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Current Status and Future Challenges of the National Population Projection in Korea with a Super-Low Fertility Pattern: A Case Study through International Comparison

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1. INTRODUCTION

Most developed countries in Europe, North America, and Japan of East Asia have experienced a series of huge demographic changes since the second quarter of the 20th century. These changes include drop in fertility and mortality rates, rapid evolution of population aging, and increase in international migration as accompanied by secular trend in regional integration and economic globalization. Meanwhile, the beginning of the 'second" demographic transition in the 1960s in most European countries and the emergence of the so-called "lowest-low" fertility patterns in Southern and Eastern Europe in the 1990s have contributed significantly to the heightening of either scholarly or policy-oriented interests in the shape of future population and its potential impacts on the sustainability of social security and other welfare systems as well as the prospect of national economic development.

In the first half of the 20th century, South Korea was an underdeveloped country in demographic terms. Beginning in the 1960s, Korea experienced an unprecedented demographic change. The total fertility rate (TFR) was 6.0 in the 1960s, but dropped to a replacement-level (2.1) in 1983, and eventually to 1.29 in 2001. Despite its minor fluctuation, TFR has continued to maintain a super-low fertility pattern (i.e., TFR < 1.30), recording a TFR of 1.08, the lowest figure in Korean vital statistics history, in 2005 (Jun, 2005). The drop in TFR was speedier and greater in terms of tempo and magnitude when Korea is compared with other major nations in Europe, North America, Oceania, and Japan. On the other hand, life expectancy at birth had increased from 61.93 years in 1970 to 79.56 years in 2007 for both females and males. Indeed, both emergence of a super-low fertility pattern and notable mortality improvement are expected to influence the tempo of population aging in the future. Finally, South Korea was traditionally an emigrating county, but is changing its status to an immigrating country, particularly influenced by the influx of foreign workers and marriage-related brides from China and Southeast Asia.

In this paper, we will begin with the current status of the national population projection as implemented by Statistics Korea (replacing its old name, Korea National Statistical Office) by comparing the 2009 interim projection with the 2006 official national population projection. Secondly, we will describe the frame of Korean national population projection system and compare it with the population projection systems for the countries in Europe, North America, Oceania, and Japan. The topics of interests include (1) projection agencies (2) projection horizon (3) projection intervals (4) the number of projection scenarios and (5) the number of assumptions on fertility, mortality, and international migration. In doing so, we hope to reveal the major characteristics of the population projection system in the country with a super-low fertility pattern and highlight what should be improved upon these for Statistics Korea to launch the 2011 official national population projection, one year after the completion of 2010 Korean population and housing censuses. Thirdly, we illustrate a stochastic population projection for Korea, transforming the population rates into one parameter series. Finally, we describe the future challenges of the national population projection, and propose the projection scenarios for the 2011 official population projection. Here we will mention some unaddressed issues relating to the determination of base population, the treatment of non-national population, and the incorporation of a stochastic population projection in the official national projection series.

2. THE KOREAN NATIONAL POPULATION PROJECTION: 2006 OFFICIAL AND 2009 INTERIM PROJECTIONS

Statistics Korea released the third official report on the national population projection in 2006, which was based on the 2005 population and housing censuses and actual registration data on fertility, mortality, and international migration data (Statistics Korea, 2006). According to the agency, the national projection aims to provide a variety of information on future population, such as total population, population composition (by sex and age), activity population, and elderly population, all of which are needed to establish short- and long-term socioeconomic planning and produce input data for household projection as well as local population projection. Two essential features of the 2006 official national population projection include (1) the wide use of data on registered non-nationals and illegal immigrants and (2) the use of generalized log gamma model (Kaneko, 1993, 2003) and Lee-Carter method (Lee and Carter, 1992) plus Brass Logit model. According to Statistics Korea, the first was intended to establish a base population which corrects for the foreign population undercounted in the 2005 population census while the second was intended to improve the quality of projected vital statistics data and diminish uncertainty elements in producing the final population projection results.

In 2009, three years after the announcement of the 2006 official national population projection, Statistics Korea prepared an interim national population projection which was not released to the ordinary statistics users (Statistics Korea, 2009). The agency cited three reasons for doing so. First, TFR was on sudden rise and fall after registering the worst level of 1.08 births per woman in 2005. The TFR rose to 1.13 births in 2006 and 1.29 births in 2007, but fell to 1.19 births in 2008. In 2005, the number of marriages increased due to the so-called "twin-spring year" effect and the "golden boar" effect[1] also contributed significantly to a modest recuperation in TFR in 2006 and 2007 (Figures 1 and 2). At that time, the Korean government spared little efforts to promote the visible effects of "pronatalist population policy programs" on the rise in TFR, after the initiation of their so-called "Saeromaji" project[2] whose basic purpose was to cope with super-low fertility and the aging of population. Second, the crude death rate was relatively stable at 5.0 per thousand, and the annual number of deaths was between 240 and 268 thousand in the years between 2000 and 2008. Third, there was a significant shift of international migration from net emigration (42 thousand) to net immigration (13 thousand) in the years between 2005 and 2008. Korea is now changing from an emigrating country to an immigrating one, as a result of the increased inflow of foreign workers and marriage-related reproductive-age women, compared with the nearly constant or slightly decreasing outflow of people with Korean citizenships to other countries.

It might be tempting to shorten the 5-year projection interval in the countries which experience rapid and unexpected sudden changes in each of the demographic components that have uncertain effects on the shape of future population. Indeed, Statistics Korea had to prepare and release the 2005 interim population projection, four years after the announcement of the 2001 official national population projection, one year after the completion of the 2000 population and housing censuses. There have been greater concerns by policy planners and parliamentarians about the projection exercise designated by the Korean statistics ordinance as the official projection when fertility dropped sharply from 1.47 births in 2000 to 1.08 births in 2005. Statistics Korea had been under great pressure to produce more accurate prediction surpassing a straightforward projection or "forecasting" while the other government agencies have done little policy efforts to stop rapid drop in fertility to a super-low level, as we have seen in some parts of Europe.

In the 2006 interim national projection, Statistics Korea aimed at updating the forecasted values on fertility rate and death rates, using the actual vital statistics data whose quality is being rapidly improved in recent years. The national statistical agency has done a careful examination of the 1970-2008 vital statistics data by distinguishing the vital events which occurred in the country proper from those which occurred abroad. Also it decided to continue exploiting the merits of new basic methodology adopted for the 2006 official national population projection, such as the generalized log gamma distribution model for fertility projection, Lee-Carter method and Brass Logit model for mortality projection, and ARIMA model for migration projection (Statistics Korea, 2009).

Table 1 shows the difference between the 2009 interim national projection and the 2006 official national projection in the values forecasted for the assumptions on fertility, mortality, and international migration. For the 2006 official projection, the target fertility (TFR) at the end of projection horizon is 1.28 births per woman, but it increases moderately to 1.30 births per woman in the 2009 interim projection. Between the two national projections, the difference in life expectancy at birth (for both male and female) tend to increase to a maximum of 0.6 years (in 2015), but gradually decreases or in fact the life expectancy at birth is a little lower in the 2009 interim projection than in the 2006 official projection. Finally, international migration are also forecasted differently between the two national projections: during the entire projection horizon, the 2006 national projection is characterized by a net outflow of 16

[1] This recent fertility increase was concurrent with the Year of the Golden Boar in the Asian lunar calendar. As in some other East Asian countries (e.g. China), children, especially boys, born during this year are thought to be prosperous and lucky. Moreover, because the lunar calendar is based on a cycle of 60 years (12 animals and five characteristics), meaning that the next Year of the Golden Boarg will not come till 2067, it is likely that many Mongolian parents wanted to bear their child during this favorable year, producing hence a tempo distortion in Korean fertility.

[2] This project was established during the tenure of President Roh Moo-Hyun (2003-2008) and continues during the administration of President Lee Myung-Bak (2008-2013). To cope with the persistence of a super-low fertility pattern, it tries to foster the environment favorable to marriage formation, to build child-rearing infrastructure, extend the after-regular-class schools, improve work-life balances, and increase domestic adoption relative to overseas adoption.

thousands but the 2009 interim national projection is characterized by a net inflow of 13 thousands, which reflects recent trend in both a decrease in the outflow of Korean domestic population and an increase in the inflow of foreign workers and marriage-related reproductive age women, both of whom came from mainland China as well as Vietnam and Philippines in Southeast Asia.

According to the 2009 interim projection result, the size of total population reaches its peak at 50.6 thousands in 2025 (Table 2). On the other hand, the size of total population at its peak is 49.0 thousand in 2018 for the 2006 official national population projection, and 50.0 thousands for the 2005 interim population projection. In both of the projection exercises (plus the 2006 projection with the assumption of zero international migration), the persistence of a super-low fertility pattern has the strongest effect on decreasing the size of the peak population and accelerating the timing of reaching it, but the shift of international migration from net outflow to net inflow tends to increase the size of a peak population and delay its timing.

Population composition by major age groups (14 years and younger, 15-64 years, and 65 years and older) reveals little significant differences between the 2006 official projection and the 2009 interim projection (Table 3). In both projections, the percentage shares of those aged 14 and younger and those aged 15-64 years decline from 17.4 percent and 72.9 percent in 2009 to 8.9 percent and 53 percent in 2050, respectively. On the other hand, the percentage share of those aged 65 years and over increases from 10.3 percent in 2009 to 38.2 percent in 2005. Comparing the 2006 official projection with the 2009 interim projection with no migration assumption, the percentage shares of those aged 14 and younger and those aged 15-64 decrease a little more slowly from 17.4 percent and 72.4 percent in 2009 to 9.4 percent and 53.7 in 2050, respectively. On the other hand, the percentage share of those aged 65 years and over increases from 10.3 percent in 2009 to 36.9 percent in 2050.

The percentage share of elderly population does not reveal any major differences between the 2006 official projection and the 2009 interim projection (Table 4). In both 2006 and 2007 projections, the percentage share of those aged 75 years and over increases from 6.6 percent in 2009 to 30.2 percent in 2050, and the percentage share of those aged 85 years and over increases from 1.7 percent in 2009 to 14.5 percent in 2050. Comparing the 2009 interim projection with no migration assumption with the 2006 official projection, the percentage share of those aged 75 years and over increases a little more slowly from 6.5 percent in 2009 to 29.2 percent in 2050 and the same is true for those aged 85 and over showing an increase from 1.7 percent in 2009 to 13.9 percent in 2050. In Korea, where the total fertility rate is very low, the shift of international migration from net outflow to net inflow does not have any noticeable effect on the tempo of population aging. South Korea will be one of the countries having the highest share of elderly population in the world in the middle of the 21st century.

Statistics Korea made a decision that it would not officially release the 2009 interim population projection to the ordinary statistical users for three main reasons. First, sudden rise of TFRs to 1.17 and 1.25 births in 2006 and 2007 might not be sustained in the aftermaths of the global economic crisis which began with the subprime mortgage crisis in the United States. Indeed, TFR dropped again to 1.19 births in 2008 and 1.15 births in 2009. Since 2001, when TFR fell to 1.30 births after the millennium baby boom (TFR = 1.47) in 2000, the average TFR between 2002 and 2008 was 1.28 births, and it was most probable that TFR would continue to fall below the current level. In this case, there has been great uncertainty about the prospect that the total fertility would rise to 1.30 births, and many demographers believes that TFR will continue to fall below 1.0 in the near future, as the government does not pay attention to strong family support program, such as cash support, in helping those who wish to have more children.

With regard to mortality, crude death rates were relatively stable at 5.0 deaths per thousand, probably before 2020, somewhat earlier than the year of its peak population. However, the compilation of death statistics has revealed that life expectancy at birth has increased more rapidly than what was assumed in the 2006 national population projection. On the basis of the 2006 official and 2009 interim population projections, Statistics Korea expects that decreasing number of deaths will delay the exact timing of depopulation, but reinforce the negative effect on the workings of Korean society by accelerating the tempo of population aging, defined as the percentage share of the population aged 65 and over, and the elderly dependency ratios, defined as those aged 65 years and over divided by those aged 15-64 years.

With regard to international migration, Statistics Korea believes that the national population projection results cannot be used to predict a long-term direction of immigration and emigration policies although the Korean government shifts its policy focus to the importation of foreign workers and marriage-related immigrants to overcome the shortage of the domestic workforce in the manufacturing and tertiary sectors and the shortage of Korean brides who wish to marry with Korean grooms in rural and medium-sized cities. According to recent migration statistics, the net outflow of Korean nationals will continue since they leave Korea in order to obtain overseas job and study abroad. On the other hand, the net inflow of Korean non-nationals will continue because they wish to get jobs and live with their marriage partners in Korea, particularly when the Korean government sticks to the current direction of immigration policy for people from China (including ethnic Korean) and various countries in Southeast Asia.

From both of the 2006 and 2009 population projections, Statistics Korea concludes that the overall effect of the total fertility rate and the number of deaths on the shrinkage of the size of total population will be fairly stable and limited in its magnitude. In the persistence of a super-low fertility pattern and the gradual rise in life expectancy at birth, the

projection results indicate that international migration should be an option for maintaining the size of the future total population to a sustainable one, but do not clarify the genuine effect of the super-low fertility pattern on the eventual size of the national population and the tempo of population aging.

3. THE KOREAN NATIONAL POPULATION PROJECTION: COMPARISON WITH OTHER COUNTRIES

In this part, we discusses a broad strategy of population projection implementation to understand the current status of Korean national population projection, comparing it with the national population projections by developed countries and the international organizations, such as the United Nations and the European Union (United Nations, 2008, Eurostat, 2009). The national population projections are usually implemented by the national statistical agencies or departments, which release their major projection results either in the paper publication or on the official websites.

Table 5 summarizes the name of national projection agencies, projection horizon, and projection interval for a selected number of countries and two international organizations. According to our review, the projection methods are essentially the same, namely, the cohort component method. This method projects future population by calculating the annual changes due to the aging of individuals by each age bracket for each component (birth, death, and international migration). As for the already existing individuals, the future population is calculated by subtracting the number of deaths due to aging and international migration. The new born population is determined by calculating the number of live births from the female population in the reproductive ages (15-49 years) and the number of babies remaining from death and international migration is added to the population of the following year.

In the projection process, the cohort component method requires the following input data: (1) the base or launch population (2) future fertility rate (and the sex ratio at birth), (3) future survival rate, and (4) future international migration rates (numbers). This projection method requires a set of assumptions by implementing projection techniques based on actual statistics for each component. Given that future changes in fertility and mortality are inherently indeterminate or uncertain, the national statistical agency or international organization believe that this routine practice provides a range of population projections based on alternative assumptions.

To establish the base population, or the starting point of the national population projection, Statistics Korea use population flow data on births, deaths, and international migration as well as census data on the total population by age and sex. Statistics Korea uses the post-enumeration survey and civil population register data as well as data on registered non-citizen population and illegal immigrants in correcting for the census population figures and preparing the mid-year base population. In the countries reviewed in this paper, there are different practices in preparing the base population. For example, the United Kingdom conducts the census coverage survey to adjust for enumeration errors in the main census survey, and the Nordic countries widely use their population registers along with results from register-based censuses in establishing the base population. In Japan, the national population projection accepts the population census figures as they are in establishing the base population. In general, however, the accuracy of the base population becomes more and more problematic in the era of globalization and borderless migration.

In the deterministic projection model, the core of the cohort component method is how to establish main assumption on future changes in fertility, mortality, and international migration, but in most cases alternative assumptions are established along with the main assumption to cope with the uncertainty issue governing the future demographic trends. In the projection exercises, Statistics Korea combines the main and alternative assumptions on each of the three demographic components to provide broader insight into the shape of future population.

In most countries, probably except Japan, the national statistical agency or department produces the official national projection results on the behalf of the national government. In Japan, the National Institute of Population and Social Security Research, as a government research institution affiliated with the Ministry of Health, Labor, and Welfare, is responsible for producing projection statistics on the behalf of the Japanese government. The horizon length of official projection usually lasts ranges between 45 and 55 years in the majority of selected countries, but often extends to 100 years in the United States, Japan, and Australia. In recent years, Statistics Korea releases 50-year length official projection results, but the other government agencies, such as the National Pension Fund, extend them for the additional 50-year population projection, whenever they are needed. In some very low-fertility countries, like Spain, the national statistics agencies tend to classify the official national population projections into two classes, short-term (10 years) and long-term (40 years) projections, and update the long-term projection once every three years on the basis of annual short-term projections.

The intervals of national population projections are varied. Projections are produced once every year in Austria, Denmark, Norway (since 2009), and Sweden; once every 2-3 years in Australia, New Zealand, the United Kingdom, and the United Nations, and the European Union, and once every 5 years in the rest of the selected countries. The United States produces the official national population projections once every ten years, but the interim projections once every 2 years to process it as an input data for the projection of social security funding requirement. By statistical ordinance, Statistics Korea produces the official projection results once every five years, usually one year after the

completion of population and housing censuses which are conducted every five years in the calendar years ending with zeros and fives. In Germany, the Federal Statistical Office had once produced the official population projection at irregular intervals, but in recent years produces projection results more regularly at 3-5 year intervals. In general, more and more countries try to shorten the length of projection intervals in reducing projection error due to uncertainty elements in the trend of fertility, and mortality, and fertility, and Statistics Korea hopes to produce the official population projection results once every year by compiling improved vital statistics data probably after the completion of a register-based population census which is planned in 2015.

Among the international organizations which produce national population projections are United Nations Population Division and Eurostat, the official statistical department of the European Union. The United Nations population projections are revised once every two years, and the horizon of the most recent projection lasts 43 years (2008-2050). In 2004, the Eurostat began to produce the first official, single-framework population projection for each of its member states plus acceding countries (Bulgaria and Romania). The Eurostat releases its revised projection once every two or three years and the horizon in the most recent projection lasts 63 years (2008-2060). The international organizations produce a single-frame, unified approach to the national population projection for each of their member countries, while each country's national statistical agency or department produces its official national population projections after carrying out a detailed analysis of vital statistics trends and establishing alternative assumptions on fertility, mortality, and international migration. The national population projections produced by the international organizations will be helpful for demographers and policy administrators who wish to gain access to data on future population for its member countries which do not produce their own national population projection.

In Table 6, we summarize the number of assumptions the selected countries establish for each of the three demographic components (fertility, mortality, and international migration) and the number of projection scenarios they produce by sorting out each of the assumptions on future demographic change. In most countries, the main standard projection scenario often called the "medium-variant" projection is made using a combination of the medium-variant assumptions on fertility, mortality, and international migration. In addition, the basic alternative projection scenarios are high-variant and low-variant scenarios which combine high-variant and low-variant assumptions on fertility, mortality, and international migration.

In most selected countries, the national statistical agency develops additional scenarios that combine main and alternative assumptions on future demographic changes in addition to the three major projection scenarios. Sweden and Denmark develop one single, main projection scenario without either low-variant or high-variant scenarios because they produce the national population projection once every year. In a sense, this single scenario approach to population projection may provide easier access to ordinary statistical users. Among the countries and international organizations with more than 20 projection scenarios are France (32 scenarios), Australia (24 scenarios), and the United Kingdom (20 scenarios). Among those with the projection scenarios ranging between 10 and 15 are Germany (15 scenarios), Switzerland (14 scenarios), New Zealand (14 scenarios), Norway (14 scenarios), the United Nations (11), Austria (10 scenarios), and the United States (10). Finally, among those with the projection scenarios smaller than 10 are Japan (9 scenarios), Sweden (7 scenarios), the European Union (6 scenarios), Canada (6 scenarios), Korea (4 scenarios), Poland (4 scenarios), Italy (3 scenarios), and Spain (3 scenarios). In general, the countries with a super-low fertility pattern, such as Italy and Spain in Southern Europe and South Korea in East Asia tend to develop a smaller number of projection scenarios compared to the countries of Western Europe, North America, and Oceania, probably due to the lack of concern with the potential effect of mortality and international migration on the shape of future population.

In most countries, the national statistical agency develops three major fertility assumption, say, medium, high, and low-variant assumptions, comparing cohort fertility with period fertility and establishing target fertility at the end of projection horizon. In the 2006 official national projections, Statistics Korea adopts another additional, so-called "constant" fertility assumption, which states the persistence of currently super-low TFR lower than 1.3 births per woman to the end of the entire projection horizon. In some countries of Western Europe and Oceania, the national statistical agency develops another supplementary fertility assumption that the current fertility will recuperate to the replacement level at a given time in the entire projection horizon.

The number of assumptions on mortality and international migration is mainly three (medium, high, and low variant), which reveals smaller variations than the number of assumptions on fertility. For mortality assumptions, the national statistical agency and the international organization often establishes the so-called "no mortality change" assumption that states the persistence of current mortality pattern to the end of the entire projection horizon. In addition, the United Nations develop various HIV/AIDS-related mortality assumptions to measure the HIV/AIDS effects on the evolution of future population. For international migration, many countries in Western Europe develops the "zero migration" assumption to measure the pure effects of natural growth (births minus deaths) on the shape of future population.

4. A STOCHASTIC NATIONAL POPULATION PROJECTION: ILLUSTRATION FOR KOREA

The 2006 official and 2009 interim population projections rest on deterministic models. In these models, today's population and assumptions on the development of demographic rates determine future population. To account for forecast uncertainty, the 2006 official projections used four major scenarios, based mainly on "high", "medium", "low", or "constant" assumptions of fertility rate. This technique -though common practice - suffers mainly from two shortcomings: First, it does not provide information on the probability of a certain projection scenario. Second, modeling uncertainty by means of different projection scenarios is necessarily inconsistent.

To overcome these problems, probabilistic approaches to population forecasting have been developed in recent years (Lee, 1998; Choi, 2005). The main goal of probabilistic population projections is to obtain prediction intervals of demographic variables and thus to measure projection uncertainty. Probabilistic projections make use of historical forecast errors (Keyfitz, 1992), rest on expert opinion (Lutz, Sanderson, and Scherbov, 1998) or rely on time series analysis to project future population parameters (Lee, 1998).

We illustrate a stochastic projection for Korea in which we use a time series analysis to project future demographic parameters using actual statistics on fertility from 1984 to 2008, which was below a replacement level of 2.1 births and actual data on mortality from 1970 to 2008. The length of projection horizon is 50 years which ranges between 2009 and 2058. In the projection, the first step is to transform raw input data. We first establish the fertility boundary, using TFR. Upper boundary is 8 births, approaching the so-called natural TFR found in pre-industrial populations, while low boundaries are set to 0.6, 0.7, 0.8, and 0.9 births. Mortality is projected using Lee-Carter method, by gender and two age groups (0-64 years, and 64 years and over). The second step is to find ARIMA model of input data: ARIMA (0, 1, 1) and simple exponential smoothing with growth. The third step is to predict the future input considering the error term distribution. The fourth step is to apply cohort component method. The fifth step is to iterate step 3 and step 4, 1000 times. The sixth and final step is to find median and 70% and 95% confidence interval. In this projection exercise, international migration is not considered (no migration is assumed), and the base population is the 2009 mid-year registered population, which comes from the Korean Statistical Information System (Statistics Korea, 2010).

It is a very hard question to establish the lower fertility boundary in Korea with a super-low fertility pattern, particularly since there is prevalent pessimistic mood with respect to the direction of future fertility (Golini, 1998; Bongaarts and Feeney, 2000, Jun, 2005). Thus, it would be desirable for the stochastic projection to prepare not a single model, but four models that assume 4 different limits and then compare the predicted results. The future TFRs are different by the fertility boundary assumptions. If the boundary is assumed to range between 0.6 and 8, the medium TFR will be 0.646, if between 0.7 and 8, it will be 0.728, if between 0.8 and 8, if between 0.8 and 8, it will be 0.815, and if between 0.9 and 8, it will be 0.90 (Figure 3). All of them are lower than the assumption of Statistics Korea in both the 2006 official projection and the 2009 interim projection. Statistics Korea assumes the TFR at the end of projection horizon (here 2050) will be a little higher than the TFR in 2005 or 2008, where this time series projection assumes the current decreasing trend will persist until the end of projection horizon. The 95% probabilities of future TFRs show the effect of boundary assumption. The highest plausible TFRs are almost identical. The TFR will increase in the near future, and then by 2058 it will decrease a little. As the upper boundary (8) is far from the projected fertility rates and the effect of boundary limitation increases as the rate approach to the boundary, the upper boundary effect is small here. However the lower boundaries of the confidence interval are changed by the ultimate boundary assumption. Figure 3 shows the lower boundaries compress the confidence interval and they make the median projection approaches to the lower boundary

Based on these assumptions, future populations are like those found in Figure 4. The size of total population will start to decrease soon. The overall patterns are similar but according to the fertility assumption, the lower limits of the confidence intervals are somewhat different. When the lower TFR boundary is 0.6, population will be more likely to shrink quickly. Future population are expected to decrease by more than 25 percent, the median population in 2058 will be 77 percent of the population in 2009 if the boundary is 0.7 to 8, if 0.8 to 8, then it will be 78 percent, and if 0.9 to 8 then it will be 80%.

This illustrative stochastic projection provides useful insights into the significance of fertility assumption for the determination of future population size. When the lower TFR boundary is 0.6, the size of median total population in 2050 will be 3.8 percent smaller in this illustrative projection than in the 2009 interim national population projection with the assumption of zero migration; the size of the median total population in 2050 will be 2.7 percent smaller than in the 2009 interim projection if the boundary is 0.7 to 8, if 0.8 to 8, then it will be 1.5 percent smaller, and if 0.9 to 8, then it will be nearly identical as the figure in the interim projection. This indicates that the shape of future population is more likely to be determined by the direction of a super-low fertility pattern in Korea, and it might be unreasonable if we put more emphasis on the total population impact of international migration, which assumes growing importance as repeated by some scholars and policy administrators in the slogan of multiculturalism or multi-ethnic society in Korea.

5. FUTURE CHALLENGES OF THE KOREAN NATIONAL POPULATION PROJECTION

In the country, like Korea with a super-low fertility pattern, we believe, the national population projections can improve their forecasting accuracies by updating them more frequently or distinguishing them into short-term and long-term projection. In the case of minor fluctuation in fertility or international migration, it might be more desirable to update a short-term national projection on an annual basis, as seen in the Spanish system of national population projection, than restructuring an entire long-term national projection. Also, the national population projections should develop how to improve the quality of data on vital statistics for the non-national population, particularly, those who immigrate to the country for marriage reasons, and how the assumed values of births and deaths for the non-national foreign population should be taken into consideration in relation to those for the population whose nationalities are Korea, since many policy administrators believe that the influx of foreign workers and marriage-related immigrants, rather than the persistence of a super-low fertility pattern, might contribute more significantly to delaying both the timing of depopulation and the speed of population aging in Korea.

In preparing for the 2011 official population projection, Statistics Korea will hopefully develop more than four projection scenarios and take into account more than four assumptions on fertility, more than one mortality assumption, and more than one international migration assumption. Like in the system of population projection in France, Australia, and the United Kingdom, Statistics Korea will need to prepare and release a total of 27 population projection scenarios, which consider (1) three fertility assumptions (medium, low, high) (2) three mortality assumptions (medium, low, high) and (3) three migration assumptions (medium, low, high). In addition, we may add “constant” assumptions on fertility, mortality, and international migration. However, both of the 2006 official and 2009 interim national population projection indicate that the “constant” and “medium-level” fertility assumptions will not make any large differences in the final projection results, since in the “medium-variant” assumption the level of target fertility at the end of projection horizon is a little larger than the level of fertility observed at the beginning of projection horizon. In such a case, it would be more desirable that the national fertility projection pays more attention to additional types of “low-variant” fertility assumptions by taking into consideration that the current super-low fertility pattern may deteriorate to its much worse level, say, TFR lower than the target fertility forecasted for the “low-variant” assumption in the 2006 official national population projection.

In preparing the 2011 official national population projection, we expect Statistics Korea to pay more attention to the determination of a base population that should include both national and non-national population. We believe that various demographic techniques must be used to determine the base population, since Korea is changing rapidly to an immigrating country, and the census undercounts the non-national population. Statistics Korea wishes to implement a register-based population census beginning in 2015 and the determination of base population will be facilitated by the adoption of one-number-census approach in the United Kingdom or the dual-system estimation approach used in the 2008 Israel’s integrated population census.

The long-term fertility which is often the target fertility to be forecasted for the end of projection horizon in the national population projection is an important element in determining details of the population projection results (Jun, Kim, and Cho, 2005). In both the 2006 official projection and the 2009 interim projection, the quantum and tempo of cohort fertility is taken into consideration to establish the target fertility in period terms (Bongaarts and Feeney, 2000). In the study commissioned by Statistics Korea, the medium-variant assumption establishes the target fertility of the cohort born in 1991 as 1.28, which is a little smaller than in the 2005 interim population projection[3]. This clearly illustrates that marital fertility continues to decline together with a steady rise in marriage age and increasing proportion of the women single or divorced during the reproductive span. We expect that the target fertility of the 2011 official national population projection can be more reasonably determined by using the result from the 2010 population and housing censuses, which include the topics on marital status, age at first marriage, actual number of children born, and the number of children whom the female respondents plan to have. These census topics, as well as actual vital statistics data, will have to be fully exploited to avoid the error in input parameter in the national population projection, refining the generalized log gamma distribution which is used in the Japanese system of population projection

Finally, we hope that Statistics Korea will find wise ways to incorporate the ideas underlying the system of stochastic population projection as part of the official national population projection. One merit of the stochastic population projection models is to use it as a framework for assessing the value of demographic sensitivity tests with various “pronatalist” population policy models. More specifically, they will be used to describe particular problems, such as (1) how the omission of random shocks in each component of demographic change, particularly, fertility (e.g., increase in births due to millennium baby boom, twin-spring years and golden swine years), or international migration (e.g., increase in immigration of foreign-born brides resulting from imbalances in gender composition in the rapid drop of fertility over past 30 years) will lead to population sizes growing beyond all projected population sizes soon after the

[3] The target fertility at the end of projection horizon is substantially higher in the countries of Europe, as compared with the countries of Asia, like Korea and Japan. In general, the medium-variant fertility assumption in the countries of Europe assumes that current low fertility, even in the case of a super-low fertility pattern, is due to the tempo of fertility than the quantity of fertility.

projections are released; (2) to what extent the practice of restricting demographic changes to the beginning of the projection horizons can lead to confusing results for trends in age structure; and (3) with a discussion of the value of stochastic population projections, which are a promising alternative to the current deterministic approach.

6. REFERENCES

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Table 1. Differences in Assumed Values between the 2009 and 2006 Korean Population Projections

	2005	2006	2007	2008	2010	2015	2020	2025	2030	2040	2050
	TFR (per woman)										
2009	1.08	1.12	1.25	1.19	1.15	1.18	1.23	1.26	1.29	1.3	1.3
2006	1.08	1.13	1.14	1.15	1.15	1.17	1.2	1.25	1.28	1.28	1.28
Difference (2009-2008)	-0.01	-0.01	0.11	0.04	0	0.02	0.03	0.01	0.01	0.02	0.02
	male life expectancy at birth										
2009	75.1	75.7	76.1	76.2	76.5	77.7	79.1	79.7	80.4	81.6	82.7
2006	75.1	75.3	75.5	75.7	76.1	77.1	78	78.9	79.8	81.4	82.9
Difference (2009-2008)	0	0.4	0.6	0.5	0.4	0.6	1	0.8	0.6	0.2	-0.2
	female life expectancy at birth										
2009	81.9	82.4	82.7	83	83.5	84.4	85.5	86.1	86.6	87.6	88.6
2006	81.9	82.1	82.3	82.5	82.9	83.8	84.7	85.5	86.3	87.7	88.9
Difference (2009-2008)	0	0.3	0.4	0.5	0.6	0.6	0.8	0.6	0.3	0	-0.3
	international migration										
2009	50	7	118	2	5	12	16	15	14	13	13
2006	-40	-39	-39	-38	-36	-32	-27	-25	-24	-21	-16
Difference (2009-2008)	90	46	157	40	41	44	43	40	38	34	29

Table 2. Peak Population and Peak Year in Recent Korean Population Projections

	2009 Projection (interim)	2006 Projection (official)	2005 Projection (interim)
Population in 2008 (1,000)	48,972	48,607	48,877
Peak Population	50,672	49,340	49,956
Peak Year	2025	2018	2020

Table 3. Population Composition by Major Age Groups in Recent Korean Population Projections

			2009	2010	2080	2020	2030	2040	2050
2006 projection -A		0-14	17.4	16.2	12.7	12.4	11.4	10.3	8.9
		15-64	72.3	72.9	72.9	72	64.4	57.2	53
		65+	10.3	11	14.3	15.6	24.3	32.5	38.2
2009 projection -B		0-14	17.4	16.1	12.8	12.5	11.3	10.3	8.9
		15-64	72.4	72.9	72.8	71.9	64.4	57.3	52.9
		65+	10.3	10.9	14.3	15.6	24.3	32.5	38.2
2009 projection -C (no migration)		0-14	17.4	16.2	13	12.7	11.6	10.7	9.4
		15-64	72.4	72.9	72.8	71.8	64.5	57.7	53.7
		65+	10.3	10.9	14.2	15.5	23.9	31.6	36.9
Difference	B-A	0-14	0	0	0.1	0.1	0	0	0
		15-64	0.1	0.1	-0.1	-0.1	0	0	-0.1
		65+	-0.1	0	0	0	0	0	0.1
	C-A	0-14	0	0	0.2	0.3	0.3	0.4	0.5
		15-64	0.1	0	-0.1	-0.1	0.2	0.4	0.7
		65+	-0.1	-0.1	-0.1	-0.1	-0.4	-0.8	-1.2

Table 4. The Structure of Elderly Population in Recent Korean Population Projections

			2009	2010	2080	2020	2030	2040	2050
2006 projection -A		65+	10.3	11	14.3	15.6	24.3	32.5	38.2
		70+	6.6	7.3	9.7	10.4	16.5	24.1	30.2
		80+	1.7	1.9	3.3	3.6	5.3	9.5	14.5
2009 projection -B		65+	10.3	10.9	14.3	15.6	24.3	32.5	38.2
		70+	6.5	7.2	9.7	10.4	16.5	24.2	30.2
		80+	1.7	1.9	3.3	3.6	5.3	9.5	14.5
2009 projection -C (no migration)		65+	10.3	10.9	14.2	15.5	23.9	31.6	36.9
		70+	6.5	7.2	9.6	10.3	16.2	23.5	29.2
		80+	1.7	1.9	3.2	3.6	5.2	9.3	13.9
Difference	B-A	65+	-0.1	0	0	0	0	0	0.1
		70+	0	0	0	0	0	0	0
		80+	0	0	0	0	0	0	0
	C-A	65+	-0.1	-0.1	-0.1	-0.1	-0.4	-0.8	-1.2
		70+	0	0	-0.1	-0.1	-0.3	-0.6	-1
		80+	0	0	0	0	-0.1	-0.2	-0.5

Table 5. Projection Outline for Selected Countries and International Organizations

Country	Population Projection Agency or Department	The Length of Horizon in Recent Projection[1)]	Projection Cycle
Korea, Republic of	Statistics Korea	2006-2050	5 years[3)]
Japan	National Institute of Population and Social Security Research	2006-2055	5 years
Austrailia	Austrailian Bureau of Statistics	2005-2101	2-3 years
Austria	Statistics Austria	2007-2050	1 year
Canada	Statistics Canada	2006-2031	5 years
Denmark	Statistics Denmark	2007-2050	1 years
Finland	Statistics Finland	2009-2060	3 years
France	National Institute of Statistics and Economic Studies	2006-2050	5 years
Germany	Federal Statistical Office	2006-2050	irregular interval (or 3-5 years)
Italy	Italian National Institute of Statistics	2007-2051	4-5 years
New Zealand	Statistics New Zealand	2009-2061	2-3 years
Norway	Statistics Norway	2010-2060	1 year (since 2009) 3 years (prior to 2009)[2)]
Poland	Central Statistical Office of Poland	2008-2035	5 years
Portugal	Statistics Portugal	2008-2060	2 years
Spain	Statistics Spain	2009-2049 (long-term) 2009-2019 (short term)	3 years (long term), 1 year (short term)
Sweden	Statistics Sweden	2009-2060	1 years
Switzerland	Statistics Switzerland	2005-2050	5 years
United Kingdom	UK Office for National Statistics	2006-2081	2 years
United States	US Bureau of Census	2001-2050	10 years
Europeam Union	Eurostat (Statistical Office of the European Commission)	2008-2060	3-5 years
United Nations	United Nations Population Division	2009-2050	2 years

Note:

1) The length of projection horizon is relevant to the national population projection only.

2) Statistics Norway began to release the national projection once every year since 20009, but the projection cycle was 3 years before 2009.

3) The US Census Bureau releases the national population projection results every 10 years, each time one year after decennial census is completed. In the meantime, interim projections are carried out irreguarly, mainly for the purpose of Social Security premium calculation.

Table 6. Projection Scenarios in the National Population Projections for Selected Countries and International Organizations

Country	Number of Scenarios in the Projection	Number of Assumptions on:		
		Fertility	Mortality	Internatinal Migration
Korea, Republic of	4	3 (Co)	1	1
Japan	9	3	3	1
Austrailia	24	3	2	3 (0)
Austria	10	3 (Co)	3 (Co)	3 (0, Co)
Canada	6	3	3	3
Denmark[1)]	1	1	1	1
Finland	1	1	1	1
France	30	3 (EU average)	3 (Co)	3 (0)
Germany	15	3 (Re, Co)	2	2 (0, 1 other)
Italy	3	3	3	3
New Zealand	14	3 (very high)	3 (very low)	3 (0, 2 others)
Norway	14	3	3 (Co)	3
Poland	4	4	3	2
Portugal	4	3	2	3 (0)
Spain	2 (long term)	1	1	2
Sweden[2)]	7	3	3	3
Switzerland	14	3 (Re)	3 (Co)	3 (0)
United Kingdom	20	3 (Re, Co)	3 (Co)	3 (0)
United States	10	3	3	3 (0)
Europeam Union	7	3	3	3 (0)
United Nations	11	3 (Re, Co)	1 (3 HIV/AIDS assumptions, Co)	1 (0)

Note: For the number of assumptions on fertility, mortality, and migrations, what is written in parenthesis refers to special assumptions other than three main assumptions (medium variant, low variant, and high variant). Re = replacement level fertility, Co = constant (fertility, mortality, or international migration), 0 = zero migration, other = migration assumptions other than zero migration or constant migration.

1) In 2004, Statistics Denmark established 3 fertility assumptions, but they were simplified to one fertility assumption.

2) In 2004, Statistics Sweden established seven projection scenarios by making three assumptions on each component (fertility, mortality, and international migration).

Figure 1. Total Fertility Rate for Selected Countries, 1960-2008

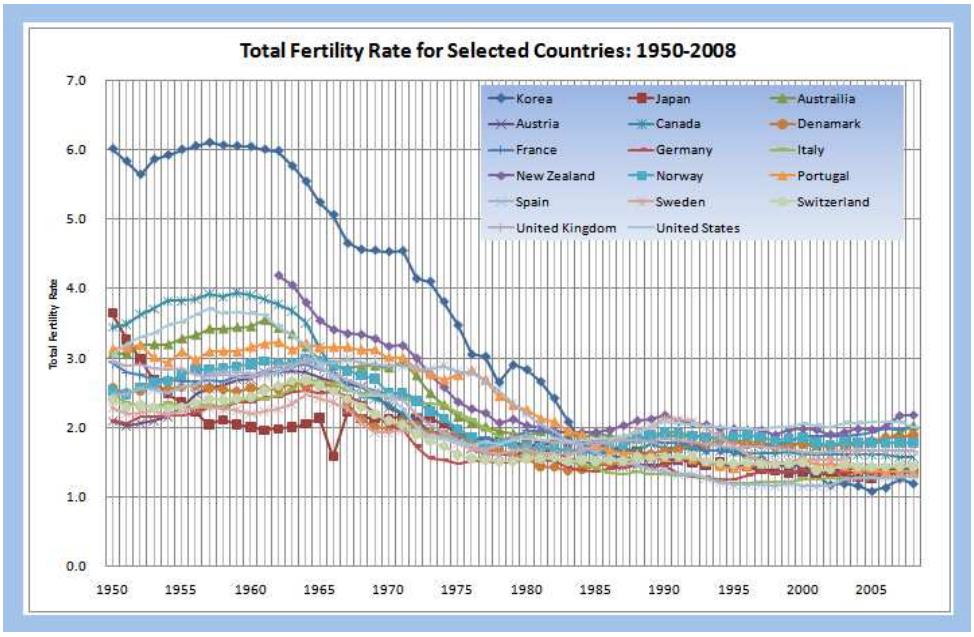

Figure 2. Total Fertility Rate and Number of Births in Korea: 1970-2009

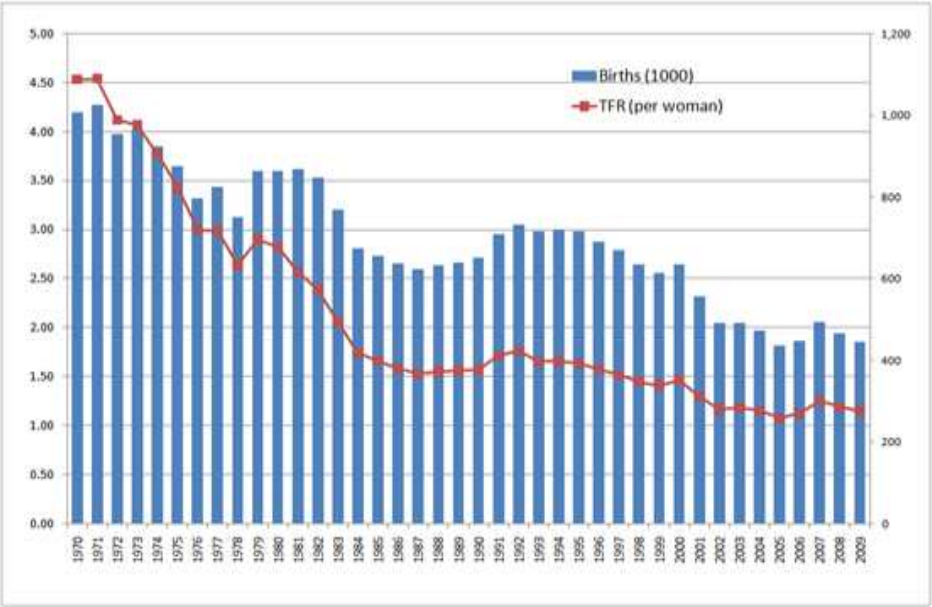

Figure 3. Confidence Interval (95%, 70%) of the forecasted TFR of Korea from 2009 to 2058

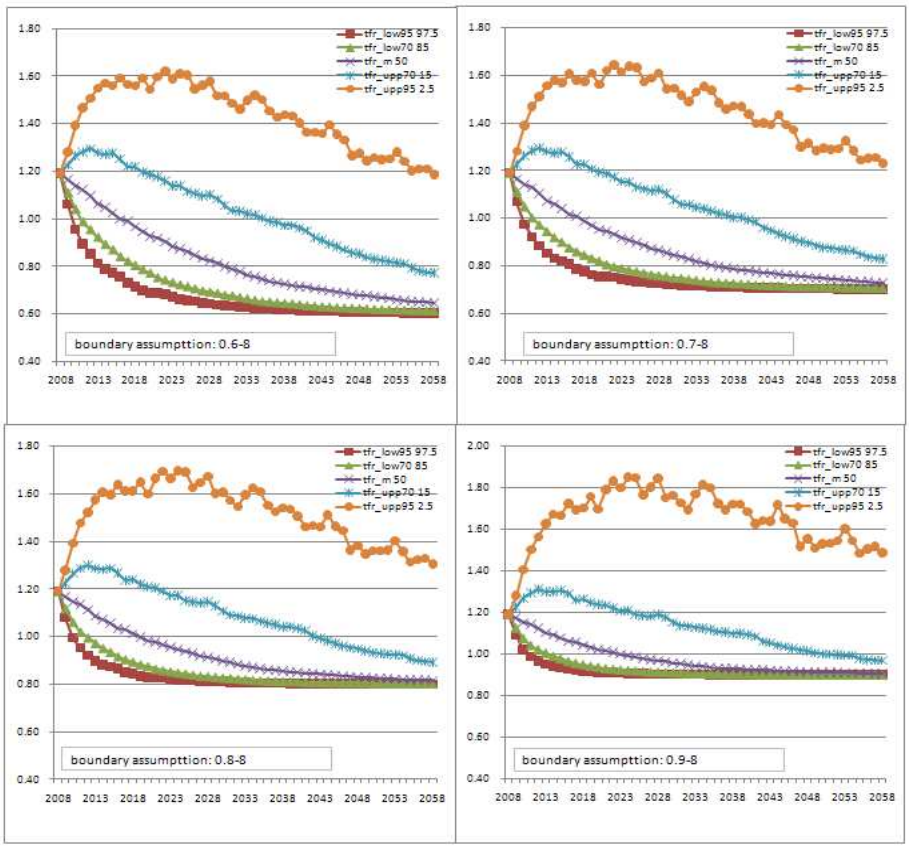

Figure 4. The Confidence Interval (95%, 70%) of the forecasted population of Korea from 2009 to 2058