special ward of Tokyo prefecture. Looking at all special wards from September 2014 to February 2015 showed 1,372 restaurants and 4,537 from October 2015 to January 2016 indicating an increase in the number of restaurants. Also, from February to June 2015, there were 4,600 shops and only 763 from January 2016 to July 2016 indicating a decrease in the number of shops. In other words, Table 1 enters from autumn to winter and exits from spring to summer. A similar tendency is observed for almost all of the special wards.

Similar trends are observed also by categories of cuisine (Table 2). It is thought that new restaurants will start or move in that place due to lags of months after the vacancy, once the place has been vacated, at the end of the fiscal year at which the lease contract of the restaurant expires.

Table 1

	The Number of Restaurants						Increase/Decrease				
	Sep-14	Feb-15	Jun-15	Oct-15	Jan-16	Apr-16	Sep-14 ~ Feb-15	Feb-15 ~ Jun-15	Jun-15 ~ Oct-15	Oct-15 ~ Jan-16	Jan-16 ~ Apr-16
Chiyoda	5,239	5,335	5,068	5,075	5,453	5,253	96	-267	7	378	-200
Chuuou	6,232	6,313	6,012	6,013	6,487	6,322	81	-301	1	474	-165
Minato	8,424	8,567	8,074	8,213	8,703	8,543	143	-493	139	490	-160
Shinjuku	7,065	7,191	6,834	6,822	6,338	7,124	126	-357	-12	-484	786
Bunkyo	1,687	1,734	1,512	1,618	1,769	1,688	47	-222	106	151	-81
Taito	3,535	3,579	3,418	3,457	3,754	3,617	44	-161	39	297	-137
Sumida	2,037	2,053	1,951	1,935	2,092	2,018	16	-102	-16	157	-74
Koto	2,653	2,702	2,565	2,583	2,774	2,669	49	-137	18	191	-105
Shinagawa	2,930	2,959	2,800	2,436	3,055	2,961	29	-159	-364	619	-94
Meguro	2,085	2,142	2,030	1,732	2,202	2,149	57	-112	-298	470	-53
Ota	3,120	3,193	2,999	2,989	3,223	3,129	73	-194	-10	234	-94
Setagaya	4,076	4,177	3,755	3,985	4,292	4,143	101	-422	230	307	-149
Shibuya	5,742	5,851	5,561	5,579	5,957	5,734	109	-290	18	378	-223
Nakano	1,784	1,835	1,735	1,736	1,889	1,834	51	-100	1	153	-55
Suginami	2,724	2,787	2,597	2,636	2,838	2,721	63	-190	39	202	-117
Toshima	3,510	3,585	3,351	3,342	3,295	3,503	75	-234	-9	-47	208
Kita	1,663	1,684	1,525	1,613	1,721	1,681	21	-159	88	108	-40
Arakawa	1,091	1,092	1,024	1,024	1,100	1,078	1	-68	0	76	-22
Itabashi	2,023	2,054	1,977	1,991	2,152	2,059	31	-77	14	161	-93
Nerima	2,023	2,051	1,954	1,954	2,102	2,031	28	-97	0	148	-71
Adachi	2,449	2,495	2,355	2,336	2,101	2,389	46	-140	-19	-235	288
Katsushika	1,894	1,946	1,731	1,833	1,972	1,945	52	-215	102	139	-27
Edogawa	2,213	2,246	2,143	2,143	2,313	2,228	33	-103	0	170	-85
All special wards	76,199	77,571	72,971	73,045	77,582	76,819	1,372	-4,600	74	4,537	-763

Table 2

	The Number of Restaurants						Increase/Decrease				
	Sep-14	Feb-15	Jun-15	Oct-15	Jan-16	Apr-16	Sep-14 ~ Feb-15	Feb-15 ~ Jun-15	Jun-15 ~ Oct-15	Oct-15 ~ Jan-16	Jan-16 ~ Apr-16
Asian or ethnic cuisine	2,128	2,194	2,055	2,047	2,176	2,139	66	-139	-8	129	-37
Italian or French cuisine	5,220	5,386	5,085	5,146	5,439	5,419	166	-301	61	293	-20
Organic food	40	41	44	42	47	46	1	3	-2	5	-1
Cafe, Sweets	8,047	8,251	7,768	7,769	8,422	8,251	204	-483	1	653	-171
Curry	659	684	648	657	718	712	25	-36	9	61	-6
Bar, Dining bar	6,453	6,630	6,379	6,415	6,818	6,732	177	-251	36	403	-86
Buffet	127	127	119	124	123	128	0	-8	5	-1	5
Family restaurant - Fast food	1,611	1,612	1,512	1,489	1,506	1,541	1	-100	-23	17	35
Ramen noodles	3,372	3,471	3,260	3,231	3,463	3,381	99	-211	-29	232	-82
Banquet, Karaoke	1,783	1,840	1,786	1,797	1,928	1,869	57	-54	11	131	-59
Tavern	12,815	13,023	12,297	12,314	12,981	12,956	208	-726	17	667	-25
Sushi	3,454	3,440	3,177	3,149	3,335	3,281	-14	-263	-28	186	-54
Yakiniku-Hormone-Teppanyaki	3,147	3,217	2,991	3,035	3,267	3,293	70	-226	44	232	26
Shokujidokoro	137	141	125	115	120	116	4	-16	-10	5	-4
Shokudo or teishoku (set menu)	1,477	1,500	1,383	1,383	1,444	1,397	23	-117	0	61	-47
Creative cuisine	127	133	121	125	131	117	6	-12	4	6	-14
Multinational cuisine	24	23	21	21	25	23	-1	-2	0	4	-2
Chinese	5,170	5,246	4,830	4,816	5,045	4,927	76	-416	-14	229	-118
Hot pot	1,332	1,376	1,282	1,292	1,350	1,354	44	-94	10	58	4
Boxed lunches	11	9	11	11	12	13	-2	2	0	1	1
Fusion food	267	224	178	186	188	159	-43	-46	8	2	-29
Vegetable dishes	58	62	48	58	56	47	4	-14	10	-2	-9
Yakuzen	10	10	11	11	13	11	0	1	0	2	-2
Western, western cuisine	2,452	2,508	2,393	2,386	2,527	2,495	56	-115	-7	141	-32
Japanese food	16,061	16,237	15,206	15,047	15,955	16,070	176	-1,031	-159	908	115
All category(except for unknown)	75,982	77,385	72,730	72,666	77,089	76,477	1,403	-4,655	-64	4,423	-612

5. Entry and Exit Rates

According to Kish (1998), the rolling sample can use different sampling fractions in different strata. Perhaps in the rolling survey of "Economic Census for Business Frame" in Japan, it is assumed that the survey is conducted frequently for areas with high entry rates and exit rates. Therefore, the

restaurant web data is converted into panel data that summarize the situation of entry and exit for about one year from February 2015 to January 2016.

The definitions of “entry,” “reactive,” “continue,” “cessation” and “exit” are as shown in Table 3. "Entry" exists at the end of the term, but it will be a restaurant that did not exist at the beginning and one term before. "Exit" is a restaurant that existed at the beginning, but did not exist at the end of the period and one period later. Restaurants that did not temporarily exist are designated "reactive" and "cessation.” "Continue" is a restaurant that existed at all four points in time.

Table 3

	One period before	Beginning period	End of period	One period later
Entry	×	×	○	
Reactive	○	×	○	
Continue	○	○	○	○
Cessation		○	×	○
Exit		○	×	×

Table 4 shows the situation of entry and exit by special ward of Tokyo prefecture. The denominator of entry rate and exit rate is the beginning and end of the year average. The standard deviation of entry rate and exit rate by special ward is as small as 1.4% and 1.2%, respectively. Entry rate and exit rate are also small, and the correlation coefficient is as low as 0.214. However, excluding Adachi Ward, Toshima Ward, and Shinjuku Ward as outliers, there is a weak positive correlation of 0.749.

Table 4

	Beginning period	End of period	Entry	Reactive	Continuous	Cessation	Exit	Beginning and end of the year average	Entry rate	Exit rate
Chiyoda	5,335	5,453	634	20	4,799	64	472	5,394	11.8%	8.8%
Chuuou	6,313	6,487	746	24	5,717	91	505	6,400	11.7%	7.9%
Minato	8,567	8,703	1,120	35	7,548	192	827	8,635	13.0%	9.6%
Shinjuku	7,191	6,338	777	27	5,534	898	759	6,765	11.5%	11.2%
Bunkyo	1,734	1,769	205	2	1,562	18	154	1,752	11.7%	8.8%
Taito	3,579	3,754	455	13	3,286	14	279	3,667	12.4%	7.6%
Sumida	2,053	2,092	211	2	1,879	18	156	2,073	10.2%	7.5%
Koto	2,702	2,774	292	6	2,476	11	215	2,738	10.7%	7.9%
Shinagawa	2,959	3,055	342	6	2,707	29	223	3,007	11.4%	7.4%
Meguro	2,142	2,202	266	7	1,929	44	169	2,172	12.2%	7.8%
Ota	3,193	3,223	305	8	2,910	37	246	3,208	9.5%	7.7%
Setagaya	4,177	4,292	510	11	3,771	42	364	4,235	12.0%	8.6%
Shibuya	5,851	5,957	823	18	5,116	127	608	5,904	13.9%	10.3%
Nakano	1,835	1,889	211	2	1,676	16	143	1,862	11.3%	7.7%
Suginami	2,787	2,838	321	7	2,510	38	239	2,813	11.4%	8.5%
Toshima	3,585	3,295	362	10	2,923	292	370	3,440	10.5%	10.8%
Kita	1,684	1,721	186	5	1,530	23	131	1,703	10.9%	7.7%
Arakawa	1,092	1,100	100	3	997	17	78	1,096	9.1%	7.1%
Itabashi	2,054	2,152	270	3	1,879	14	161	2,103	12.8%	7.7%
Nerima	2,051	2,102	217	3	1,882	23	146	2,077	10.5%	7.0%
Adachi	2,495	2,101	172	3	1,926	342	227	2,298	7.5%	9.9%
Katsushika	1,946	1,972	189	4	1,779	32	135	1,959	9.6%	6.9%
Edogawa	2,246	2,313	228	10	2,075	9	162	2,280	10.0%	7.1%
All special wards	77,571	77,582	8,942	229	68,411	2,391	6,769	77,577	11.5%	8.7%
Arithmetic average	3,373	3,373	389	10	2,974	104	294	3,373	11.1%	8.3%
Standard deviation	1,932	1,901	255	9	1,640	191	202	1,914	1.4%	1.2%

Table 5 shows the entry and exit by category of cuisine. Standard deviation of entry rate and exit rate by category of cuisine is as large as 9.7% and 3.4%, respectively. The correlation coefficient between entry rate and exit rate is 0.004, which is almost uncorrelated. However, excluding Boxed lunch,

Yakuzen, Fusion food, Vegetable dishes and Shokujidokoro as outliers, there is a weak positive correlation of 0.775.

Table 5

	Beginning period	End of period	Entry	Reactive	Continuous	Cessation	Exit	Beginning and end of the year average	Entry rate	Exit rate
Asian or ethnic cui	2,194	2,176	356	2	1,818	90	286	2,185	16%	13%
Italian or French cu	5,386	5,439	715	21	4,703	153	530	5,413	13%	10%
Organic food	41	47	11	1	35	1	5	44	25%	11%
Cafe, Sweets	8,251	8,422	1,092	25	7,305	284	662	8,337	13%	8%
Curry	684	718	124	3	591	18	75	701	18%	11%
Bar, Dining bar	6,630	6,818	1,150	23	5,645	240	745	6,724	17%	11%
Buffet	127	123	12	1	110	5	12	125	10%	10%
Family restaurant -	1,612	1,506	52	2	1,452	58	102	1,559	3%	7%
Ramen noodles	3,471	3,463	448	11	3,004	107	360	3,467	13%	10%
Banquet, Karaoke	1,840	1,928	314	6	1,608	54	178	1,884	17%	9%
Tavern	13,023	12,981	1,447	57	11,477	360	1,186	13,002	11%	9%
Sushi	3,440	3,335	156	8	3,171	109	160	3,388	5%	5%
Yakiniku-Hormone-	3,217	3,267	437	10	2,820	90	307	3,242	13%	9%
Shokujidokoro	141	120	5	0	115	5	21	131	4%	16%
Shokudo or teishok	1,500	1,444	106	2	1,336	55	109	1,472	7%	7%
Creative cuisine	133	131	21	0	110	5	18	132	16%	14%
Multinational cuisin	23	25	3	1	21	0	2	24	13%	8%
Chinese	5,246	5,045	390	9	4,646	154	446	5,146	8%	9%
Hot pot	1,376	1,350	115	4	1,231	39	106	1,363	8%	8%
Boxed lunches	9	12	5	0	7	1	1	11	48%	10%
Fusion food	224	188	6	0	182	4	38	206	3%	18%
Vegetable dishes	62	56	9	0	47	4	11	59	15%	19%
Yakuzen	10	13	4	0	9	0	1	12	35%	9%
Western, western cı	2,508	2,527	287	4	2,236	77	195	2,518	11%	8%
Japanese food	16,237	15,955	1,277	38	14,640	476	1,121	16,096	8%	7%
All category(except	77,385	77,089	8,542	228	68,319	2,389	6,677	77,237	11%	9%
Arithmetic average	3,095	3,084	342	9	2,733	96	267	3,089	14%	10%
Standard deviation	4,091	4,066	436	14	3,644	122	334	4,078	10%	3%

6. Simulation

A simulation was conducted to clarify to what extent the business frame quality can be secured when Rolling Census is adopted. As restaurant web data which was obtained at six points from September 2014 to April 2016, the special ward area of Tokyo prefecture was divided into five groups (k = 5), and each group was assumed to be surveyed once between February 2015 and April 2016.

The problem is how to survey special wards, e.g. in what frequency / order. Since rolling census is intended to level the number of researchers, survey areas are selected so that the number of restaurants does not fluctuate much in each sample. In addition, it is possible frequently to investigate the areas where the entry rate or the exit ratio is high, but from the result of the entry / exit status by panel data, it was found that the variation of entry rate and exit rate of the special ward was small. Based on this finding, the survey frequency of each special ward may be the same.

Special wards were selected by the following procedure. First we sorted special wards in descending order of number of restaurants. Next, in order to update the number of restaurant data once at 5 points, the sections with the largest number of restaurants were updated at regular intervals. For example, in February 2015 data was updated assuming that Minato Ward, Setagaya Ward, Suginami Ward, Sumida Ward and Bunkyo Ward had been investigated, but other special wards were left as “2014” and “September.” Also, data was updated assuming that Shinjuku Ward, Taito Ward, Koto Ward, Itabashi Ward, Kita Ward were investigated in June 2015, and other special wards were left as February 2015. Other special wards updated data sequentially in the same way.

Table 6 shows simulation results of the number of restaurants. In June and October 2015, the deviation rate from the actual value is a positive value (larger than the actual value), January 2016, February 2015, April 2016 the deviation rate is negative (smaller than the actual value). The deviation

rate is within 5% in all special districts, and accuracy is high considering that the entry rate for one year is 12% and the exit ratio is 9%. Looking at the special wards, the deviation rate of Shinagawa Ward and Meguro Ward in October 2015 exceeds 20% because these wards were not surveyed in the summer when the number of restaurants decreased and the data was updated when the number of restaurants was exceptionally high. However, if the regional unit to be rolled is changed to a smaller district than the special ward, the deviation rate of the special ward level will become smaller.

Table 6

	Simulation						Deviation rate (%)					
	Sep-14	Feb-15	Jun-15	Oct-15	Jan-16	Apr-16	Sep-14	Feb-15	Jun-15	Oct-15	Jan-16	Apr-16
Minato	8,424	8,567	8,567	8,567	8,567	8,567	0	0.0	6.1	4.3	-1.6	0.3
Shinjuku	7,065	7,065	6,834	6,834	6,834	6,834	0	-1.8	0.0	0.2	7.8	-4.1
Chuuou	6,232	6,232	6,232	6,013	6,013	6,013	0	-1.3	3.7	0.0	-7.3	-4.9
Shibuya	5,742	5,742	5,742	5,742	5,957	5,957	0	-1.9	3.3	2.9	0.0	3.9
Chiyoda	5,239	5,239	5,239	5,239	5,239	5,253	0	-1.8	3.4	3.2	-3.9	0.0
Setagaya	4,076	4,177	4,177	4,177	4,177	4,177	0	0.0	11.2	4.8	-2.7	0.8
Taito	3,535	3,535	3,418	3,418	3,418	3,418	0	-1.2	0.0	-1.1	-9.0	-5.5
Toshima	3,510	3,510	3,510	3,342	3,342	3,342	0	-2.1	4.7	0.0	1.4	-4.6
Ota	3,120	3,120	3,120	3,120	3,223	3,223	0	-2.3	4.0	4.4	0.0	3.0
Shinagawa	2,930	2,930	2,930	2,930	2,930	2,961	0	-1.0	4.6	20.3	-4.1	0.0
Suginami	2,724	2,787	2,787	2,787	2,787	2,787	0	0.0	7.3	5.7	-1.8	2.4
Koto	2,653	2,653	2,565	2,565	2,565	2,565	0	-1.8	0.0	-0.7	-7.5	-3.9
Adachi	2,449	2,449	2,449	2,336	2,336	2,336	0	-1.8	4.0	0.0	11.2	-2.2
Edogawa	2,213	2,213	2,213	2,213	2,313	2,313	0	-1.5	3.3	3.3	0.0	3.8
Meguro	2,085	2,085	2,085	2,085	2,085	2,149	0	-2.7	2.7	20.4	-5.3	0.0
Sumida	2,037	2,053	2,053	2,053	2,053	2,053	0	0.0	5.2	6.1	-1.9	1.7
Itabashi	2,023	2,023	1,977	1,977	1,977	1,977	0	-1.5	0.0	-0.7	-8.1	-4.0
Nerima	2,023	2,023	2,023	1,954	1,954	1,954	0	-1.4	3.5	0.0	-7.0	-3.8
Katsushika	1,894	1,894	1,894	1,894	1,972	1,972	0	-2.7	9.4	3.3	0.0	1.4
Nakano	1,784	1,784	1,784	1,784	1,784	1,834	0	-2.8	2.8	2.8	-5.6	0.0
Bunkyo	1,687	1,734	1,734	1,734	1,734	1,734	0	0.0	14.7	7.2	-2.0	2.7
Kita	1,663	1,663	1,525	1,525	1,525	1,525	0	-1.2	0.0	-5.5	-11.4	-9.3
Arakawa	1,091	1,091	1,091	1,024	1,024	1,024	0	-0.1	6.5	0.0	-6.9	-5.0
All special wards	76,199	76,569	75,949	75,313	75,809	75,968	0	-1.3	4.1	3.1	-2.3	-1.1
Arithmetic average	3,313	3,329	3,302	3,274	3,296	3,303	0	-1.3	4.4	3.5	-2.9	-1.2
Standard deviation	1,900	1,916	1,905	1,898	1,905	1,902	0	0.9	3.6	5.9	5.1	3.5

7. Conclusion

The rolling sample design is expected to level the number of enumerators and ensure stable, quality enumerators necessary for the Economic Census for Business Frame. When implementing the rolling census, it is fully conceivable that the surveyed area will change over a period shorter than one year. Therefore, in order to simulate rolling census, data with a cycle shorter than one year is required. In this paper, simulation was conducted using restaurant web data at 6 points from September 2014 to January 2016. As a result, in June and October 2015, the deviation rate from the actual value was a positive value (greater than the actual value), the deviation rate was negative (January 2016, February 2015, April 2016) It was smaller than the actual value. However, the deviation rate is within 5% in all the special districts, the accuracy is high considering that the entry rate for one year is 12% and the exit ratio is 9%. Further examination by expanding target industries and areas is necessary, but with regard to restaurants in special wards, the rolling census can be expected to be effective.

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