Immigration Policy and Sustainability of Social Security in Japan‡

Naomi Miyazato*

Nihon University

Abstract

The aging of the population in Japan is the most severe among all developed countries. Before the baby-boomer generation started to retire, Japan's government proposed and implemented many social security reforms. Unfortunately, it is hard to say if those reforms will achieve sustainability of Japan's social security system. There are only two ways for sound financing of social security: decreasing benefit levels or increasing tax revenues. Although analyzing and debating the recovery of the birthrate have often been discussed for increasing tax revenues, immigration policy has barely been investigated, despite the strong implication for the sustainability of social security.

This paper explores whether an immigration policy could mitigate intergenerational imbalances and achieve sustainability of the social security system in Japan. I apply a dynamic general equilibrium simulation model, which was developed by Auerbach and Kotlikoff (1978), to study the effects of immigration policy. By adopting a dynamic set-up, I'm able to investigate the impact on the financing of social security before and after the retirement of immigrants. In addition, I am able to analyze the effect that their descendants would have on the sustainability of social security. Before retirement, an inflow of working-age immigrants increases tax revenues. When these immigrants retire, this effect is reversed. Their descendants have the same effect.

I analyze the effects of immigration in Japan by using an over-lapping generation framework. According to the simulation results, immigration policies, which are both low immigration and high immigration, have decreasing effects on social security taxes overall.

Keywords: Immigration, Sustainability of Social Security, Simulation Analysis

JEL Classification: H55, J11, F22, D58

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* Nihon University College of Economics,
1-3-2 Misaki-cho, Chiyoda-ku, Tokyo, 101-8360 Japan.
Tel/Fax +81-3-3219-3466
E-mail: miyazato@eco.nihon-u.ac.jp

1. Introduction

The aging of the population in Japan is the most severe among all developed countries. Before the baby-boomer generation started to retire, Japan's government proposed and implemented many social security reforms. Unfortunately, it is hard to say if those reforms will achieve sustainability of Japan's social security system. There are only two ways for sound financing of social security: decreasing benefit levels or increasing tax revenues. Although analyzing and debating the recovery of the birthrate have often been discussed for increasing tax revenues, immigration policy has barely been investigated, despite the strong implication for the sustainability of social security.

Razin and Sadka (2000) analyzed the effects of immigrants in a dynamic set-up which included a pay-as-you-go system. They showed the positive effect of immigrants. First of all, working-age immigrants make a net contribution to pensioners in the host country. In the next period, these immigrants have retired and receive pensions. The present value of their pensions may outweigh their contributions during the former period. However, their children make a positive contribution which is sufficient to cover the expenses of their parents. Therefore, the burden of the first generation of immigrants is moved forward into the future. As a result, residents in the host country receive a one-shot gain. If immigration is repeated in each period, or the gain is spread out over all the following periods, all the people in the host country could receive gains, in theory.

Borjas (1994) provided an overview of most of the immigration issue: immigration changes the age composition of the population from the point of view of public finance in a positive direction because immigrants are usually of working age when they arrive in the host country. At same time, they have, on average, a shorter period as retirees. Then, they have effects on lowering public old-age-dependent expenditures and pension benefits. On the other hand, immigrants tend to have higher unemployment and lower wage levels. That means immigrants tend to pay less tax and are a larger fiscal burden. And there may be several general equilibrium effects. An increase in labor supply may lower wages relative to capital. Furthermore, the fertility behavior of immigrants is important. In general, fertility rates of average immigrants are higher than that of host country residents. Wage levels of immigrant's children tend to be relatively low.

There are some studies that carry out empirical and numerical calculations on the effects of immigration. Borjas (1994) computed the net government surplus yielded from the cross-section of immigrants currently residing in the U.S. Simon (1984) and Akbari (1989) computed the tax revenues and government expenditures associated with different immigration cohorts. Bonin, Raffelhuschen and Walliser (1997) and Auerbach and Oreopoulus (1999) analyzed the effects of immigration through partial equilibrium generational accounting approaches for the U.S. and Germany, respectively. Storesletten (2000) builds a simple computable general equilibrium model to examine the effects of various immigration policies for the U.S. He finds that selective immigration policies, involving an increasing inflow of working-age high- and medium-skilled immigrants, can remove the need for future fiscal reform. In contrast, an inflow of immigrants with the age and skills composition of average immigrants cannot induce a long-run budget balance.

There are some studies which concern European countries. Much empirical evidence was surveyed in Coleman and Rowthorn (2004). Bonin, Raffelhüschen, and Walliser (2000) carried out an analysis for Germany using a generational accounting approach. They found that the increase in average-skilled immigrations improved the fiscal condition of Germany, but inflows of high-skilled immigrants will only be able to partially remove the present fiscal imbalance induced by ageing. Roodenburg, Euwals, and ter Rele (2003) also used a generational accounting approach and found that the lifetime net contribution of average immigrants is negative in the Netherlands and an increase in immigration rates would contribute to the sustainability of public finances. Storesletten (2003) performed a partial equilibrium analysis of fiscal implications of immigration to Sweden. He calculated the net present values of immigration effects and shows that average immigrants are not beneficiaries, but some types, 20- to 30-year-old immigrants, improve fiscal conditions. Schou (2006) performed general equilibrium analyses of fiscal implications for the Danish. He found increased immigration would generally worsen the Danish fiscal sustainability problem.

This paper explores whether an immigration policy could mitigate intergenerational imbalances and achieve sustainability of the social security system in Japan. I apply a dynamic general equilibrium simulation model, which was developed by Auerbach and Kotlikoff (1978), to study the effects of immigration policy. By adopting a dynamic set-up, I'm able to investigate the impact on the financing of social security before and after the retirement of immigrants. In addition, I am able to analyze the effect that their descendants would have on the sustainability of social security. Before retirement, an inflow of working-age immigrants increases tax revenues. When these immigrants retire, this effect is reversed. Their descendants have the same effect.

2. The model

I employ the lifecycle general equilibrium model and make use of the overlapping generation model developed by Auerbach and Kotlikoff (1987). This allows us to rigorously analyze changes in the supply of assets caused by demographic change. The basic structure of the model is explained below.

2.1 Demographic Structure and Immigration Policies

The model's households differ by their dates of birth and their lifetime labor-productivity endowments. Every cohort includes three lifetime-earning groups, each with its own endowment of human capital and pattern of growth in this endowment over its lifetime. The three lifetime-earning groups are the low-skilled group, the average-skilled group, and the high-skilled group, respectively.

I used actual demographic structures to achieve realistic simulation results. In this paper, I analyze the transition path in addition to steady states. Simulation periods are 150 years. Demographic structures from year 0 to year 49 in the simulation correspond to real demography from 1955 to 2004, provided by the Ministry of Public Management, Home Affairs, Posts and Telecommunications. After the 50-year simulation, I used population projections for Japan (2007), estimated by the National Institute of Population and Social Security in Japan from 2005 to 2105. Figure 1 shows the total population in Japan from 1950 through to 2105. This figure reaches the top at 2005 and decreases after 2005. Total populations are 127,768,000 at 2005, 119,270,000 at 2025, 91,152,000 at 2050, and44,592,000 at 2100, respectively. Figure 2 shows the ratio of the elderly population. This index is the ratio of people 65 years old and over to the total population. These figures are 30.5% at 2025, 39.6% at 2050, respectively. Figure 1 and Figure 2 imply large impacts from immigration into Japan.

The immigrants' skills take on three values; low skilled, average skilled and high skilled. Skill are exogenous and do not change during their lifetime. It is assumed that immigrants have children from 21 to 49 years old. The fertility rate of immigrants is assumed to be same rate in "Population Projections for Japan". It is assumed that skills of immigrants' children are given randomly. Even if immigrants have high skills, one third of their children become low skill labor and vice versa.

According to OECD (1998), 22,000,000 more immigrants are needed to maintain the ratio of elderly population at preset level in Japan. However, this value is impractical policy because Japan's government has not officially absorbed immigrants yet. So I start to analyze less number of immigrants. According to OECD (2007), 2,000,000 foreigners have lived in Japan. Then I start to analyze effects of 2,000,000 immigrants. Case 1 is inflow of low-skilled immigrants aged 21 to 30. Case 2 is inflow of high-skilled immigrants aged 21 to 30. The number of immigrants at each age is 20,000, so 200,000 more immigrants (inflow) each year. I assume that immigration policies are implemented from 2015 to 2025. Therefore, the total number of immigrants is 2,000,000. Next, I analyze the effects of immigrants increasing permanently. Case 3 is that inflow of low-skilled immigrants aged 21 to 30 continues permanently from 2015. Case 4 is that inflow of high-skilled immigrants aged 21 to 30 continues permanently from 2015.

2.2 Households

Households live for 80 periods at maximum and face fatality at each period. Income classes are divided into three classes. There are the same numbers of each skill type household among each cohort. Therefore, one third of the cohort is high skill, average skill and low skill, respectively. Each household is assumed to have the same utility function. However, unequal labor endowments create different income levels. It is also assumed that each household appears in the economy as a decision-making unit from the age of 21 and lives to no more than 100 years. Each j-type (j=1,2,3) household who begins economic life at date t chooses perfect-foresight consumption paths (c), leisure paths (l) to maximize a time-separable utility function of the form

$$U_i^j = \frac{1}{1-\frac{1}{\gamma}}\left[\sum_{s=21}^{199} PS_{s,t+s-21}\beta^{s-21}\left(c_{s,t+s-21}^{j\ 1-\frac{1}{\rho}} + \alpha l_{s,t+s-21}^{j\ 1-\frac{1}{\rho}}\right)^{\frac{1-\frac{1}{\gamma}}{1-\frac{1}{\rho}}}\right] \tag{1}$$

j = 1,2,3

where α is the utility weight on leisure, γ is the intertemporal elasticity of substation in the leisure/consumption composite, and ρ is the intratemporal elasticity of substitution between consumption and leisure. The term $\beta=1/(1+\delta)$, where δ is the rate of time preference, is assumed to be the same for all household. $PS_{s,t}$ is probability of survival at each age. c is consumption. l is leisure. Furthermore, s represents age, t year.

Letting $a^j_{s,t}$ be capital holdings for type j household, of age s, at time t, maximization of (1) is subject to a lifetime budget constraint defined by equation (2)

$$a_{s+1,t+1}^j = (1+r_t)a_{s,t}^j + \left(1-\tau_t^{w,1}-\tau_t^{w,2}\right)w_t\varepsilon_s x^j\left(E-l_{s,t}^j\right) + b_{s,t}^j + ps_{s,t}^j - c_{s,t}^j \tag{2}$$

$$E \geq l_{s,t}^j \tag{3}$$

and

$$a_{100,t}^j \geq 0 \tag{4}$$

Where $a_{s,t}^j$ represent the amount of assets held by the household at the beginning of age s, r_t interest rate, E the time endowment (twenty-four hours), ε_s the age profile of earning ability[1], x^j the weight coefficient corresponding to the different levels of labor endowment. τ_t^w is wage income tax($\tau_t^{w,1}$ is public pension tax, $\tau_t^{w,2}$ is pubic assistance tax respectively). $b^j_{s,t}$ is public pension benefits. $ps^j_{s,t}$ is public assistance. There are no liquidity constraints, so the assets in (2) can be negative.

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[1] In this paper, the age profile of earning ability ε_s follows values in Auerbach and Kotlikoff (1987) .

In this paper, I consider cost of immigration as public assistance. Equation (2) includes this cost. Public assistance follows below:

$$ps_{s,t}^{j} = z\eta\overline{w}_t \qquad (j=1) \qquad (5)$$

$$ps_{s,t}^{j} = 0 \qquad (j=2,3) \qquad (6)$$

where z is probability of pubic assistance recipient (or welfare recipient), η is replacement rate of public assitance, and $\overline{w}_t$ is average wage of middle class.

The age at which households start to receive public pension benefits is RE, the average annual remuneration is H, the replacement ratio of earning related pension is κ. The variables related to the public pension are represented as follows:

$$b_{s,t}^{j} = f + \kappa H^{j} \qquad (s \geq RE) \qquad (7)$$

$$b_{s,t}^{j} = 0 \qquad (s < 0) \qquad (8)$$

$$H = \frac{1}{RE-1}\sum_{s=1}^{RE-1} w_t \varepsilon_s x^{j}\left(E - l_{s,t}^{j}\right) \qquad (9)$$

$$f = d\overline{w}_t \qquad (10)$$

where H represents earned income that is used for calculating the amount of pension benefits. H also reflects the wage rate during the working period. f is basic pension portion. In this paper, I assume basic pension benefit is average wage of middle class $\overline{w}_t$ multiple by replacement rate of basic pension portion d.

2.3 The Government

The public pension system is a pay-as-you-go system, and aggregate pension benefits are equal to aggregate pension insurance payments for each period. The budget constraint of public pension is:

$$AB_t = AP_t \qquad (10)$$

where AP_t represents the total revenue from the pension insurance contribution. And

AB_t represents the total public pension benefit to retired generations. AP_t is defined as follows:

$$AP_t = \sum_{j=1}^{3} \sum_{s=21}^{RE-1} N_{s,t}^{j} \tau_t^{w,j} w_t \varepsilon_s x^j \left(E - l_{s,t}^{j}\right) \tag{11}$$

where $N^j_{s,t}$ is population of each type.

On the other hand, the total public pension benefit AB_t is defined as follows:

$$AB_t = \sum_{j=1}^{3} \sum_{s=RE}^{100} N_{s,t}^{j} b_{s,t}^{j} \tag{12}$$

There is another budget constraint of government in this paper. Total benefit of public assistance equals total revenue from tax. I assume that this tax collected from wage income tax. The budget constraint of public assistance is:

$$TPA_t = TPL_t \tag{13}$$

where TPA_t represents the total revenue from public assistance tax. And TPL_t represents the total public assistance benefit to recipients. TPA_t is defined as follows:

$$TPA_t = \sum_{j=1}^{3} \sum_{s=21}^{RE-1} N_{s,t}^{j} \tau_t^{w,2} w_t \varepsilon_s x^j \left(E - l_{s,t}^{j}\right) \tag{14}$$

On the other hand, the total public assistance benefit TPL_t is defined as follows:

$$TPL_t = \sum_{j=1}^{3} \sum_{s=21}^{100} N_{s,t}^{j} ps_{s,t}^{j} \tag{15}$$

2.4 Firms and Technology

Aggregate capital (K) and labor (L) equal the respective sums of individual asset and labor supplies as indicated in equation (16) and (17).

$$K_t = \sum_{j=1}^{3}\sum_{s=21}^{100} N_{s,t}^{j} a_{s,t}^{j} \tag{16}$$

$$L_t = \sum_{j=1}^{3}\sum_{s=21}^{RE-1} N_{s,t}^{j} \varepsilon_s x^{j}\left(E - l_{s,t}^{j}\right) \tag{17}$$

Output is produced by identical competitive firms using constant-returns-to-scale production technology. In the base case, the aggregate production technology is the standard Cobb-Douglas form:

$$Y_t = AK_t^{\theta} L_t^{1-\theta} \tag{18}$$

where Y_t is aggregate output and θ is capital's share in production. A is production scale parameter. The competitive pretax rate of return to capital at time t is given by the marginal product of capital

$$r_t = \theta A k_t^{\theta-1} \tag{19}$$

3. Simulation Analysis

The model is solved under perfect foresight by households. The simulation model can be solved using the Gauss-Seidel method.

3.1 Specification of the Parameters

First of all, I have to specify the parameters in order to solve the model. All of the parameters have been set so that the actual value could be reproduced as close as possible. Table 1 shows the value of parameters. The value for δ, the rate of time preference is set equal to 0.004 to generate a realistic value for the capita-output ratio in the initial steady state. The values of γ and ρ are those in Auerbach and Kotlikoff (1987). The intertemporal elasticity, γ, is set equal to 0.25. I chose α, the utility function's leisure intensity parameter, such that, on average household devote about 40 percent of their available time endowment to labor during their working years. Three lifetime-earning groups are the low-skilled group, the average-skilled group, and the high-skilled group. I assume that differences in earnings come from different wage rates. Furthermore, I assume the wage rate of the low-skilled group is 0.5 times that of average-skilled group, and high-skilled group's wage rate is 2.0 times the average-skilled group[2]. That is, I assume x^1 is 0.5, x^2 1, and x^3 2.0 respectively. Recently, probability of pubic assistance recipient is around 0.02. Then I assume probability of pubic assistance recipient z is 0.02. According to Basic Survey on Wage Structure (Chingin Kozo Kihon Chosa), average wage is about 300,000 yen in 2005. On the other hand, public assistance benefits per capita are 148,444 yen in 2005 from National Institute of Population and Social Security. Then I assume η is replacement rate of public assistance η is 0.5.

3.2 Simulation Results

I show simulation results for capital stock, consumption and utility levels, etc from Table 2 to Table 6. Table 2 shows the no immigration case results. In the no immigration case, population structures follow Population Projections for Japan (2007). In the steady state, the model generates an interest rate of 4.302 percent. Capital stock, labor and consumption are 186.348, 24.048, and 40.925, respectively. The social security tax rate is 4.302 percent and the average utility level is -681701.9. In 20 years from the initial steady state, the interest rate is 3.749. Capital stock is 219.265, labor 23.552, consumption 41.345. The social security tax rate is 8.52, and the utility level is -705686.1. Capital stock is 224.045, labor 26.692, consumption 38.836 after 60 years. The social security tax rate is 31.137, and the utility level is -974841.1. Capital stock is 175.952, labor 27.079, consumption 36.816 after 90 years. The social security tax rate is 30.714, and the utility level is -905451.3. Capital stock is 170.569, labor 26.305, consumption 37.185 after 120 years. The social security tax rate is 21.534, and the utility level is -759463.1.

Table 3 shows the effects of low-skilled immigrants increasing temporarily. In this case, I assume that age 21 to 30 low-skill immigrant inflow was from 2015 to 2025 (which corresponds to 61 periods to 70 periods in the simulation). The number of immigrants at each age is 20,000. Then 200,000 more immigrants (inflow) each year and the total number of immigrants is 2,000,000 from 2015 to 2025. Results show that capital stock, consumption, and utility level are lower than that of the no immigration case in 2045 and 2075 (which corresponds to 90 periods and 120 periods in the simulation)[3]. Table 4 shows effects of high-skilled immigrants increasing temporarily. Results show that capital stock, consumption, and utility level are higher than that of the no immigration case after 2015 (which corresponds to 60 periods).

Table 5 shows the effects of low-skilled immigrants increasing permanently. In this

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[2] Okamoto(2004) calculates the weight coefficient corresponding to the different levels of labor endowment by using the Statistical Year Book of National Taxes (Kokuzeicho Tokei-Nenposho).

[3] In this paper, utility level is higher when it close to 0.

case, I assume that age 21 to 30 low-skill immigrant inflow was from 2015 to 2105 (which corresponds to 61 periods to 150 periods in the simulation). The number of immigrants at each age is 20,000. Then 200,000 more immigrants (inflow) each year and the total number of immigrants is 18,000,000 from 2015 to 2105. Results show that capital stock, consumption, and utility level are lower than that of the no immigration case in 2045 and 2075 and 2105 (which corresponds to 90 periods and 120 and 150 periods in the simulation). Table 6 shows effects of high-skilled immigrants increasing permanently. Results show that capital stock, consumption, and utility level are higher than that of the no immigration case after 2015 (which corresponds to 60 periods).

Figure 3 is simulated social security taxes which also includes public assistance taxes. In the no immigration case, the social security tax in 2005 is 24.224% and it reaches 34.045% in 2025, 30.714% in 2045. Figure 4 shows difference of social security taxes between the temporal immigration case and the no immigration case. In low-skill immigration case, those differences become to be positive (than is, social security taxes in immigration case are higher than in no immigration case) after 2032. In high-skill immigration case, those become to be positive after 2054. Figure 5 shows difference of social security taxes between the permanent immigration case and the no immigration case. In low-skill and high-skill immigration case, those differences become to be positive continuously after 2054. A climbing power of social security taxes in permanent immigration is larger than in temporal case.

Figure 6 and 7 show the effects on the net preset value of social security. First of all, I calculate net preset value of social security as (20).

$$NPV_t = \frac{\sum_{s=RE}^{100} b_{s,t+s-1}^{j}\left(1+r_t\right) \Big/ \prod_{j=1}^{s}\left(1+r_{t+j-1}\right)}{\sum_{s=1}^{RE-1}\left(\tau_{t+s-1}^{w,1}+\tau_{t+s-1}^{w,2}\right) w_{t+s-1}\varepsilon_s x^j \left(E-l_{s,t+s-1}^{j}\right)\left(1+r_t\right) \Big/ \prod_{j=1}^{s}\left(1+r_{t+j-1}\right)} \tag{20}$$

The numerator on the right-hand side of (20) is the net present value of social security benefits, and the denominator on the right-hand side of (20) is the net present value of social security payments. Next I calculate the difference in NPV between the immigration case and the no immigration case for each generation. Figure 6 shows these results in temporal immigration case. The horizontal axis represents the birth year. There are some generations whose differences of NPV are negative in high-skill immigration case. On the other hand, almost generations have negative effects of NPV in low-skill immigration case. Figure 7 shows these results in permanent immigration case. Almost generations have negative effects of NPV in low-skill immigration case. On the other hand, all generations have positive effects in high-skill immigration case.

4. Conclusion

I analyzed the effects of immigration in Japan by using an over-lapping generation framework. According to the simulation results, the social security taxes for the immigration case are higher than that of the no immigration case after 2054. A climbing pressure of social security taxes in permanent immigration is larger than in temporal case. In addition, I calculated the difference of the NPV between the immigration case and the no immigration case for each generation according to (20). There are some generations whose differences of NPV are negative in temporal high-skill immigration case. Almost generations have negative effects of NPV in temporal low-skill immigration case. On the other hand, almost generations have negative effects of NPV in permanent low-skill immigration case. All generations have positive effects in permanent high-skill immigration case.

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Table 1. Parameters

	Definition	Value
α	Utility weight on leisure	1
δ	Rate of time preference	0.004
γ	Intertemporal substitution elasticity	0.25
ρ	intratemporal substitution elasticity	0.8
θ	Capital share	0.25
A	Production scale parameter	1
x1	weight on labor endowments of low income class	0.5
x2	weight on labor endowments of middle income clas	1
x3	weight on labor endowments of high income class	2
κ	replacement ratio of earning related pension	0.2
d	replacement rate of basic pension portion	0.2
z	probability of pubic assistance recipient	0.02
η	replacement rate of public assitance	0.5

Table 2. No immigration case

Year	Capital stock	Laobr supply	Consumption	Wage rate	Interest rate	Net saving rate	Social security tax	Utility
Initial steady state	186.3486	24.04884	40.92528	1.00001	0.04302	−0.12828	0.04729	−681702
1	186.3484	22.13255	39.34426	1.02098	0.04042	−0.03155	0.0487	−655140
20	219.2652	23.55247	41.345	1.04695	0.03749	−0.05667	0.0852	−705686
60	224.0451	26.69247	38.83643	1.02019	0.04051	0.07093	0.31137	−974841
90	175.9526	27.07932	36.81663	0.95693	0.04909	0.07484	0.30714	−905451
120	170.569	26.30581	37.18536	0.95643	0.04917	0.03709	0.21534	−759463
150	194.4333	24.7562	42.58301	1.00337	0.04258	−0.11702	0.12829	−700079

Table 3. Low-skilled immigrants increasing case (temporal immigrants)

Year	Capital stock	Laobr supply	Consumption	Wage rate	Interest rate	Net saving	Social security tax	Utility
Initial steady state	186.3486	24.04884	40.92528	1.00001	0.04302	−0.12828	0.04729	−681702
1	186.3484	22.11798	39.31976	1.02115	0.0404	−0.03177	0.0488	−655229
20	219.4188	23.55352	41.35012	1.04712	0.03747	−0.0564	0.08518	−705195
60	226.095	26.74631	38.8664	1.022	0.0403	0.0737	0.31089	−1050431
90	173.8478	27.05006	36.30274	0.95432	0.0495	0.08359	0.30758	−918930
120	167.8709	26.3409	36.66163	0.95231	0.04981	0.04809	0.2267	−768882
150	207.191	24.93433	42.7653	1.01762	0.04082	−0.09857	0.13272	−692641

Table 4. High-skilled immigrants increasing case (temporal immigrants)

Year	Capital stock	Laobr supply	Consumption	Wage rate	Interest rate	Net saving	Social security tax	Utility
Initial steady state	186.3486	24.04884	40.92528	1.00001	0.04302	−0.12828	0.04729	−681702
1	186.3484	22.11823	39.32011	1.02114	0.0404	−0.03177	0.0488	−655295
20	219.4137	23.55314	41.35022	1.04712	0.03747	−0.05641	0.08518	−705909
60	225.311	26.70058	38.87862	1.02155	0.04035	0.07156	0.31144	−884836
90	178.8859	27.10642	37.47682	0.96066	0.04852	0.06427	0.30663	−906397
120	172.682	26.45405	37.62884	0.95803	0.04892	0.03346	0.22013	−762142
150	207.0366	24.93939	42.7524	1.01738	0.04085	−0.09828	0.133	−693157

Table 5. Low-skilled immigrants increasing case (permanent immigrants)

Year	Capital stock	Laobr supply	Consumption	Wage rate	Interest rate	Net saving rate	Social security tax	Utility
Initial steady state	186.3486	24.04884	40.92528	1.00001	0.04302	−0.12828	0.04729	−681702
1	186.3484	22.11174	39.30981	1.02122	0.04039	−0.03189	0.04884	−655287
20	219.4704	23.55401	41.35137	1.04718	0.03746	−0.05627	0.08517	−704985
60	226.8773	26.76804	38.87706	1.02267	0.04022	0.07474	0.31072	−1046215
90	173.0896	27.12714	35.36687	0.9526	0.04976	0.10669	0.30707	−1047425
120	159.1011	26.47841	33.48107	0.9384	0.05206	0.11821	0.23882	−968138
150	163.2858	25.15574	35.43209	0.95669	0.04913	0.03355	0.17411	−928657

Table 6. High-skilled immigrants increasing case (permanent immigrants)

Year	Capital stock	Laobr supply	Consumption	Wage rate	Interest rate	Net saving rate	Social security tax	Utility
Initial steady state	186.3486	24.04884	40.92528	1.00001	0.04302	−0.12828	0.04729	−681702
1	186.3484	22.12168	39.3251	1.0211	0.04041	−0.03172	0.04878	−655253
20	219.3708	23.553	41.34884	1.04707	0.03747	−0.0565	0.08518	−706108
60	224.6676	26.6793	38.87239	1.02102	0.04042	0.07059	0.31162	−888863
90	179.3661	26.97129	38.70051	0.9625	0.04824	0.03361	0.30731	−784799
120	188.2314	26.66598	41.70017	0.97696	0.04613	−0.03313	0.23827	−639319
150	245.4358	25.36741	50.27596	1.05708	0.03642	−0.20865	0.15461	−570040

Figure 1. Total populations

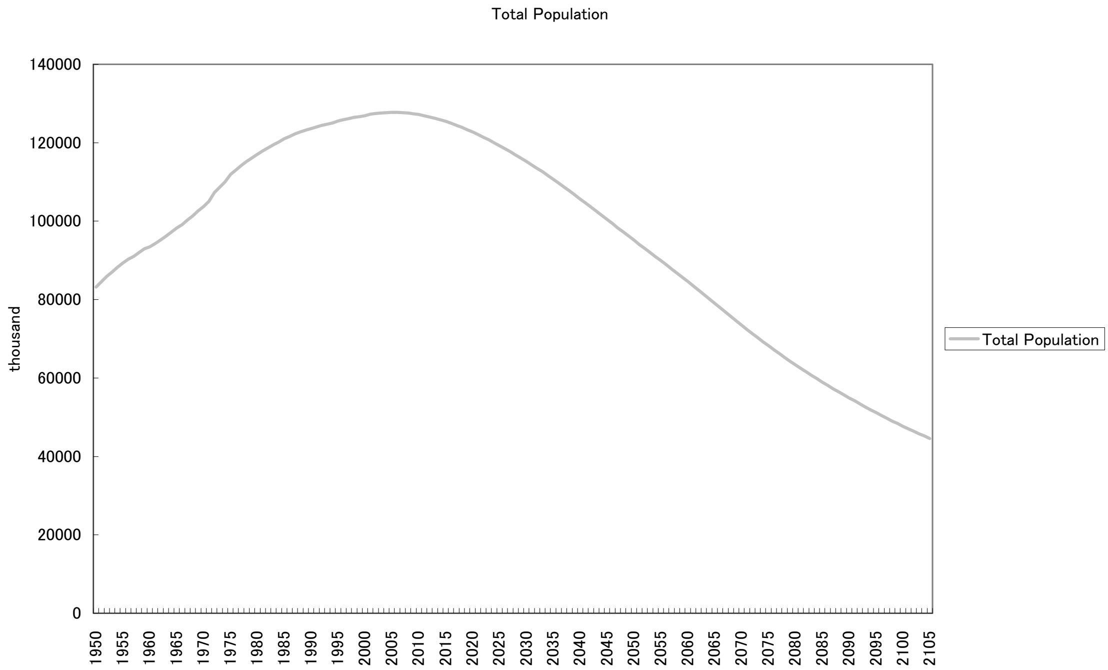

Figure 2. The ratio of elderly population

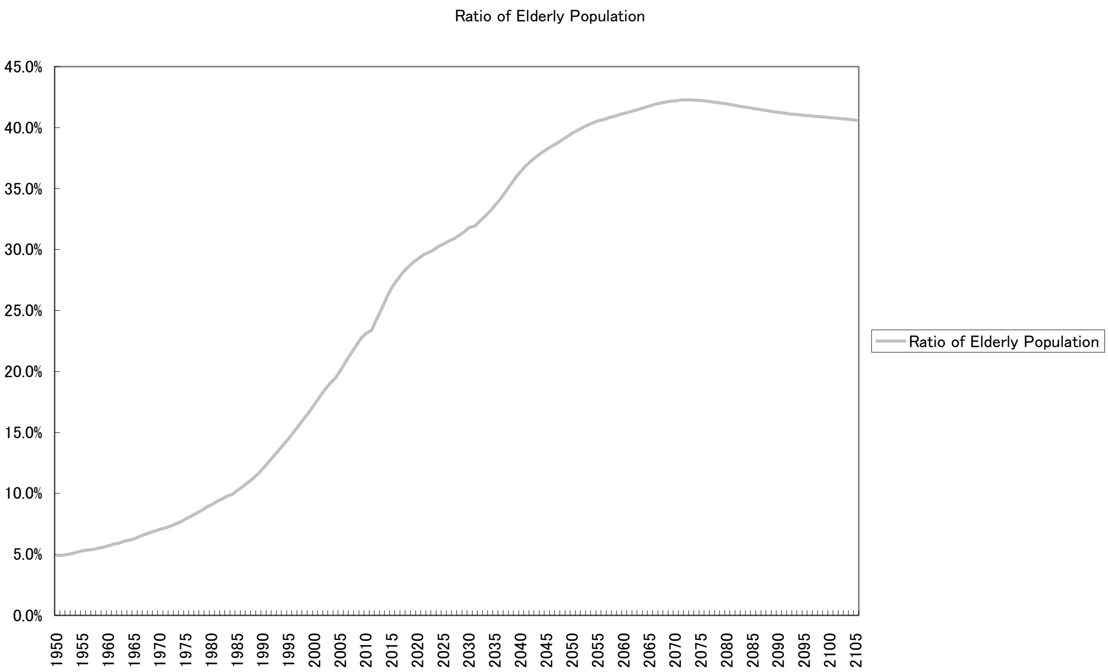

Figure 3. Social Security Tax

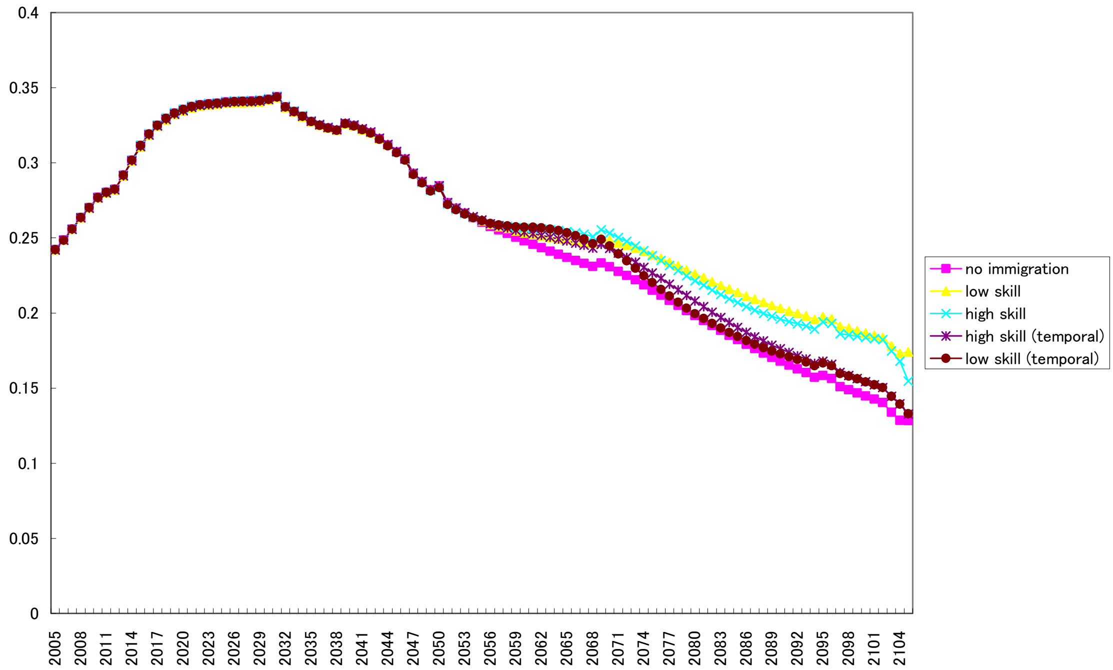

Figure 4. Difference between the immigration case and the no immigration case (temporal immigration case)

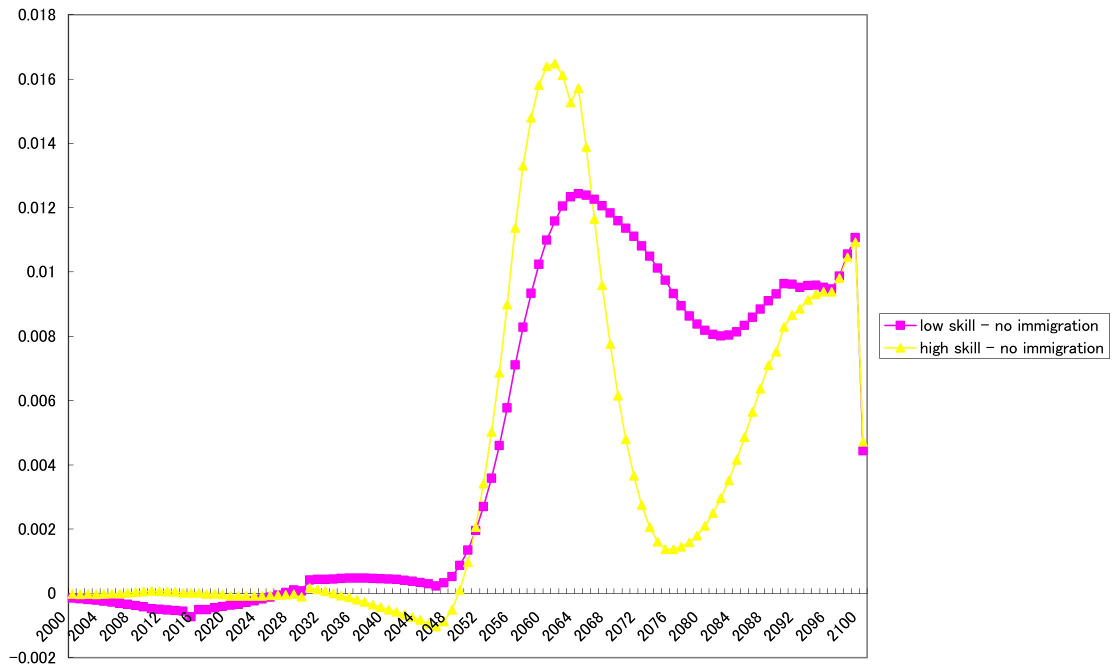

Figure 5. Difference between the immigration case and the no immigration case (permanent immigration case)

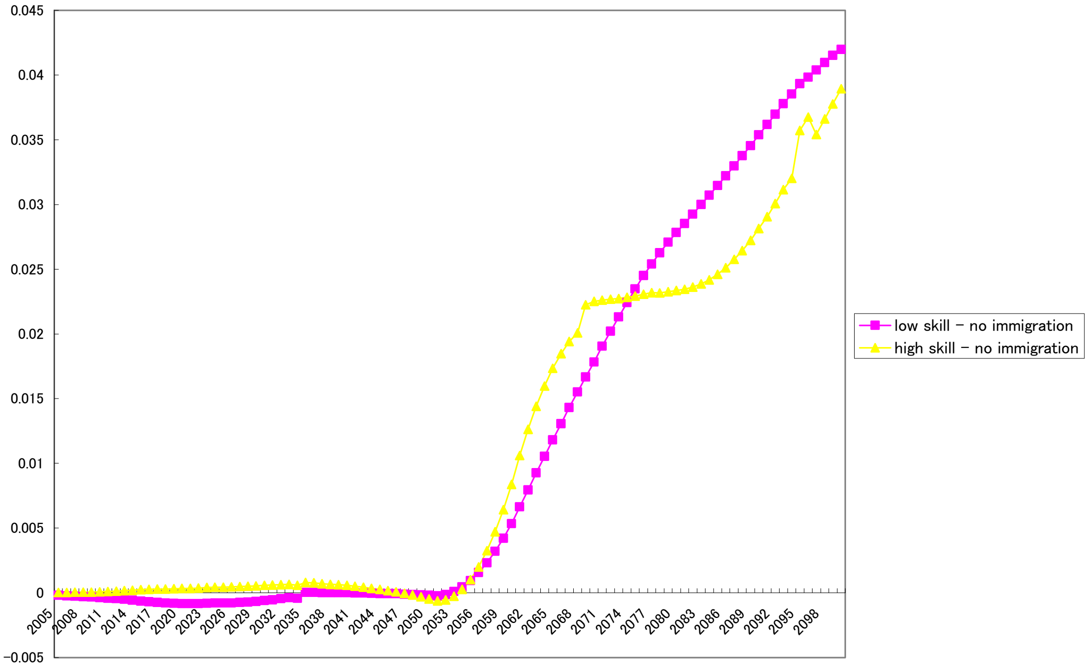

Figure 6. Effects on net present values of social security (temporal immigration case)

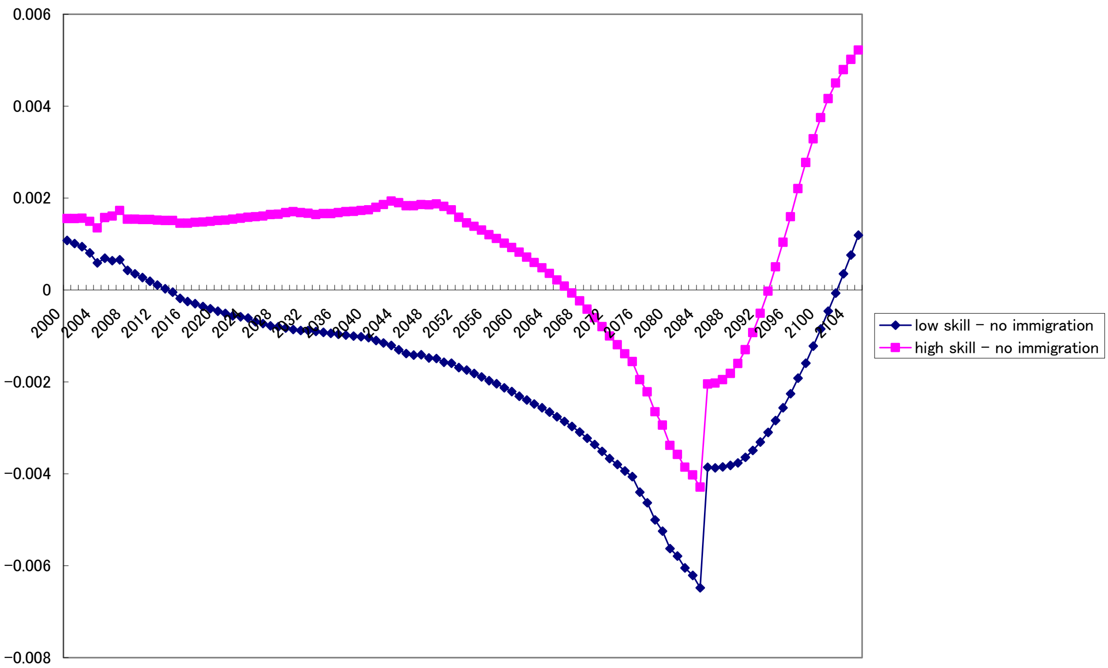

Figure 7. Effects on net present values of social security (permanent immigration case)