

Japan's official subnational population projections accuracy: Comparative analysis of projections in Japan, English-speaking countries and the EU

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Introduction

Japan is one of the countries dealing with an aging and declining population. Faced with concerns about the repercussions of the anticipated decrease of the working population and the increase in elderly population in the future to the Japanese economy and society, the government of Japan has announced its “Regional Empowerment for Japan's Growth—Overcoming population decline and revitalizing local economies: Japan's long-term vision and comprehensive strategy” in December 2014.

One of the basic materials for formulating government policies such as the above strategy is a population projection. In Japan, the government agency responsible for preparing population projections is the National Institute of Population and Social Security Research (IPSS). In addition to national projections, IPSS prepares subnational projections by prefecture and municipality. These subnational population projections of IPSS are used widely not only by the Japanese government, but also by subnational governments and private companies.

In this study, we sought to evaluate the projection accuracy of the prefectural and municipal projections of IPSS. In addition, we compared the accuracy of IPSS subnational population projections with that of official subnational projections conducted by official agencies in English-speaking countries and by the EU.

Data and Method

IPSS has published population projections for the national, prefectural, and municipal levels based on the population census. The first prefectural population projection published by IPSS was based on 1985 census population, while the municipal projection was based on 2000 census population (Table 1). In this paper, we analyzed total populations for five prefectural projections, namely P1_1985, P2_1990, P3_1995, P4_2000, and P5_2005, and two municipal projections, namely M1_2000 and M2_2005. Since we could not obtain actual population data for 2015 at the time of the writing of this paper, we did not include P6_2010 and M3_2010 in the analysis.

The main index used in the analysis of accuracy is APE (Absolute Percent Error), which is one among many indices used in assessing accuracy. Actual populations used for calculating APE were based on the population data obtained through the population census. Due to changes in prefectural and municipal boundaries, population data used were those for the area representing the boundaries at the time the projections were made.

Rather than looking simply at the APE of each area, we focused on the overall distribution and relationship of the APEs of the different areas. Thus, in Section 4 and 5, for example, we used the median APE (MedAPE) and 90 percentile of APE (90%APE) in analyzing accuracy of IPSS subnational population projections. Also, in the comparative analyses of projections by different

countries in Section 6, other than these two indices, we also used three other indices, namely, mean APE (MAPE), the proportion of the number of areas falling within the scope of a particular APE within the area covered in the analysis, and RMSE (Root Mean Square Error). These indices were used in order to make comparisons with results of existing studies.

Table 1. Official subnational population projections conducted by IPSS, Japan

ID	Level of geography	Number of areas	Base year	Projection horizon	Release date
P1_1985	Prefecture	47	1985	2025	January 1987
P2_1990	Prefecture	47	1990	2010	November 1992
P3_1995	Prefecture	47	1995	2025	May 1997
P4_2000	Prefecture	47	2000	2030	March 2002
P5_2005	Prefecture	47	2005	2035	May 2007
P6_2010	Prefecture	47	2010	2040	March 2013
M1_2000	Municipality	3,244	2000	2030	December 2003
M2_2005	Municipality	1,805	2005	2035	December 2008
M3_2010	Municipality	1,799	2010	2040	March 2013

Accuracy data regarding the subnational population projections conducted by official agencies in the EU and English-speaking countries used in this study were those from Rees et al. (2001), Wang (2002), Statistics New Zealand (2008), Wilson (2012), and Office for National Statistics (2015). Projected and actual subnational population data indicated in the papers, such as in Rees et al. (2001) and Wang (2000), were used in calculating the necessary accuracy measure.

It should be noted that the subnational population projections analyzed by these studies were based on different numbers of areas, population sizes, projection methods, and base years.

Results and Discussion

For prefectural projections, MedAPE increased with longer lengths of horizon, ranging from 0.5 to 1.4% for 5-year projections, 1.3 to 2.1% for 10-year projections, and 2.5 to 3.1% for 15-year projections. For municipal projections, MedAPE increased with longer lengths of horizon, ranging from 1.3 to 1.7% for 5-year projections, and at 3.5% for the 10-year projection.

We conducted multivariate regression analysis to clarify the factors associated with the accuracy of prefectural and municipal population projections conducted by IPSS. The accuracy of prefectural projections was correlated to base-period net migration rate, TMA dummy, length of horizon, and base year. In particular, it was found that accuracy was adversely related for areas with high absolute migration rates and those that went through drastic change in migration patterns, for projections with longer lengths of horizon and those wherein the base year coincided with the turning point for marked changes in migration pattern.

The accuracy of municipal projections was associated with base-year population size, base-period net migration rate, TMA (Tokyo Metropolitan Area) dummy, and length of horizon. In particular, it was found that accuracy was adversely related for areas with small base-year population

size, those with high absolute migration rates, and those that went through drastic change in migration patterns, and for projections with longer lengths of horizon.

Among the factors associated with accuracy, those that had the same relationship with both the prefectural and the municipal projections were base-period net migration rate, TMA dummy, and length of horizon—a result that is consistent with previous studies (e.g. Smith et al. 2013).

On the other hand, factors that associated with the prefectural and the municipal projections differently were base-year population size and base year. This means that although accuracy was not correlated when there was a large base-year population size, as with the prefectural projections, accuracy was correlated when there was a large variation in population size, as with municipal projections. Also, in regard to base year, there is a possibility that no relationships were observed for municipal projections since there were only two projections analyzed. It is possible that base year would be associated with accuracy for future municipal projections to be conducted by IPSS.

To assess accuracies of IPSS subnational population projections relative to projections of other countries, we compared them with those of subnational projections conducted by official agencies in English-speaking countries and in the EU. In particular, we made comparisons with projections conducted by the Australian Bureau of Statistics, the UK Office for National Statistics, Statistics New Zealand, the United States Census Bureau, and the EU. Although variations in projection accuracy due to length of horizon and population size were found, there were no major differences as a whole. The accuracy of IPSS projections was found to be relatively high.

We suggest two reasons for the high accuracy of the IPSS subnational population projections. First is that the effect of foreigners on population changes in Japan is limited. Since the 1990s, like in other countries, there has also been an increasing inflow of foreigners to Japan, and in various aspects their activities have become more conspicuous (Ishikawa 2015). Despite these developments, however, Japan's international migration rate remains very low, wherein foreigners account for only 2% of Japan's population. We believe that the limited effect of foreigners on changes in Japan's population (e.g. Yamauchi 2015) contributed to the high accuracy of IPSS subnational population projections.

Second is that Japan's population is aging. The low fertility rate from mid 1970's has aggravated the aging of the population, making Japan one of the countries with highly aged population. An aging population means that the size of younger generations, which have a significant effect on migration and births, is also decreasing. As such, the effect to population change of migration and births, for which assumptions for population projection are difficult to make, becomes relatively smaller, leading to the high accuracies of IPSS subnational population projections.

In regard to the relationship between projection accuracy and projection method, we would like to add that the method used in the IPSS subnational population projections, namely, the cohort component method using net migration, is not sufficiently refined theoretically¹⁰, compared to the methods used by other official agencies. Although the use of this method in IPSS projections was mainly due to data availability, projections of other official agencies, which are based on theoretically refined methods, did not necessarily have higher projection accuracies¹¹.

Subnational population projections conducted by official agencies are widely used as forecasts of future populations. Recently, official agencies not only publish their subnational population projections, but also report the errors of their projections. Although these activities are very useful for the users of their projections, there have been little studies based on comparative analysis of these projections. In this study, we tried to compare IPSS subnational population projection errors with other official agencies ones. In the future, it will be necessary to conduct more rigid comparative analysis of projection errors of not only total population projections, but also of age-specific population projections. Further, it would also be necessary to compare and delve deeper into the methods used for projection and assumptions on which the projections are based. We believe that these comparative analyses will further improve the reliability of official population projections.

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