Evaluating Coverage and Accuracy of Census List of Households using New IT

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OUTLINE

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- 4. A New Map Service "Web Blocker"
- **5. Concluding Remarks**





1. Research Background

- In Korea, the Census list of households is commonly used as sampling frames for small areas (e.g., enumeration districts (EDs)), randomly selected in national household surveys.
- It enables many surveys to be done cheaper and faster than is possible with on-site enumeration for building area sampling frames.



1. Research Background (Cont.)

- But since the Census is conducted every five years, the list of households is often out of date in many regions, especially due to the construction for high-rise residential and apartment buildings.
- However, the coverage or accuracy of the list has never been estimated systematically in a national or provincial level.



1. Research Background (Cont.)

- We evaluate the coverage and accuracy of the 2010 Census list of households based on highly advanced information technology (IT) including *Road Name Address Information System* (new address Internet information service) and *online map service* (daum, naver, etc.) in *2013* as well as a sophisticated sample design.
- Also, we illustrate an alternative, which uses a new map service called "Web Blocker" and may be more useful to measure undercount or overcount of the Census list of households or housing units in the near future.





2. Study Design & Methodology

Sample Design

- Stratified two-stage unequal-probability sampling method is used to estimate the coverage or accuracy of the Census list of households.
 - 1) The first stage of sampling involves dividing Korea into **226** primary sampling units (PSUs). The PSUs are then grouped into **48** strata on the basis of survey information. Two or three PSUs are sampled in each stratum with πPS sampling.
 - 2) In the second stage, a sample of EDs is drawn with probability proportional to size sampling with replacement. The number of the selected EDs is **4,644**. These EDs have about **60** households on average.



• Sample Design (Cont.)

Selection Procedures for Two-Stage Area Sampling

	First stage	Second stage
Sampling Unit	City or County	Enumeration District (ED)
Sampling Method	πPS sampling(Sampford, 1967) for selecting 2 or 3 cities from each stratum	PPS without replacement sampling for selecting several EDs from each selected city



• Sample Design (Cont.)

Size Distribution of EDs by Province





• Using New IT

- The detailed maps with new address information on the Internet services showing the location of individual households open to the public are matched to the Census list of households in each selected ED.
- Additionally, a variety of online map services are used.



Advantages of Using New IT

- New IT provides useful information such as
 - 1) Address of every structure or building
 - 2) Type of structure
 - 3) Number of dwellings
 - 4) Outside of a structure and surroundings



• Advantages of Using New IT (Cont.)

• Road Name Address Information System (Ministry of Security and Public Administration)





• Advantages of Using New IT (Cont.)

Road Name Address Information System (Cont.)





Advantages of Using New IT (Cont.)

• Matching to other online map service





- Estimation of Proportion of EDs with Non-coverage (Erroneous Enumerations, Omissions, New Constructions, Demolitions)
 - Notation
 - *G* : The number of all EDs in population
 - *H*: The number of strata, h = 1, ..., H
 - N_h : The number of all PSUs (Cities or Counties) in stratum h
 - M_{hi} : The number of all EDs in i^{th} PSU of stratum h
 - n_h : The number of selected PSUs in stratum h
 - π_{hi} : The first-order inclusion probability for i^{th} PSU in stratum h of sample
 - π_{hik} : The second-order inclusion probability for i^{th} and k^{th} PSU in stratum h of sample
 - m_{hi} : The number of sampled EDs in i^{th} PSU of stratum h
 - p_{hij} : Relative size for j^{th} ED in i^{th} PSU of stratum h
 - y_{hij} : Value of the study variable for j^{th} ED in i^{th} PSU of stratum h
 - Y_{hi} : Value of the sum of all y_{hij} s in i^{th} PSU of stratum h
 - \hat{Y}_{hi} : Estimator of the sum of all y_{hij} s in i^{th} PSU of stratum h



Estimation of Proportion of EDs with Non-coverage (Cont.)

$$\hat{P}_{st} = \frac{1}{G} \sum_{h=1}^{H} \sum_{i=1}^{n_h} \sum_{j=1}^{m_{hi}} \frac{1}{\pi_{hi}} \frac{1}{m_{hi} p_{hij}} y_{hi}$$

$$V(\hat{P}_{st}) = \frac{1}{G^2} \sum_{h=1}^{H} \sum_{i=1}^{N_h} \sum_{k>i}^{N_h} (\pi_{hi} \pi_{hk} - \pi_{hik}) \left(\frac{Y_{hi}}{\pi_{hi}} - \frac{Y_{hk}}{\pi_{hk}}\right)^2 + \frac{1}{G^2} \sum_{h=1}^{H} \sum_{i=1}^{N_h} \frac{1}{\pi_{hi}} \left(\sum_{j=1}^{M_{hi}} \frac{y_{hij}^2}{p_{hij}} - Y_{hi}^2\right) / m_{hi}$$

$$\hat{V}(\hat{P}_{st}) = \frac{1}{G^2} \sum_{h=1}^{H} \sum_{i=1}^{n_h} \sum_{k>i}^{n_h} \left(\frac{\pi_{hi}\pi_{hk}}{\pi_{hik}} - 1\right) \left(\frac{\hat{Y}_{hi}}{\pi_{hi}} - \frac{\hat{Y}_{hk}}{\pi_{hk}}\right)^2 + \frac{1}{G^2} \sum_{h=1}^{H} \sum_{i=1}^{n_h} \frac{1}{\pi_{hi}} \sum_{j=1}^{m_{hi}} \left(\frac{y_{hij}}{p_{hij}} - \hat{Y}_{hi}\right)^2 / m_{hi}(m_{hi} - 1)$$



• Joint selection probabilities π_{hik} for all pairs of selected PSUs in each stratum

•
$$\pi_{hik} = Q_h \lambda_{hi} \lambda_{hk} \sum_{t=2}^{n_h} [\{t - n_h(z_{hi} + z_{hk})\} L_{h,(n_h-t)}(i\bar{k})] / n_h^{t-2}$$

where
$$z_{hi}$$
 is the relative size for i^{th} PSU, $\lambda_{hi} = z_{hi}/(1 - n_h z_{hi})$,
 $Q_h = 1/\sum_{t=1}^{n_h} (tL_{h,(n_h-t)}/n_h^t)$,
 $L_{h,v} = \sum_{S_h(v)} \lambda_{hi_1} \lambda_{hi_2} \cdots \lambda_{hi_v}$.

 $S_h(v)$ denotes all possible samples of size v, for $v = 1, 2, ..., N_h$. The sum $L_{h,v}(i\bar{k})$ is defined similarly to $L_{h,v}$ but sums over all possible samples of size v that do not include units i and k.





3. Study Results

• Examples of EDs that need to be replaced

• Paper Map of 2010 Census EDs (A, B) (ED 035-1, Pungsan-dong, Hanam-si, Gyeonggi-do)





• Examples of EDs that need to be replaced (Cont.)

- Satellite image in 2013 (ED 035-1)
 - : Development-prearranged area (Misa-bogeumzari)





• Examples of EDs that need to be replaced (Cont.)

- 2013 Road Name Address Information System (ED 035-1)
 - No dwellings in EDs (A, B)
 - Need to be replaced with new sample EDs





• Examples of EDs that need to be replaced (Cont.)

• Census list of households in EDs (ED 035-1)





Examples of new constructions in ED

• Paper Map of 2010 Census ED (ED 052-1, Geomam Gyeongseo-dong, Seo-gu, Incheon)





• Examples of new constructions in ED (Cont.)

- 2013 Road Name Address Information System (ED 052-1)
 - Some new constructions in ED
 - Need to update the list of households



• Examples of new constructions in ED (Cont.)

• Census list of households in ED (ED 052-1)

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Name of multi-unit dwellings



• Examples of new constructions in ED (Cont.)

• List of added buildings (ED 052-1)

Name of multi-unit dwellings

행정구번호	조사구번호	시도명	시군구명	읍면동명	법정동리	번지	도로명	건물번호명	공동주택 명칭	거처의종류
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230805105 21	52	인천광역시	서구	검암경 <mark>서동</mark>	검암동	<mark>635-9</mark>	승학로 450 번길	26	하모니 카운티8차	연립
230805105 21	52	인천광역시	서구	검암경 <mark>서동</mark>	검암동	635-10	승학로 450 번길	28	하모니 카운티8차	연립
230805105 21	52	인천광역시	서구	검암경 <mark>서동</mark>	검암동	635-5	승학로512 번길	58	하모니 카운티8차	연립
230805105 21	52	인천광역시	서구	검암경 <mark>서동</mark>	검암동	635-12	승학로 450 번길	30	휴케슬 (가동)	연립
230805105 21	52	인천광역시	서구	검암경 <mark>서동</mark>	검암동	635-12	승학로 450 번길	30	휴케슬 (나동)	연립
230805105 21	52	인천광역시	서구	검암경 <mark>서동</mark>	검암동	635-13	승학로451 번길 20-3	31	아이빌리지	연립
230805105 21	52	인천광역시	서구	검암경 <mark>서동</mark>	검암동	635-13	승학로451 번길 20-4	31	아이빌리지	연립
230805105 21	52	인천광역시	서구	검암경서동	검암동	635-7	승학로 450 번길	32	스페이스 빌	연립
230805105 21	52	인천광역시	서구	검암경 <mark>서동</mark>	검암동	635-11	승학로 450 번길	34	정성드림 빌 3 차	연립
230805105 21	52	인천광역시	서구	검암경서동	검암동	634-11	승학로 4 34 번길	21-1	잔쉐르빌	연립



Distribution of EDs with Undercount or Overcount of HHs

• Erroneous Enumerations, Omissions, New Constructions, and Demolitions

Erroneous Enumerations or Omissions	No. of EDs	Demolitions of HHs	No. of EDs
or New Constructions of HHs		1	191
1	225	2	125
2	111	3	79
3	52	4	53
4	26	5	45
5	13	5	13
6	10	6	29
7	10	7	20
8-10	11	8-10	28
11-20	12	11-20	26
21-298	12	21-39	7
Total	482	Total	603







• Distribution of EDs with Undercount or Overcount of HHs (Cont.)

 Erroneous Enumerations Only, Omissions Only, New Constructions Only, and Demolitions Only

Erroneous Enumerations Only or Omissions Only or New Constructions Only of HHs	No. of EDs	Demolitions Only of HHs	No. of EDs
1	07	1	121
	57	2	75
2	52	3	32
		4	19
3	16	5	18
4-6	12	6	15
		7	10
7-20	10	8-10	12
21_67	7	11-20	10
21-07	/	23-32	3
Total	194	Total	315







National Level Estimates of Proportion of EDs

	Estimated Percent	Standard Error
1) Erroneous Enumerations or Omissions or New Constructions or Demolitions of HHs	17.75 %	3.51%
2) Erroneous Enumerations or Omissions or New Constructions of HHs	10.22 %	2.53%
3) Demolitions of HHs	13.41 %	2.57%
4) Erroneous Enumerations or Omissions or New Constructions and Demolitions of HHs	5.87 %	1.60%
5) Erroneous Enumerations Only or Omissions Only or New Constructions Only of HHs	4.35 %	1.33%
6) Demolitions Only of HHs	7.54 %	1.41%



• Estimates by Province

Province	1)	2)	3)	4)	5)	6)
Gangwon	40.64 %	24.79 %	36.34 %	20.49 %	4.30 %	15.85 %
Gyeonggi	10.79 %	6.71 %	6.93 %	2.85 %	3.86 %	4.07 %
Gyeongnam	26.15 %	16.20 %	21.50 %	11.56 %	4.65 %	9.95 %
Gyeongbuk	36.20 %	20.02 %	29.93 %	13.75 %	6.27 %	16.18 %
Busan	12.18 %	5.81 %	8.02 %	1.65 %	4.15 %	6.37 %
Seoul	9.09 %	4.73 %	6.69 %	2.33 %	2.40 %	4.36 %
Jeonnam	37.90 %	23.74 %	28.14 %	13.98 %	9.76 %	14.17 %
Jeonbuk	30.76 %	21.64 %	26.00 %	16.88 %	4.76 %	9.12 %
Chungnam	31.99 %	9.47 %	28.48 %	5.95 %	3.51 %	22.53 %
Chungbuk	28.23 %	16.60 %	21.81 %	10.18 %	6.42 %	11.64 %
Gwangju	9.54 %	7.16 %	2.38 %	0.00 %	7.16 %	2.38 %
Daegu	12.49 %	10.03 %	7.69 %	5.23 %	4.81 %	2.46 %
Daejeon	6.94 %	5.35 %	3.00 %	1.41 %	3.94 %	1.59 %
Ulsan	29.92 %	14.51 %	19.47 %	4.07 %	10.45 %	15.40 %
Incheon	6.08 %	3.75 %	4.66 %	2.33 %	1.42 %	2.33 %
Jeju	29.67 %	14.10 %	21.31 %	5.74 %	8.36 %	15.57 %



• Errors in Lists of HHs or Paper Maps

Type of Errors	Content					
	Error of land-lot number					
List of LULS	Error of a road name address					
	Error of a residence number in the list					
	Error of a name of apartments					
	Reversed Locations of apartments					
Domor Mon of CDa	Shape or location of buildings different from satellite images					
Paper wap of EDS	Unable to identify residence number					
	No entire map of EDs					
	List of HHs and the corresponding map of EDs do not match.					
Othors	Whether a new building is dwelling or not is not identified.					
Others	The number of HHs in EDs are changed because of new constructions.					
	There is no HH in a list but in the map of EDs.					



• Errors in Lists of HHs or Paper Maps (Cont.)

• Estimates of proportion of EDs with errors by Province

Province	Percent
Gangwon	17.1%
Gyeonggi	10.4%
Seoul	2.6%
Gyeongnam	16.4%
Gyeongbuk	12.1%
Daegu	0.5%
Daejeon	2.4%
Incheon	9.0%
Chungnam	20.7%
Chungnuk	9.6%
Busan	30.9%
Gwangju	0.0%
Ulsan	5.6%
Jeonnam	23.4%
Jeonbuk	26.3%
Jeju	13.3%
Total	12.5%





4. A New Map Service "Web Blocker"

- Map service provided by a commercial company
- Residential mailing lists available
- More useful in checking the coverage





4. A New Map Service "Web Blocker" (Cont.)

표8주소 불록 좌표수정 지역경색	좌표추출 결창기 이런것도만	들어주세요 메뉴얼	
공동추백 신기리)시객 가면쇼등학교		• 좌표 선택 18 ^{22년} 미금 18 ^{22년} 삼중산업	● 지역검색 (배) 세종6량화동 김
전 전 		×	
블록 DB 접속 설점			
DB5: 203.236.200.78:1521/webd	İb		
UID: DONGGUK_SHPRC	PWD: ••••••		
행정동태이블:			
블록테이블: NAVER_BLK_JOSAGU_SHPR	с		
좌표 수정 DB 접속 설정			
DBS: 203.236.200.78:1521/webd	db		
UID: DONGGUK_SHPRC	PWD:		
좌표태이블: XY_CRD_TARGET_JOSAGU			
블록테이블: BLK_JOSAGU_SHPRC			
	51/25		
UID:	PWD:		



4. A New Map Service "Web Blocker" (Cont.)







5. Concluding Remarks

- New IT offers significant reductions in time and cost of evaluating the Census coverage as compared with a post-enumeration survey based on on-site enumeration.
- Census lists or maps have a large non-coverage that include erroneous enumerations, omissions, new constructions, or demolitions.
- Census lists or maps also have a large number of errors.



5. Concluding Remarks (Cont.)

- Since Census lists or maps will miss many dwellings or housing units, specific remedies or treatments for the non-coverage or inaccuracy should be given or offered.
- We need to develop field procedures which can result in drastic improvements in housing unit coverage.
- In the near future we may use a map service called "Web Blocker" to be more accurate in checking the coverage or to be used as a sampling frame.



THANK YOU

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