



Economic and Social Council

Distr.: General
14 July 2015

Original: English

Economic Commission for Europe

Conference of European Statisticians

Group of Experts on Population and Housing Censuses

Seventeenth Meeting

Geneva, 30 September to 2 October 2015

Item 3 of the provisional agenda

Innovations planned for 2010 census round, and results of tests

The First Round of the Rolling Integrated Census in Israel – Methodology, Results and Flaws

Note by the Central Bureau of Statistics of Israel

Summary

Israel conducted a first round of the planned Rolling Integrated Census in 2012 with the reference date December 31, 2011. It was planned as a pilot to explore the feasibility of moving to a Rolling census as soon as possible after the 2008 census. The organizational decision was made before the 2008 census, the methodology was designed in 2010 and the implementation was planned for 2011.

This paper presents the methodology adopted and the results obtained.

I. Background

1. The 2008 Integrated Census (IC) produced high quality census estimates¹. The methodology implemented in the 2008 IC justified the theoretical method, and could therefore be reused in the future. The 2008 IC methodology used the Dual Estimation System (DES), the method is based on sampling from two sampling frames as was fully explained in previous papers^{2, 3, 4}. The IC used the Central Population Register (CPR) as the backbone for census population estimates, demographic-geographic estimates for the country and for all the sub-population groups. The method was based on samples from two independent sampling frames which were intended to estimate over and under coverage in the CPR; an area sample, to estimate under-coverage and a sample from the CPR to estimate over-coverage. The population register was improved by linkage with various external administrative sources, the most important were:

- The Border Control file, which was used to indicate residents that are abroad for extended periods.
- The National Insurance file, to identify the residents that are not eligible for health services which is an indicator that they no longer reside in the country usually.

2. The transfer to a Rolling Integrated Census (RIC) instead of a second IC, evolved from organizational constraints and future strategic plans. The announced strategy was to maximize the use of the knowledge, complex methodology, skills and experience, gained from the 2008 IC on one hand, and on the other to produce more timely and updated estimates for the country even if the annual estimates will be with higher variation (CV). In other words the RIC will produce less quality estimates for small population groups and increase timeliness and update for large population groups with similar quality. This transfer would be accompanied with progressing towards a full register based census.

3. The basic principles for the RIC were:

- (a) Maintaining the statistical methodology of the IC.
- (b) Maximize the use of current surveys conducted by the Central Bureau of Statistics (CBS).
- (c) Increase the use of administrative sources.
- (d) Integration of census procedures into the usual (routine) workflow of the CBS.
- (e) Reducing peaks in the organizational structure and maintaining the professionals and their experience.
- (f) Ease budget assurance for the next census.

¹ Central Bureau of Statistics, Israel, (2009) *Quality Assessment of the 2008 Integrated Census-Israel* United Nations, Economic Council for Europe, ECE/CES/GE.41/2009/12

² H. Glickman, R. Nirel and D. Ben Hur (2003) *False Captures in Capture-Recapture Experiments with Application to Census Adjustment*. Bulletin of the International Statistical Institute, 54th Session, Contributed Papers, Vol. LX (2003), pp. 413-414

³ R. Nirel, H. Glickman and D. Ben Hur (2004), *A Strategy for a System of Coverage Samples for an Integrated Census*. Proceedings of Statistics Canada Symposium 2003: Challenges in Survey Taking for the Next Decade

⁴ Nirel, R. & Glickman, H. (2009) Chapter 21 - Sample Surveys and Censuses. In: Rao, C.R. (ed.) *Handbook of Statistic*, Elsevier

(g) Reduce response burden by using data accumulated in other current surveys conducted by the CBS

4. The first round of the RIC was conducted in 2012. The Census reference date was 31 December 2011. It was planned as a pilot to explore the feasibility of moving to a Rolling census as soon as possible after the 2008 census. The organizational decision was made before the 2008 census was fully adjusted for the RIC. The methodology for producing the estimates from the RIC was not yet completely theoretically designed at the time data collection started (beginning of 2012). A small scale pretest was conducted in 2011 that covered mainly technological aspects as there was a need to change some platforms which were no longer available (such as an update of the operating systems). The main Dual Estimating System (DES) was used as the overall methodology. Necessary modifications were implemented in the Labor Force Survey (LFS) and the Home Expenditure Survey (HES) in order to accommodate census data requirements for the Over – coverage (“O”) survey. The complementary data from the two surveys was to be used for the population estimates.

Table 1

Diversion from the 2008 procedures

IRC 2011	2008 IC
Spread the data collection of both census surveys (“O” survey and Under-coverage (“U”) survey) over 11 month period	Data collection was spread over 9 weeks.
The two samples will be independent samples	Two dependent samples (the two sample frames were independent)
Use the Dwelling Register (DR) as the sampling frame for the census “U” sample	Sample frame was area cells (each cell contains 50 household on the average)
Sample size 10% of dwellings/ buildings	Sample size 20% of “area cells”
Simultaneous data collection for both surveys (minimal response burden was expected)	Data collection for the “O” survey was conducted after the “U” survey was completed and linked to the CPR (reduce response burden and increase efficiency)
Data from the HES and from the LFS will be incorporated into the census estimates calculation	Data from the Surveys was used as a secondary source for quality reviews of the census estimates.

5. The DR as a sample frame was used for the first time for the “U” survey sample⁵.

6. There were some changes that were implemented in the basic procedures that were used in 2008. The expectations were that those changes should have minor effects on the census estimates.

II. Methodology

7. For the first round only localities with high quality of geo-coding in the DR were included. Localities were divided in to two main strata; localities with over 70K residents which will be sampled every year. All other localities will be stratified by size and

⁵ P. Zadka (2012), *Dwelling and Building Register Based on Municipal Taxation Lists – Quality and Distinctiveness*, United Nations, Economic Council for Europe, ECE/CES/GE.41/2012/15

geography and a 10% sample of localities in each stratum will be drawn each year and 10% sample of dwellings in sampled locality.

A. Estimation groups

8. There are about 3,000 Statistical Areas (SA) in Israel. An SA is equivalent to a “census enumeration tract” and contains 3000 residents on the average (about 1,000 households). 1099 localities are composed of a single SA (rural localities and localities with less than 10K residents). 114 localities are sub-divided into SA. An “estimation group” is the population of an SA divided into four age groups; 0-19, 20-29, 30-39, 40+, the same as in 2008 IC. These age groups were found to be homogenous in their probability to be registered properly in the CPR. Estimations groups which will not be sampled in a certain year will maintain their weights from the previous round or the 2008 IC. The underlying assumption is that the weights within estimation groups do not change rapidly.

9. The weight will be assigned to each person according to his current age and SA of residency. The longer the time lag from the 2008 IC the assumption that there was only minor change becomes weaker. Therefore a procedure to identify SAs undergoing rapid changes will be implemented. Such SAs will be over sampled and will be included more frequently in RIC sample as the weight becomes irrelevant in shorter time lags.

10. The main logic of the methodology is that, for larger population groups we need more accurate estimates with smaller relative errors.

11. Given that the changes of registration patterns in the CPR are ignorable the RIC should produce good reliable estimates for larger population groups and adequate estimates for the smaller population groups in wider time spans.

12. The estimates for SAs will be calibrated to the locality estimate which is considered a more reliable estimate.

B. Sampling frame, sampling procedures and sample sizes

13. Two main strata:

- (a) Localities with 70 thousand residents and more (divided into 20+ SAs)
- (b) Localities with less than 70 thousand residents divided into 3 subgroups
 - (i) Localities with less than 10 thousand residents (a single SA)
 - (ii) Localities with up to 10 SAs
 - (iii) Localities with 10-19 SAs
- (c) A two stage sample in each main strata

14. In group A- stage one sample - 10% of SAs in each locality each year. Stage two sample- in each sampled SA a 10% sample of dwelling/buildings.

15. In group B – stage one- 10% of the localities in each subgroup each year. Stage two - in each sampled locality a 10% sample of dwellings/buildings. Within each strata and subgroups the sample is a simple random sample. E - The expectancy of the sample in each year, E=1% and accumulated over 10 years it will be approximately 10%.

16. The LFS and The HES added about 1.5% of households (HH) each year, this adds up to 2.5% of HHs each year for the “U” survey and an extra 2.5% of HHs to the for the

“O” survey. In a ten year cycle the accumulated sample will be almost 50% of HHs for both surveys.

17. This sample size is expected to ensure that for the smallest estimation group (age group*SA) the (CV) will not exceed 10%. This sample size and sampling procedure is expected to produce a better distribution of sampled units over the SA.

18. The major merit of this design were a. the possibility to increase the sample size with no extra cost by integrating dwelling that were sampled to other currents surveys that are drawn from the same sampling frame, the DR, b. Better distribution of sampled units over the SA land and c. Minimize the possibility that a dwelling will sampled to more than survey within a year.

19. One major de-merit which was expected was that buildings/dwellings not listed in DR will be omitted. The magnitude of unlisted buildings and dwellings varies widely between localities and can reach up to 5% in some localities. This omission was expected to fadeout in the next few years with the continuous improvement of the DR.

20. The sampling frame for the “O”, survey, was a list of “administrative HHs” (nuclei families residing in same address in the CPR) as calculated from the CPR.

21. The “O” sample for the census consisted 22,000 dwellings in 41 localities half of them in localities with over 70 thousand residents (covering about 40% of total population) and half of them from localities with less than 70 thousand residents. The “O” sample for the LFS contained 18 thousand dwellings (spread proportionally over all localities) which were added to the census. In the first round the HES was not yet integrated into the census.

22. The “U” survey sample was 44 thousand administrative HHs (about 2% of HHs).

C. Improved Central Population Register (ICPR)

Pt – CPR for Dec 31 year t

Dt – Deaths occurring in year t and registered in year t+1

Bt – Births occurring in year t and registered in year t+1

It – Immigrants entering the country with an immigration visa in year t and registered in year t+1, regardless of the time they resided prior to the census reference date

Et – Emigrants are defined as residents who left the county for more than 90 days in year t-1, or earlier, and did not return for more than 90 days until the end of year t.

Mt – Residents whose eligibility for health services was stopped after verification that they no longer reside usually in Israel

Dt’ – Residents exceeding the age of 110 years

ICPR t = Pt - Dt + Bt + It - Et - Mt - D’t

D. Questionnaires and technology

23. The questionnaires were mainly the same as those used in 2008. The question on disability was deleted. The questions were adjusted to conform to the extended data collection scheme.

24. The technology for the CAPI and the CATI were the same as in 2008 IC.

25. The GIS infrastructure was adjusted to the methodological change to accommodate the “U” survey. Supporting paper maps were provided to the interviewers.

III. Results

26. Two samples were drawn, a sample of dwellings from the DR for the “U” survey and an independent sample of “administrative HHS” from the ICPR for the “O” survey.

27. For the calculation of the coverage factors estimates, data from the Labor Force survey was added.

28. The “U” census survey responses yield 63,937 persons which were used to estimate the under-coverage factor P1+ for estimation groups within SA. The LFS yield 40,680 persons which were used to estimate the P1+ for estimation groups within localities.

29. The “O” census survey yield 72,022 responses that were used to estimate the over-coverage factor λ for estimation groups within SA and 58,399 persons to calculate λ for estimation groups within localities.

30. The two factors P1+ and λ for localities sampled in 2011 were compared to these factors obtained in the 2008 IC for each estimation group in each locality.

31. The results of the comparison were that 95% of P1+ parameters were higher in 2011 than in 2008. The correlation coefficient between the two results was high, $R=0.84$. This should have indicated that there was a significant improvement in the quality of registration in ICPR or that the P1+ parameters are biased. A high P1+ means that there are less people residing in the SA and registered incorrectly in the ICPR.

32. If the Register’s addresses improved in the time past between 2008 and 2011 this should have been seen also in the over-coverage parameter λ . A high λ means that there are less people registered in ICPR in a certain SA but residing in a different SA (sort of a mirror parameter from a different data source)

33. But this was not the case. Parameter λ was higher in 2011 only for 42% of the estimation groups in those localities. Comparing the final estimates for localities and SAs that were sampled in 2011 to current population estimates for 2011 (based on the 2008 IC) revealed that the estimated minimum bias for localities total population was 5% and the estimated maximum bias for SA was 27%.

34. The results were thoroughly reviewed by two expert teams which were established for this purpose; one to review the enumeration procedures and one to review the methodology.

A. The outcome of the methodological review:

35. High correlation was found between the probability of being registered correctly in the ICPR and the probability that the name in the DR will be the name of the person actually residing in a dwelling. Three files were merged to estimate the dependency rate between the sources

- (a) ICPR 2011
- (b) DR 2011
- (c) “U” survey 2008

36. The result was that 234,671 records were linked and their correct addresses were known from the survey.

Table 2
2008 census

	Incorrect registration in ICPR	Correct registration in the ICPR	Total
Incorrect registration in DR	14,445	17,486	31,931
Correct registration in DR	4,778	197,962	202,740
Total	19,223	215,448	234,671

- Chi-square = 67451, P. value=0.00001

- Cramér phi (ϕ_C) = 0.54, measures the degree of inter-correlation between two discrete variables (the value ranges from 0 to 1¹(6), - were 0 corresponds to “no association” and 1 corresponds to complete identity)

- The odds ratio = 34.2 (in the case of no association should be ≈ 1)

37. There was no failure detected in the linkage procedures.

38. There was no impact of the prolonged enumeration period. The parameters were checked for the first four months against the last four months of enumeration period and there was no difference in the estimated parameters.

39. There was no difference between the bias for small municipalities and large municipalities.

40. There was a similar tendency to assign dwellings as “vacant” or “not used for residential purposes” compared to the LFS, which uses the same sampling frame. But it was somewhat higher than that observed in the 2008 IC.

41. The “O” survey response rates were quite low (74%). Nevertheless this had no impact on the quality of the survey results.

B. The procedures review results

42. There might have been some deviation in the interviewers strict adhere to the detailed instructions in the interviewers manual. A thorough investigation of this was suggested but not performed, as it was difficult and expensive to carry out. It was assumed that interviewers used the name of the dwelling holder as the main dwelling identifier instead of other identifiers which were more ambiguous and would cause more inquiries or did not follow completely the instruction given; that the sample unit is the dwelling and not the registered holder.

43. There was no significant difference in the proportion of refusals between RIC and the LFS but it was slightly higher than that of the 2008 IC.

IV. Discussion

44. The unique identifier of a dwelling in the DR is the municipal tax number, and the address of the building. There is no unique dwelling number in the DR which corresponds to a sign on the door of a dwelling. Dwellings are identified in the field by the name on the dwelling door that corresponds usually to “dwelling holder” = “municipal tax payer”. The fact that there is correlation between the two lists (ICPR and DR), lead to the outcome that

there is higher probability to enumerate (achieve a completed questionnaire) a HH that is registered correctly in ICPR than a HH that is registered incorrectly in the ICPR.

45. These outcomes indicated that as long as there is no verified procedure to ensure that the enumerator identifies properly the sampled dwelling, the DR as a sampling frame does not conform to DES requirements.

46. A main methodological requirement for the DES to produce unbiased estimates is that the two sampling frames should be uncorrelated and independent. The correlation that was observed between the ICPR and DR was one of the main reasons for the biases.

47. The review pointed to errors in locating a specific dwelling using the data provided in the DR.

48. The consequences from the preliminary results were that the second round of the RIC (2013) was terminated at the end of April 2013 and the methodology was put under comprehensive methodological review.

49. The results of the review indicated that the DR as frame for the RIC “U” survey sample could not produce reliable estimates for population distribution nor for the estimation groups and neither for localities totals. The RIC “O” sample frame was the same as in 2008 IC and produced unbiased estimates.

50. As mentioned, the first act was to terminate data collection as soon as possible to minimize resources exploitation, while minimizing interference with human resources management. The results of the first year estimates were finalized at end of March 2013 and data collection for the second round (2012) was terminated at the end of April 2013. The results of the in-depth review were finalized at the end of June 2013.

51. The main outcome of the review was that the sampling frame does not accommodate the requirements for an RIC using the DES as the method to produce census results.

52. It was commonly agreed that the “U” survey sample should be based on a similar frame as the one used in the 2008 IC.

53. Re-evaluation of the improvements made in the various administrative sources which could enable a Register Based Census in the near future did not show any major improvements that would allow moving toward a full register based census.

54. Currently intensive work is carried out to test the possibility of an RIC by using the same sampling frames used for the 2008 IC with some modification. One such modification is to implement a two stage sampling procedure. This should improve the coverage of the SA land by sampling more “area cells”. At the first stage a 60% sample of area cells, then creating a list of dwelling in each cell and sampling 30% of the dwellings in each sampled cell (this modification was due to the assumption that there are smaller variances within cells than among cells). Reducing the cycle span to five years (instead of ten years) and developing a web response system for both surveys (“U” and “O”) to increase response rate in “hard to enumerate groups” of the population (such as young urban adult males). Another rout that is being explored is finding indicators that would provide a-priori information of SAs with expected high variances (which would indicate that in these SAs the proportion of incorrect registration in the ICPR is high). Such SAs will be sampled more frequently and with higher sampling rates. The time elapsed since 2011 first round of the RIC enforced also update of technologies; such as use of GPS, electronic maps and tablets instead paper maps and laptops and the implementation of WEB response options.

55. Two pilot censuses in two consecutive years are being planned (data collection in 2016 and 2017) these pilot censuses are aimed to test the new procedures and technologies as well as the “rolling” effects on the estimates.

56. The “O” survey needs also some technological adjustments as the possibility of sampling persons from ICPR instead of “administrative HHs” was suggested and needs to be tested.

57. The results of these two pilot censuses will be used for the final decision whether an RIC is feasible and would produce adequate population estimates as required from the census. Statistical models will be incorporated to adjust the “rolling” effect of the estimates.

58. A consulting committee which guided the planning of the future censuses suggested that an RIC, despite its advantages, would not yield quality estimates. Users’ representatives in the committee thought that the RIC results would be hard to comprehend by local communities and researchers.

59. The final census reference date as well as whether the “rolling” method is feasible for Israel’s situation are not yet set and would depend on the results from the two pilot censuses.
