DOES A CHANGE IN RETIREMENT AGE AFFECT A REGIONAL ECONOMY? EVIDENCE FROM THE CHICAGO ECONOMY

Seryoung Park and Geoffrey J.D. Hewings

REAL 07-T-6 July, 2007

Does a Change in Retirement Age Affect a Regional Economy? Evidence from the Chicago Economy

Seryoung Park

Research Department, Bank of Korea, Seoul; formerly, Department of Economics and Regional Economics Applications Laboratory, University of Illinois at Urbana-Champaign, 607 S. Mathews #220, Urbana, IL 61801-3671, USA spark2@uiuc.edu

Geoffrey J.D. Hewings

Departments of Geography, Economics and Urban and Regional Planning, Regional Economics Applications Laboratory and Institute of Government and Public Affairs, University of Illinois at Urbana-Champaign, 607 S. Mathews #220, Urbana, IL 61801-3671, USA hewings@uiuc.edu

Abstract

This paper continues the exploration of the impacts on an aging population on an economy employing a two region computable general equilibrium model that is linked with an overlapping generations framework. Two regions are specified, the Chicago metropolitan area and the Rest of the US (ROUS). A series of experiments is conducted; first, the impacts of changes in retirement age are considered, incrementing retirement from 65 to age 69. Secondly, the impacts of reduction in pension benefits are examined, reducing the replacement rate from 50% (baseline) to zero percent. Thereafter, an attempt is made to explore some optimal combinations of policies that include changing retirement age, reducing pension benefits and increasing immigration. A final set of experiments explores the impact of retiree out-migration. While the focus of attention is on the Chicago economy, some of the impacts on the ROUS are presented. The results reveal that, in combination, the results are not monotonic – for different policy mixes at one point in time and over time. A larger number of immigrants into the Chicago region and more generous pension benefits do not necessarily result in more desirable (welfare) benefits while an increase in the retirement age turns out to monotonically improve average welfare.

1. Introduction

This paper focuses on the role that aging, immigration and retirement play in changing the structure of a regional economy; further, migration is considered to play two main roles through the international immigration of essentially younger, less skilled populations and the out-migration of retirees. The analysis integrates an overlapping generations framework within a two-region (Chicago-Rest of the US) computable general equilibrium model to evaluate a number of policy outcomes; earlier work (Park and Hewings, 2007a) focused only on the role of aging while Park and Hewings (2007b) examined the interplay between aging and immigration. In this paper, issues surrounding retirement age and social security tax rates as well as retiree out-migration will be considered to provide a more extensive (and complex) analysis of outcomes.

It is only relatively recently that demographic challenges to regional economic development have been considered in a more extensive way; as Nilsson (2007) has shown, homotheticity in consumption preferences ignores the role of income distribution and the well-known Engel curve relationships between expenditures and income. However, as Yoon and Hewings (2006) demonstrated, non-homothetic consumption preferences can also arise due to age; thus, changes in the age structure of a region (through aging and/or in- and out-migration) could potentially alter not only what is consumed but also what is produced to meet local demand.

In aggregate, as Frey (2007) has noted, the aging of the baby boom generation makes pre-seniors this decade's fastest growing age group, expanding nearly 50 percent in size from 2000 to 2010. He refers to the impact as a "senior tsunami" beginning in 2011; this group will be more highly educated, have more professional women, and exhibit more household diversity than previous generations entering traditional retirement age. Lifetime expectancy is increasing and for many people approaching age 65, there is an important decision about whether or not to retire. Further, many retirees are returning to the labor force partly driven by financial exigencies and partly by psychological reasons.

If a worker learns that he will live longer than previously expected, he would be expected to consume less or work longer before retirement to finance the additional consumption expenditures during this extended lifetime. In the model developed in this paper, the maximum lifetime is limited to the age of 85; however, the average expected lifetime is assumed to be increased due to the lower probability of death under an aging population. Thus, the optimal behavior of each individual under an aging population should be similar to that of the situation where each individual lives longer. However, *ceteris paribus*, an individual is not likely to choose a smaller level of consumption because it could hurt the welfare which could be achieved otherwise. Instead, he will continue to work, if possible, beyond the initial retirement age, so that he could adjust income in proportion to increased life expectancy, which would then allow the same amount of consumption as before.[1] In this respect, increasing the retirement age can be considered as an alternative policy measure to compensate for the loss of labor supply under an aging population. Moreover, since increasing the working age is equivalent to a delay in the age

[1] This feature is stronger in this model since it is assumed that working longer does not generate any disutility.

of initial social security benefit receipts, it might contribute to the government by reducing the fiscal burden of the public social security pension system.[2]

The paper is organized as follows; in the nest section, an overview of the model is provided drawing on Park and Hewings (2007a, b) and highlighting the regional specification and the overlapping generations framework. Section 3 provides the results of the simulations, first addressing changes in retirement age, then examining the impacts of a reduction in pension benefits. Section 4 explores optimal policy mixes for these two outcomes considered together with different rates of immigration into the Chicago region. Section 5 adds a final dimension, exploring the impacts of retiree out-migration. A concluding section provides an overview of the results and some needed additional steps.

2. Overview of the Model[3]

The model to be presented has been developed for use in analyses of the impacts of aging, migration and the fiscal issues associated with the optimal funding of social security and retirement programs. This model is represented by a two-region dynamic general equilibrium model with an overlapping generations framework, whose national version was originally developed by Auerbach and Kotlikoff (1987). Like the original version, this model incorporates individual earnings heterogeneity, demographic transitions, and a social security system. However, there are some novel features that are differentiated from former overlapping generations framework in two ways. First, this model newly introduces consideration of regional features that are omitted in the national overlapping generations framework. In this model, each region is interlinked with each other by migration, trade, and the social security system. Secondly, unlike Fougere *et al*. (2004), this model features age-specific mortality and borrowing constraints which are critically important in generating realistic implications of the effects of demographic changes.

2.1 Regional Setup

The model economy is composed of two regions, Chicago and rest of the US (ROUS), but the

[2] In fact, in response to increased life expectancy, the US Social Security Administration has extended the age at which an individual may collect full benefits. Those born before 1937 would still receive full benefits at age 65; those born between 1943-1954 at age 66 and those born after 1960 at age 67; between these periods, there is an incremental (monthly) addition to the age of receipt of maximum benefits.

[3] This section draws on Park and Hewings (2007a)

basic structure of this regional model is closely related to its national counterparts. Households[4] maximize their utility by choosing a profile of consumption over the lifecycle and firms demand factors following from profit maximization, responding to differences in goods and factor prices. Prices adjust in both goods and factor markets to clear the excess demand. However, unlike the prototype OLG model, this model has a complicated structure, even more than international trade models. This model adds various components and linkages into the national version to capture the regional features. First, labor is assumed to be partially mobile in domestic regions, while internationally immobile, taking into account people's preference for staying in the region where they originally reside.[5] This locational preference is represented by the wage elasticity of labor migration. With partial mobility of the labor, wage differentials between regions take multiple periods adjust because of the lagged responses of labor market. However, capital is assumed to be immobile interregionally.[6] This results in the return on capital being different across the regions.

Secondly, the nesting structure is necessary to complete the household's decision process, since both regions trade in goods and each individual considers products from different regions as imperfect substitutes following the familiar Armington assumption. Under the Armington assumption, a good produced in one region is treated as qualitatively different from the same good produced in other regions. Thus, the Armington assumption ensures that consumers demand all the goods produced in both regions. The hierarchy in nesting structure of this model consists of the following two steps. In the first step, each agent determines the aggregated consumption path over time, maximizing a time-separable utility function subject to lifetime income. Time separability allows a separation between intertemporal and intraperiod decision-making in the nesting structure. Once optimal conditions governing the aggregate consumption levels are established, the next step is to allocate these expenditure levels among differentiated good in terms of geographic origin, i.e. Chicago produced good and imported good from ROUS. In this step, substitution elasticities play an important role in determining each agent's optimal choice, thus, the values of elasticities between two regions are very important to influence the

[4] Since each household consists of one agent in this model, "household" and "individual agent" will be used interchangeably.

[5] According to Jones and Whalley(1986), perfect labor mobility is not useful in analyzing the region specific effect of government policies because under perfect mobility, the policy effect might be underestimated with complete labor movement between regions.

[6] The treatment of capital mobility is important when assessing the regional investment policies.

magnitude of the regional effects. For example, even if the aging population changes the age structure in a similar pattern across the nation, the effect on regional economies will depend on these elasticities.

2.2. Dynamic Overlapping Generations Framework

To measure the effects of the demographic change on the behavior of different generations, it is necessary for the model to be disaggregated by the age cohorts as well as dynamic processes that describe the path of consumption and savings behavior of each age cohort over time. The dynamic overlapping generation framework satisfies these criteria. This model is constructed based on the dynamic OLG framework developed by Auerbach and Kotlikoff (1987). There are three types of agents in each region: households, firms, and government. Each sector represented by these agents has stylized components, but their interactions can be quite complex. By solving for the economy's general equilibrium transition path, the model takes into account all relevant feedbacks among these agents according to demographic changes and relating government policies.

In this model, each region is populated by individual agents who live up to age 85. This limited age does not appear to be crucial since, under this assumption, only less than 3 percent of U.S. population is not considered.[7] The individual agent enters the labor market at the age of 21 and retires mandatorily at the age of 65 (although in the simulations in this paper, this restriction is relaxed). Since all the individuals between ages 0 and 20 are considered not to perform economic activities and are assumed to be supported by their parents, this model deals with only the individual agents above age 21. Lifetime uncertainty is considered in this model, i.e., each individual faces a different probability of death in every period, which becomes higher as they age. Therefore, in every period, some fraction of people die earlier than age 85, and leave accidental bequests since annuity markets are assumed to be missing.[8] Total accidental bequests are distributed evenly over all the agents alive in the next period. Moreover, each individual is assumed to face borrowing constraints. Under borrowing constraints, social security could further distort the intertemporal consumption allocation by levying the higher payroll tax on younger generations who have significant borrowing constraints.

[7] Of course, all of these stylized facts can be changed and part of the research agenda will be to consider changes.
[8] With perfect annuity markets, each individual does not leave unintended bequests. However, the social security system substitutes partially for the missing annuity system and reduces unintended bequests.

Individuals are endowed with one unit of time and supply their labor inelastically. Since all agents in the same age cohort are identical in terms of preferences, individual heterogeneity is present only across age cohorts with respect to labor productivity and wage income depends on the individual's productivity, which is assumed to be identical across regions. However, wage income might differ across regions because the wage rate per unit of effective labor is region-specific due to the partial labor mobility. Because of wage differences by age, the individual life cycle of an individual is described by a hump shaped income profile. The individual agent starts to work at age 21 and receives the highest wage income during his/her middle age. Retirement terminates the flow of wage income and entitles the individual to pension benefits. As a result of the uneven pattern of wage rates over their working lifetime and borrowing constraints, individuals save during middle aged working periods and dissave in retirement, which results in uneven distribution of wealth by age cohorts.

Further details of the model may be found in Park and Hewings (2007a).

3. Simulations

3.1 Impacts of Changes in Retirement Age

Simulations for impact analysis are conducted through the four scenarios, which are differentiated by retirement age. It is assumed that the retirement age is delayed by one year for each Scenario, i.e., for Scenario 1 through 4, an individual is assumed to retire at 66, 67, 68, and 69, respectively.

<<insert figures 1,2 and 3 here>>

The effects of increase in the retirement age on the main macroeconomic and welfare variables will now be presented. Baseline results are the outcomes from the simulation that the retirement age, or initial age of pension receipt, is set at the age 65, so that only the effects of an aging population is considered in the Baseline Simulation. Figure 1 shows the evolution of capital/labor ratio. Increasing the retirement age generates a smaller capital/labor ratio compared to the Baseline Scenario since the supply of labor increases as the working age is expanded. The lower capital/labor ratio leads to a fall in wages as shown in figure 2. According to the simulation results, if the retirement age is delayed by 4 years, i.e., retirement now occurs at age

69, then wages fall by 7~8 percent until 2030s compared to the baseline. Figure 3 shows what happens to the per capita GRP. Basically, the rise in the retirement age contributes to an increase in output, and thus the per capita GRP also increases since there is no change in the size of the population. In particular, if individuals could continue working beyond the age 65 by at least 2 or 3 years longer, then the per capita GRP around 2050s starts to rise above the level that would be experienced with just an aging population. However, the additional gain in per capita GRP corresponding to a one-year increase in retirement age becomes smaller, reflecting the fact that labor productivity decreases dramatically from age 65.

<<insert figure 4, 5, and 6 here>>

Figure 4 shows how much the social security tax rate changes. Not surprisingly, there is a marked decline in the social security tax rate over the transition period. For example, the maximum tax rate around 2030s decreases from 11 percent in the Baseline Scenario to below 6 percent in Scenario 4, which is even lower with just the effects of an aging population. The significant fall in tax rate becomes possible thanks to both increases in pension contributions by increasing the number of the working-age population and the concomitant delay in the payment of pension benefits.

Figures 5 and 6 show the effect of increasing retirement age on income and asset distribution. The Gini coefficients for both cases appear to increase, though not noticeably, over the entire transition period as the retirement is delayed to a later age. This result is consistent with expectation which is suggested by transitional paths of wage and interest rates since wages fall and interest rates increase. Smaller wages under the increasing retirement age scenario reduce the income of young poor generations who significantly rely on labor income. On the contrary, higher interest rates increase the capital income of the middle-aged, richer populations who holds large accumulated assets thanks to the reduced social security tax payments. However, the income Gini coefficient increases marginally because this upward impact is partially offset by the increase in income of those between 65 and 68, who are retirees, and relatively poor before the reforms. Assets are slightly redistributed to wealthy populations, reflecting the fact that the middle-aged wealthiest populations can save more assets when they have larger, disposable income. But, they would not increase saving as much as before the reforms generate because

they are less motivated to save due to the prospect of higher earnings under the situation where they can work longer than before.

<<insert figure 7 here>>

By affecting the social security tax rate, the increasing retirement age influences the allocation of consumption over an agent's lifetime, and this reallocation may cause either an increase or decrease in welfare. Figure 7 shows how the welfare benefits changes depending on the size of the increase in retirement ages. All individuals (over all age cohorts) appear to favor an increasing retirement age. Furthermore, younger generations gain more than older generations who have already retired. For younger generations, they benefit from the longer payrolls with smaller taxes until far in the future, whereas for the older generations, welfare gains are limited since all the benefits are generated from increasing capital income arising from the increase in the interest rate.

3.2 Reducing Pension Benefits

This simulation focuses on how the current pension system should be modified to deal with increases in the fiscal burden associated with an aging population. A fiscal deficit in the current pension system should be balanced by reductions in pension benefits (replacement rate) or increases in pension contributions (social security tax rate). However, it would be better for the government to reduce benefits, even though politically difficult, rather than increasing the social security tax rate, since the latter will be more costly because the increase in distortionary taxes will reduce private saving and thus damage economic growth.

In this respect, this section considers four different possible pension reforms which are implemented by reducing the replacement rate. Scenario 1 assumes that the replacement rate is set to 40 percent, lower by 10 percent from the initial rate, and Scenario 2 and 3 assumes the replacement rate to be 25 percent and 10 percent, respectively. In Scenario 4, it is assumed that the public pay-as-you-go pension system will be entirely abolished; thus individuals should depend on private savings to support their longer life after retirement. It is assumed that the government announces the pension reforms at the beginning of second period, i.e., year 2006,

but the pension reforms will be implemented ten years later, i.e., year 2015, so that each individual can adjust his/her consumption plans responding to expected lower pension benefits.

<<insert figures 8 and 9 here>>

The next set of figures depicts the effect of cuts in pension benefits on the main macroeconomic variables, income and asset distribution, and welfare. Figures 8 and 9 show the evolution of capital/labor ratio and wage under pension reforms, respectively. According to the figure, a cut in pension benefit turns out to increase the capital/labor ratio. Before the announcement of pension reforms, most workers did not save enough in private accounts, anticipating the future pension benefits that exceed what they will actually receive after pension reforms, thereby increasing saving and capital stock. The increase in capital stock without a change in labor supply, in turn, raises the capital/labor ratio and wage.

<<insert figures 10 and 11 here>>

Figure 10 shows the transitional path of per capita GRP under pension reforms. A proportional reduction in pension benefit has a positive impact on GRP. However, since pension reforms do not directly affect the labor supply, as in the case where the retirement age was extended, the positive growth impact of pension reforms purely results from the increase in capital stock. Without a change in population size, the increase in GRP leads to the increase in per capita GRP as shown in the figure. Figure 11 shows the effect of pension reforms with smaller benefits on the social security tax rate. Obviously, the cut in pension benefits makes a significant contribution to lowering social security tax rates.

<<insert figures 12 and 13 here>>

These simulated benefits in both per capita GRP and social security tax burden are similar to those found from the scenarios in which an increasing retirement age was considered. However, there is a significant difference in the source of economic growth in that the GRP growth in pension reforms is obtained by an increase in capital stock, while the labor supply shock contributes to economic growth through increasing the retirement age. Because of these differences, pension reforms generate different policy implications for both income (asset) distribution and intergenerational welfare. Both figures 12 and 13 show how the pension reforms redistribute the income and assets. First, a cut in pension benefit turns out to exacerbate

the income differentials between rich and poor populations, even more so than for the case where the retirement age was extended. The reason for this result is that, with the benefit cut, the retirees suffer from the significant loss in their income, which is further reduced by the decrease in capital income due to a lower interest rate, whereas the middle-aged rich populations benefit from the partial or complete removal of the payroll tax. Reflecting this fact, around 2050s, the income Gini coefficient significantly increases to about 0.4 in Scenario 4 from just below 0.2 in the Baseline Scenario. This result provides very important policy implications because even with the large benefit for economic growth and fiscal status, pension reforms cause severe distortions in the income distribution. For asset distribution, the cut in pension benefit also increases the imbalance, though not as seriously as for income distribution, but generating a larger effect compared to the one from increasing retirement age. The reason for this is based on the fact that wealthy, productive populations, aged between 50s and early 60s, tend to have higher assets preparing for the loss in pension benefits, whereas young populations cannot afford to adjust their assets as much as they want because most of them are facing liquidity constraints.

<<insert figure 14 here>>

Figure 14 shows how the welfare effects of the benefit cut vary with the different age cohorts over the transition period. According to the figure, it appears that the benefit cut hurt the welfare of most current populations except very oldest and youngest generations. This welfare effect is quite contrary to the results found from increasing the retirement age where all the populations benefit from the reforms. For the current oldest generations, who are over the age of 75, they belong to the only supporters of all the pension reforms since they benefit from the higher interest rate for the rest of their lives without facing the loss in pension benefits. Together with the oldest generations, the very youngest generations favor the modest reforms because they benefit from reduced social security payment for the rest of their lives of a sufficient size to outweigh the cost of smaller pension benefits during their retirement period. However, current middle-aged workers and young retirees are the big losers of the pension reforms. Especially, populations of age mid 50s are the biggest losers by losing about 10~40 percent of welfare in Scenario 1 through 4 compared to the pure PAYG system. This happens because those generations will receive reduced pension benefits after they retire, whereas they can enjoy higher after-tax wage for relatively short period. Because of this negative welfare effect, it seems to be

very difficult to reform the current pension system because of the quite low political support from the current voters.

4. Optimal Policy Mix

The previous section explores the respective impact of the two major policy reforms assuming each reform is implemented while the others remain at their baseline levels. However, the impacts of these policy reforms might be radically altered if these policies are combined at the same time; in addition, further synergetic effects could be generated if immigration reforms were added to the mix (see Park and Hewings, 2007b). For example, in most findings supporting immigration, many of the benefits of immigration have been generated from the reduced social security tax burden, which in turn increases the level of consumption and leads to a more desirable age-consumption profile. However, if immigration is considered together with pension reform that is oriented more toward a more pre-funded system, the benefit might be substantially decreased because the effect of pension reforms on reducing the social security tax rate may considerably decrease the potential benefits expected from changes in immigration policy. Then, the benefits of immigration are rapidly offset by the cost associated with wage loss.

This section explores optimal policy combinations and suggests the optimal mix. For this purpose, this section simulates two alternative policy mixes: 1) immigration and pension reform, 2) immigration, retirement age, and pension reform. Each policy mix includes immigration policy since it is the only policy measure which the local government (in this case Chicago) can manage as a way of responding to the impacts of an aging population. Thus, both simulations suggest the policy implications of ways in which the local government could maximize the benefit from the differentiated immigration policy of the federal government under the situation where the federal government also implements two other policy measures; pension reforms and extension of the retirement age.

Optimality is evaluated by welfare changes as in the previous section. However, there is a difference in welfare measures. In the previous section, consumption equivalent variation is used for quantifying the welfare changes by age cohort, but it does not represent the overall welfare of the population as a whole. However, in order to find the optimal policy mix, we need a measure of average utility which considers all age cohorts. In this study, following

Imrohoroglu *et al*. (1995), the average utility[9] is measured by the expected discounted lifetime utility of a newly born individual under a given policy mix.

<<insert table 1 here>>

4.1. Immigration and Pension Reforms

Table 1 presents the welfare changes corresponding to various combinations of immigration shares and pension benefits. Each row in the table represents four different shares of newly adopted immigrants out of total regional population, which are increased by 0.6 percent from no immigration to 1.8 percent.[10] It is assumed that only the Chicago local government adopts more favorable immigration policies, such as 1.2 percent and 1.8 percent share of immigration, while the rest of the U.S. keeps the immigration share at 0.6 percent. Each column represents six different replacement rates, which are increased by 10 percent from no benefit to 50 percent. Thus, there are twenty-four policy combinations which are considered as possible policy mixes. All the values in the table provide the average utility that results from the corresponding policy combinations.

From the table, it can be seen that the welfare changes according to the different combinations of share of immigrations and pension benefits, but not in a monotonic pattern. First, in case of the pension reforms, welfare gains rises proportionally, increasing from zero percent to 40 percent of replacement rate. Beyond this point, an increase in the replacement rate, on the contrary, lowers the welfare. To explain this irregular welfare changes, we need to consider both welfare benefits and costs associated with changes in replacement rate. First, the welfare benefits result mainly from the efficient consumption allocation associated with an increase in the replacement rate. That is, mortality risk motivates individuals to discount the future consumption more heavily and to consume less in old age than they otherwise would. Thus, in the absence of a private annuity market against lifetime uncertainty, the age-consumption profile diverges from a more efficient allocation which shows a relatively smoother consumption profile. In addition, positive unintended bequests by early death also cause inefficient consumption allocation in the absence

---

[9] Average utility *W* is calculated as $W(a) = \sum_{j=1}^{65} \sum_{a} (\frac{1}{1+\rho})^{j-1} (\prod_{k=1}^{j} s_k) \frac{(C_{i,j}(a))^{1-\gamma}}{1-\gamma}$, where *a* is end of period asset holdings

[10] The current immigration rate in Chicago is 0.6% of the base population.

of an annuity market. That is, the absence of an annuity market causes inefficient consumption allocation under lifetime uncertainty. However, the social security pension program partially substitutes for missing annuity markets acting as a public insurance against uncertain lifetimes. With the financial support of a pension program, each individual could allocate the lifetime consumption closer to a more desirable age-consumption profile by increasing the consumption in old age which would otherwise fall far below the optimal level. According to the simulation results, the average consumption of retirees increases 18 percent as the replacement rate shifts from zero percent to 50 percent. This beneficial feature of the pension program explains the reason why the generous pension benefit increases the welfare. Conversely speaking, this feature explains why the welfare changes for the worse with the pension reforms.

On the other hand, an increase in the replacement rate also generates welfare costs. Most working age populations reduce their consumption corresponding to the higher tax rate required for supporting the generous pension benefit. Especially, in this specification, those in their 20s give up about 20 percent of their consumption when the replacement rate increases from zero to 50 percent. As a result, an increase in replacement rate lowers the aggregate consumption, and this loss partially offsets the insurance benefits of pension program associated with a more efficient consumption allocation. Another important cost of the social security pension program arises from the existence of borrowing constraints. The higher the replacement rate, the more incomes are redistributed away from the young generations who face liquidity constraints. Once an individual is subject to a binding liquidity constraint, the equilibrium age-consumption cannot be allocated according to the optimal rule. Thus, an individual's consumption further diverges from the desirable age-consumption profile; this negative welfare impact becomes stronger as the pension benefit becomes more generous. Beyond a replacement rate of between 40 percent and 50 percent, both negative welfare costs eventually outweigh the insurance benefits of pension system, meaning that the optimality of pension system occurs at a replacement rate of around 40 percent. However, this optimality condition occurs under an immigration policy. Without immigration, it drops to 30 percent because without the financial contributions from immigrants, the social security tax rate increases substantially; hence, more generous pension benefits cause higher welfare costs.

The level of welfare associated with immigration also changes according to the volume of immigration. According to the simulation, the optimal immigration occurs at the share of

immigrants in the neighborhood of 0.6 percent of the base population in Chicago. However, beyond this point, like pension reforms, an increase in immigrants generates welfare cost. Now, it is a question why the optimal share of immigration does not occur at zero percent, since immigration distorts the local labor market by reducing wages. The main reason is because immigrants significantly contribute to reducing the distorting payroll tax which makes it hard to allocate consumption following the optimal conditions. However, this benefit does not imply that an increase in the share of immigrants necessarily results in more welfare benefits. The main reason for this prediction is attributable to the difference of the immigration policies between federal and local government. Increasing the immigration share from zero percent to 0.6 percent, both regions admit the same share of immigrants, so that the social security tax rate is substantially lowered since it is determined at the national level. Beyond the 0.6 percent, only the Chicago region attracts more new immigrants. However, the additional number of new immigrants admitted in Chicago region is not sufficient to lower the tax rate, meaning that the increase in the number of local immigrants beyond the national average does not generate the additional benefits arising from the tax cuts that occurred when both regions moved from zero to 0.6%. The welfare cost arising from smaller wages becomes larger as more local immigrants are newly admitted. Of course, there still exits the welfare benefits for local residents because more immigrants generally stimulate higher economic growth. However, as long as the share of local immigration is higher than national average, this benefit is necessarily dominated by welfare cost.

As a result, the optimal combination found in this model occurs at 0.6 percent of immigration share and 40 percent pension replacement rate. This result importantly implies that the larger immigrants and more generous pension benefit do not necessarily result in more desirable policy combinations. Especially, the local government should pay attention to keep the volume of local immigrants at about the national average.

A further interesting finding is closely related to the dependence of immigration policy on pension reforms. The welfare benefit of immigration changes according to the size of pension reforms. In particular, the welfare effect of immigration is totally reversed once the pension reforms are completed. In this economy, immigration leads to the welfare benefit only when the share of immigration shifts from zero percent to 0.6 percent. However, the size of the welfare benefit from this change becomes smaller as the pension system is reformed towards a lower

benefit. In particular, under the case with no public pension system with zero replacement rates, immigration only carries the welfare cost which monotonically increases as the number of immigrants rises. As mentioned earlier, the reason for this result is that pension reforms towards the smaller benefit unambiguously lowers the tax burden, which reduces the potential benefit of the immigration. Thus, once the social security pension program is entirely abolished, then the welfare benefit from the immigration might disappear or at least be significantly reduced.

<<insert table 2 here>>

4.2. Immigration, Retirement Age, and Pension Reforms

This simulation considers the optimal combinations of three policy reforms; immigration, retirement age, and pension reforms. Ideally, all possible combinations have to be simulated to obtain the optimal combination. However, this would require multiple computations of the whole dynamic system, which is very costly. Reflecting this cost, the simulation is implemented given that the replacement rate is fixed at 40 percent, which is previously identified as the optimal rate. Table 2 shows the simulation results of this policy mix between immigration and retirement age given a replacement rate of 40 percent. Each row in the table represents four different shares of newly adopted immigrants out of total population. All assumptions of immigration policy are the exactly same as in the previous simulation. Each column represents five different retirement ages, which are increased by one year from the age of 65 to 69. Thus, there are 20 combinations which are considered as possible policy mixes.

From the table it can be seen that the optimal benefit occurs when the share of immigration and the retirement age are 0.6 percent and the age of 69, respectively. The welfare effects of immigration with retirement age are quite similar to those found in the policy mix between immigration and pension reforms. That is, local immigration at the same rate as the national average improves the regional welfare, whereas if it is higher than the national average, local immigration results in a deterioration of regional welfare, especially, this negative effect becomes much stronger as local immigrants increase more.

An increase in retirement age with immigration turns out to monotonically improve the average welfare in all policy combinations. This implies that the welfare effects arising from adjustment of retirement age is to a great extent independent of local immigration policies. The welfare benefit of increasing retirement age arises mainly because such a reform increases lifetime

income, especially income of the retirees, thereby allowing individuals to increase aggregate consumption over the lifetime as well as improving the efficiency of intertemporal consumption allocation. Therefore, insofar as the wage income is higher than the pension benefit, individuals would be better off by increasing the working age.[11] Moreover, pension reforms toward reducing benefit might put upward pressure on optimal retirement age since it will increase the opportunity cost of early retirement.

5. Impacts of Retirement Migration

This chapter analyzes how the impacts of the aging population link to the regional economy through retirement migration. This is important because Chicago is second only to New York in terms of the volume of retiree out-migration; with an increasingly aging economy, the volume of flows will increase over the next decade. In a narrow view, retirement out-migration seems to contribute to alleviating the expected problems of aging population because it will decrease the old age dependency ratio of the origin place. However, this view does not provide an accurate reflection of the impacts and originates from the misunderstanding about the causes of the problems. First, one of the major sources of the problems associated with aging population is the decrease in the size of the labor force. However, the retirement out-migration does not directly affect the supply of labor; instead, it could shrink the local labor supply over the long run. Secondly, the fiscal problem under an aging population is a national phenomenon so that the improvement in the local dependency ratio does not help to fix this problem. On the contrary, retirement out-migration has a high probability to exacerbate the local economy under an aging population. As previously mentioned, consumption expenditure by retirees provides an important source of demand which is used to purchase local goods and services, to pay wages to employees, and to pay taxes to local government. Thus, the overall economic effect of the retirement out-migration will be significantly greater than the direct loss caused by retirees' smaller per capita expenditures than those in the labor force. In particular, the problem of retirement out-migration will be more serious under aging population because this aging population is likely to increase the current out-migration generating an aggregate effect that could potentially be significant.

[11] In this economy, individuals start to be worse off at the retirement age of around mid 70s.

Bearing this in mind, the main objective of this experiment is to measure the overall macroeconomic and distributional effect of the retirement out-migration under an aging population. The simulations are conducted under 4 different sizes of retirement out-migration. The differences in each scenario are summarized as follows. Scenario 1 (very low) assumes that the share of retirement out-migrants from Chicago region to rest of the US is 0.5 percent of elderly population, or about 6,500 retirees, which is almost the half the size of current net retirement out-migrants of the Chicago region. This simulation is introduced for the purpose of providing policy implications on how much the negative impact of retirement out-migration could be reduced with a decrease in the size of out-migrants. For Scenario 2 (low) and Scenario 3 (medium), the size of retirement out-migrants is assumed to be increased to 0.9 percent and 1.2 percent, respectively, which are equivalent to the share of current net and gross out-migrants in the Chicago region. Considering the fact that the tendency for out-migration of the future generations is expected to be stronger, Scenario 4 (high) assumes that the share of retirement out-migrants increases to 1.5 percent, or about 20,000 retirees.[12] The Baseline Scenario assumes no retirement out-migration, i.e. only the aging population changes the demographic structure in Chicago region.

<<insert tables 3, 4, 5 and 6 here>>

Tables 3 through 6 summarize the main quantitative results from the above four simulations. The effects of retirement out-migration on macroeconomic variables of the Chicago region, such as wages and gross regional product (GRP), are presented in these tables. All the numbers for Scenario 1 through 4 are expressed in terms of percentage change as compared to the values of the Baseline Scenario, while all values for Baseline Scenario are expressed in terms of percentage change as compared to the corresponding values in the base year, 2005. Table 3 presents the effects of the retirement out-migration on wages of Chicago region. The second column of the table indicates that the aging population without retirement migration, which is the Baseline Scenario, substantially contributes to increasing wages by around 2030s, when the aging population achieves its greatest impact, reflecting the relatively scarcity of labor and relatively abundance in capital stock. However, the retirement out-migration appears to put

[12] After 30 years of retirement migration, for each scenario, the share of elderly population of Chicago region out of the U.S. national elderly population decreases to 2.6 percent, 2.3 percent, 2.1 percent, and 1.9 percent, respectively, from current 3.0 percent.

downward pressure on wage increases under an aging population. For example, looking at the year of 2070, corresponding to Scenario 1 through 4, wages decline by 0.7, 0.9, 0.9, and 1.0 percent compared to the baseline,. This negative impact on wage results primarily from the decline in capital stock, resulting in a decrease in the marginal productivity of labor. Under retirement out-migration, capital accumulation might be lower because excess supply associated with the negative demand shock from retirement out-migration makes capital accumulation less attractive. That is, in order to meet the small demand, a firm would reduce capital since labor cannot easily be adjusted, at least in a short run. However, the reason why wages do not change significantly responding to the increase in the share of out-migration is that some fraction of the working age populations in the Chicago region out-migrates responding to the relatively lower wages. Over the transition periods, the downward pressure on wages becomes stronger while the aging population is proceeding because the number of retirement out-migrants increases as a large number of the population retire.

Tables 4 and 5 show how the model predicts the effects of retirement out-migration on GRP and per capita GRP of Chicago region, respectively. From the earlier simulation, we know that an aging population contributes to significantly reducing the regional output because of the expected negative shock from the labor supply. However, the impact of retirement migration on GRP, especially per capita GRP, is hard to predict before the simulation because retirees do not participate in the production activities. According to the simulations, the retirement out-migration is expected to reduce more seriously the regional output under an aging population. Moreover, the situation even becomes worse as the share of out-migrants increases. From table 4, it can be seen that in 2040, the decline in GRP of the Chicago region associated with aging population is exacerbated by 2.1 percent and 3.9 percent, respectively, corresponding to relatively small out-migration like Scenario 1 and 2. However, for relatively large out-migration from Scenario 3 and 4, the additional decline in GRP is extended more dramatically, from around 7 percent to 9 percent. This implies that the GRP of the Chicago region will be decreased by 16~18 percent over the next 35 years because of the aging population in combination with significant retirement out-migration.

The more interesting finding of this simulation is how the retirement out-migration affects the per capita GRP. Table 5 shows the impacts of retirement out-migration on per capita GRP of Chicago region. For the two relatively small out-migration scenarios, it appears they have

positive upward pressure on per capita GRP. This result is previously expected because retirement out-migration contributes to reducing the older populations who do not contribute to producing regional output. Thus, loss of retirees acts as a positive contributor to per capita GRP when relatively small numbers of retires out-migrate. However, in the case of relatively large out-migration, this positive effect is reversed. For example, the per capita GRP in Scenario 4, decreases by 1 percent around the 2030s. The main reason for this negative impact is due to the fall in local capital stock arising from excess supply in the goods markets as well as the loss of labor force. These results also may contribute to the explanation for the slower pace of economic growth of Chicago region over the last 30 years. Finally, table 6 reveals that retiree out migration does not significantly change the share of gross national product accounted for by Chicago.

<<insert tables 7, 8 and 9 here>>

Tables 7 through 9 summarize the main quantitative impacts of the retirement out-migration from the Chicago region on the economy of rest of the U.S. First, in case of wage changes (see table 7), retirement out-migration from the Chicago region to rest of the U.S. does not significantly affect the wages in rest of the U.S., reflecting the small share of out-migrants compared to the total population of rest of the U.S. Even the insignificant effect, for the relatively small migration like Scenario 1 and 2, retirement in-migration has upward pressure on wages in the rest of the U.S. because of the increase in labor demand caused by the additional output demand by in-migrants. For the relatively large retirement in-migration, this upward pressure becomes weaker or turns to negative in some cases, because active labor in Chicago region starts to out-migrate to rest of the U.S. to reduce the wage differentials between two regions.

For gross regional output, an increase in retirement in-migrants from Chicago region positively contributes to the economic growth of rest of the U.S., though not markedly (table 8). Moreover, this positive effect becomes stronger as more retirees move into the region. However, per capita GRP of rest of the U.S. slightly falls with the arrival of new older migrants, contrary to the Chicago region experiencing the higher per capital GRP with the loss in older population (table 9).

As a consequence, the GRP share of Chicago region out of the U.S. decreases over the whole transition periods as shown in table 6. During the peak of the aging population, which is between 2030 and 2040, the GRP share records its lowest level in all four scenarios. Especially, in case of Scenario 4, the GRP share of Chicago region falls to below 2.7 percent from 2.9 percent in the base year.

<<insert figures 15, 16, 17 and 18 here>>

The projected time paths of the Gini coefficients for income and assets is shown in figures 15 and 16. First, the income Gini coefficient rises significantly as the share of out-migration increases. This result clearly implies that out-migration has an adverse effect on income distribution. However, this result is not previously expected since wages do not change as much to generate such an increase in the Gini coefficient. One possible reason for this is that although a slight fall in wages contributes to reducing the income gap between the higher income working group and the lower income retirees, the changes in population structure associated with losing retirees increases the income gap between both groups. That is, as the more retirees out-migrate, the age structure of the region is more skewed to the high income middle aged working populations. Secondly, the asset Gini coefficient under retirement out-migration also increases, though, relatively, at a smaller rate than the income Gini coefficient. The reason for the higher asset Gini coefficient can be also found in the change of the population structure, which is moving toward having relatively more wealthy working population as the retirees out-migrate. However, since young retirees hold relatively large assets, out-migration of these retirees decreases the average asset level of the economy, putting downward pressure on Gini coefficient. This explains why the asset Gini coefficient increases relatively less than income Gini coefficient. In contrast to the Chicago region, retirement in-migration does not significantly change the income and asset distribution of rest of the U.S., reflecting the small size of in-migrants compared to the total populations of rest of the U.S. (see figures 17 and 18)

6. Conclusions and Policy Implications

This paper has analyzed the dynamic effects of demographic changes on two regional economies, whose national effects have been already intensively analyzed before this study. This paper focused on filling the void of analyses at the regional level. To generate the

simulated results, a two-region dynamic general equilibrium model has been used, which also incorporates an overlapping generations structure with individual heterogeneity and uncertainty. Considering the distinctive demographic features and expected dramatic changes in local population structure under an aging population, theChicago region is chosen as the reference region. To capture the distinctive socio-economic impacts arising from regional demographic changes, most of the simulations consider the comprehensive impacts on economic growth, income (asset) distribution, and welfare benefits. The main findings are as follows.

First, an aging population turns out to substantially reduce the gross regional product in Chicago region over time. According to the simulation, there are two possible factors at play for this result to happen. The first factor is that the aging population reduces the disposable income of workers, who are responsible for a significant part of aggregate saving, due to the extremely higher social security tax rate. Secondly, an aging population significantly increases the share of the older generations, who consume more than their incomes. These two factors contribute to a substantial reduction in the capital stock, and thus economic growth. Regarding the fiscal burden associated with an aging population, this study finds that the social security tax rate hikes would need to be doubled around 2030s, changing from 6 percent to 11 percent. The rise in the tax rate contributes to improve the income disparities in the region under aging population because the higher tax rate significantly redistributes income from richer workers to poorer retirees. On the contrary, asset distribution is projected to be move in the opposite direction for the initial two decades.

The second simulation focuses on experimenting with possible policy reforms which both local and federal governments might consider in order to avoid the negative outcomes inherent in an aging population. Three types of policy reforms are considered; 1) increase in immigrants, 2) rise in retirement age, and 3) reductions in pension benefits. In the case of immigration, an uneven set of changes in capital and labor supply over the transition periods generate time variant dynamic results. Over the whole transition period, a favorable immigration policy significantly contributes to increasing economic growth in Chicago region. However, until the newly admitted immigrants acquire higher labor productivity, the per capita GRP decreases as

the number of immigrants increases.[13] In addition, the initial benefit for the social security program is reversed around 2050s, when the first immigrants start to retire. Immigration also turns out to distort the income distribution because it decreases the earnings of poor populations by reducing wages. In particular, a higher percentage of immigrants in the region (Chicago) than national average only increases the income disparity without reducing the social security tax burden.

Secondly, an increase in retirement age appears to have many positive impacts. It increases economic growth of the Chicago region and lightens the tax burden for maintaining the current pension system. The striking result of this policy is that it improves the welfare of all the current populations, especially younger generations who gain relatively more benefits. However, even large benefits, there is considerable uncertainty regarding the political will to implement this policy. Legislation can increase the initial age at which benefits can be claimed in order to lead the later retirement, as has been done with social security. However, the actual retirement depends on more than just rule. It depends on the behavior of workers and economic conditions, such as ability to work and more importantly the availability of jobs. Further, the paper has not considered the behavior of agents in preparing for retirement with a mix of social security and other private pension income (individual retirement accounts, for example). Since there are significant tax liability issues, there is an intergenerational problem that needs to be addressed and there is also greater potential for exacerbating asset distributions of retirees and thereby contributing to moving the Gini coefficient to more unequal distributions.

Finally, in similar fashion to the previous two cases, a cut in pension benefits significantly reduces the negative impact of the aging on the economic growth. However, over the long run, this policy significantly fuels the uneven distribution of income and assets. Furthermore, it appears that almost all current working-age generations suffer from the welfare loss for any pension reforms that involve a cut in benefits.

Thereafter, this study explored the optimal policy reforms in terms of policy combinations, rather than individual policies. According to the results, larger numbers of immigrants and more generous pension benefit do not necessarily result in more desirable (welfare) results, while an

[13] The present paper provides no mechanism for this skill acquisition but it clearly becomes part of the policy mix that would need to be considered in future analyses.

increase in retirement age turns out to monotonically improve the average welfare. As an optimal policy mix, this model suggests that the regional welfare is maximized when the local government admits immigrants up to national average under 40 percent of replacement rate. However, the space of all possible policy combinations was not explored; future work might consider the development of a multi-objective programming module to more fully explore these outcomes.

The last part of the simulations addresses the retirement out-migration from the Chicago region, which will dramatically change the local demographic structure under an aging population. The simulation results indicate first that retirement out-migration has a negative impact on the wages in Chicago. However, the greatest impact of the retirement out-migration appears to be on Chicago's economic growth, and even the per capita GRP. The simulated results provide that when 1.5 percent of elderly populations out-migrate from Chicago region, then the aggregate and per capita GRP of Chicago region decrease by 18 percent and 6 percent, respectively, over 30 years. This result might explain one of the reasons why Chicago economy has grown less rapidly (than the nation) over the last three decades. However, there have been some important structural changes in the economy that have not yet been incorporated into this model (see Hewings, *et al*., 1998). In addition, another result suggests that if Chicago local government succeeds to reduce the current share of retirement out-migration by half, then the decline in per capita GRP associated with the loss of retirees under an aging population is reduced by only 2 percent by 2040. On the other hand, the rest of the U.S. benefits from retirement in-migration from Chicago region, though not in a dramatic fashion since the volume of migrants from Chicago represents a small share of the ROUS population.

The various results of this study provide some valuable policy insights to local and federal governments to assist them in preparing for the economic and social consequences of future demographic changes. In particular, this study should be critically important to those regional metropolitan areas/states with high elderly out-migration rates. While this study focused on Chicago region, the methodology will be sufficiently portable to make application to other regions possible. Future research future work could extend this structure to a multiregional context. In addition, the model needs to be extended to evaluate the explicit dynamic analysis of the intersectoral reallocation of resources induced by demographic changes.

References

Auerbach, A.J. and L.J. Kotlikoff, 1987. *Dynamic Fiscal Policy*. Cambridge, University Press.

Fougere, M., S. Harvey, M. Merette, and F. Poitras, 2004. "Ageing population and immigration in Canada: An analysis with a regional CGE Overlapping Generations Model," *Canadian Journal of Regional Science* 27, pp.209-236.

Frey, William H. (2007) *Mapping the Growth of Older America: Seniors and Boomers in the Early 21st Century*, Washington DC, The Brookings Institution.

Hewings, G.J.D. M. Sonis, J. Guo, P.R. Israilevich and G.R. Schindler, (1998) "The hollowing out process in the Chicago economy, 1975-2015," *Geographical Analysis*, 30, 217-233.

Imrohoroglu A., S. Imrohoroglu, and D. Jones, 1995. "A life cycle analysis of social security," *Economic Theory* 6, 83-114.

Nilsson, D. (2007) *Essays on Trade Flows, Demand Structure and Income Distribution*, Department of Economics, Jönköping International Business School, Jönköping, Sweden

Park, S. and G.J.D. Hewings (2007a) "Aging and the Regional Economy: Simulation Results from the Chicago CGE Model." In A. Bayar (ed) *Regional General Equilibrium Modeling: The State of the Art*. Heidelberg, Springer (forthcoming).

Park, S. and G.J.D. Hewings (2007b) "Immigration, Aging and the Regional Economy," *Discussion Paper* 07-T-4, Regional Economics Applications Laboratory, University of Illinois, Urbana, www.real.uiuc.edu

Yoon, S.G. and G.J.D. Hewings, (2006) "Impacts of Demographic Changes in the Chicago Region," *Discussion Paper* 06-T-7, Regional Economics Applications Laboratory, University of Illinois, Urbana, www.real.uiuc.edu

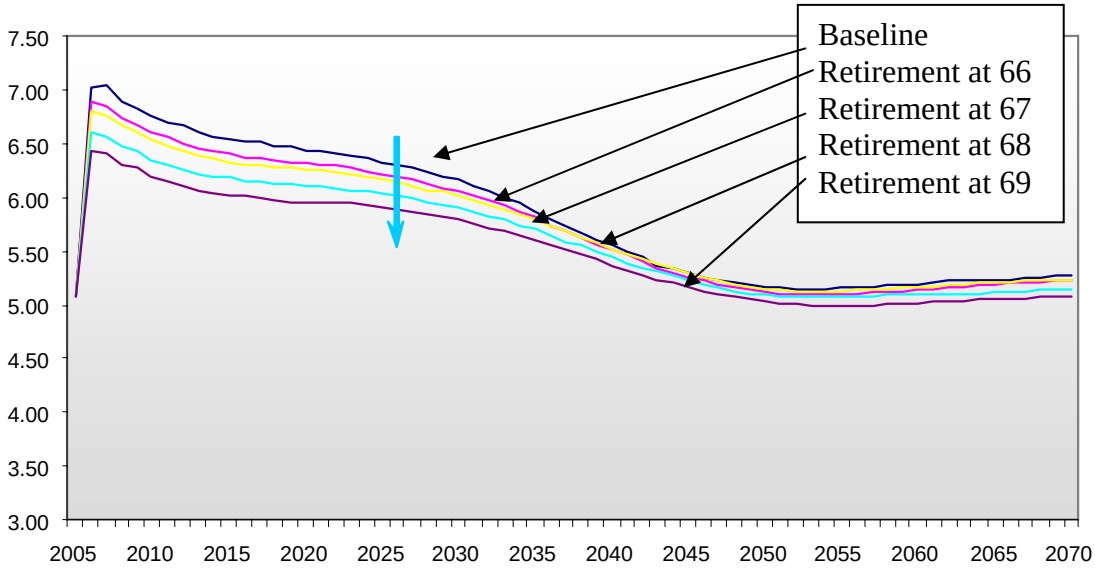

Figure 1. Capital/Labor Ratio

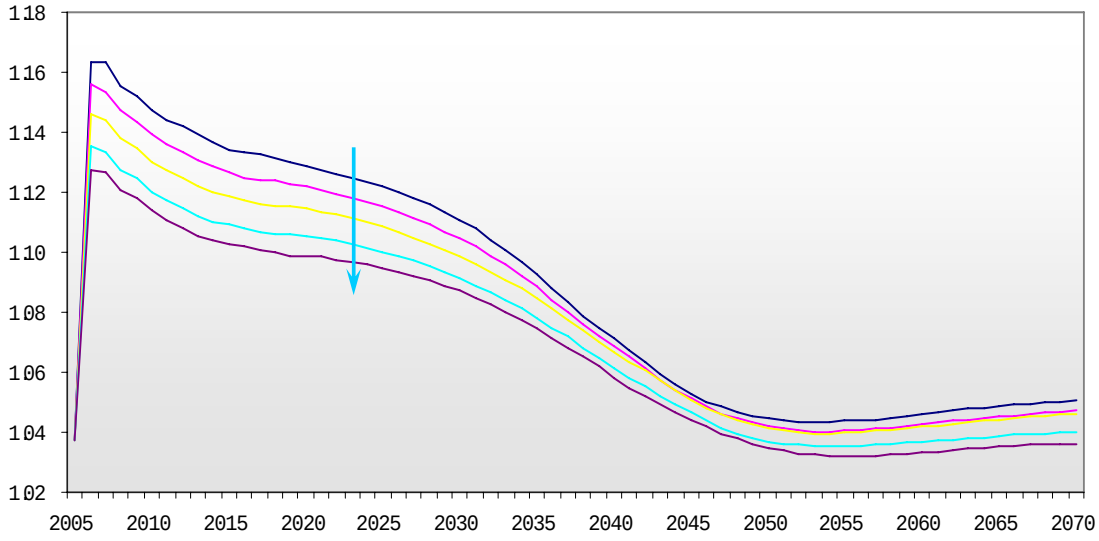

Figure 2. Wages

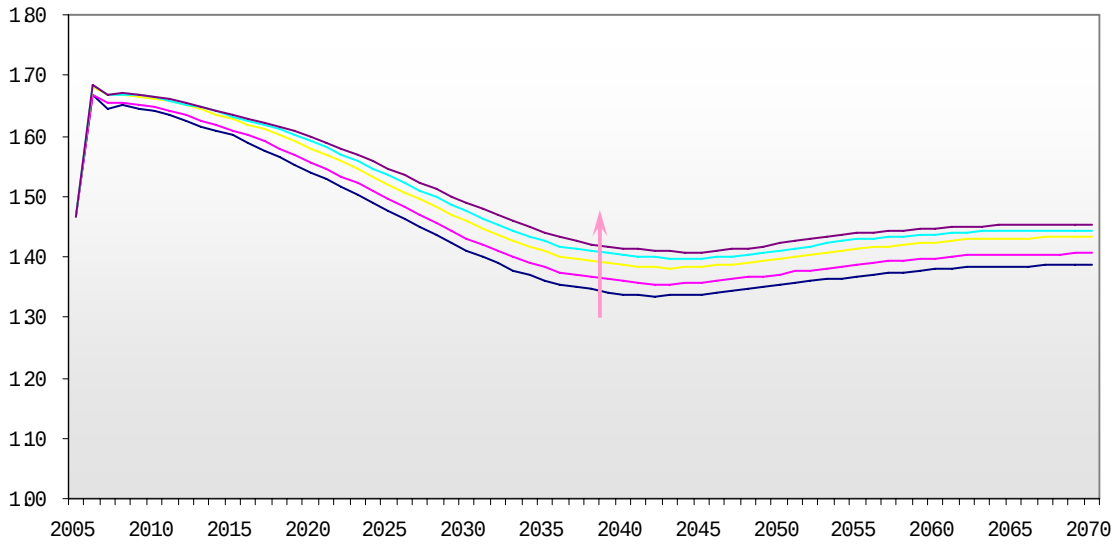

Figure 3. Per capita GRP

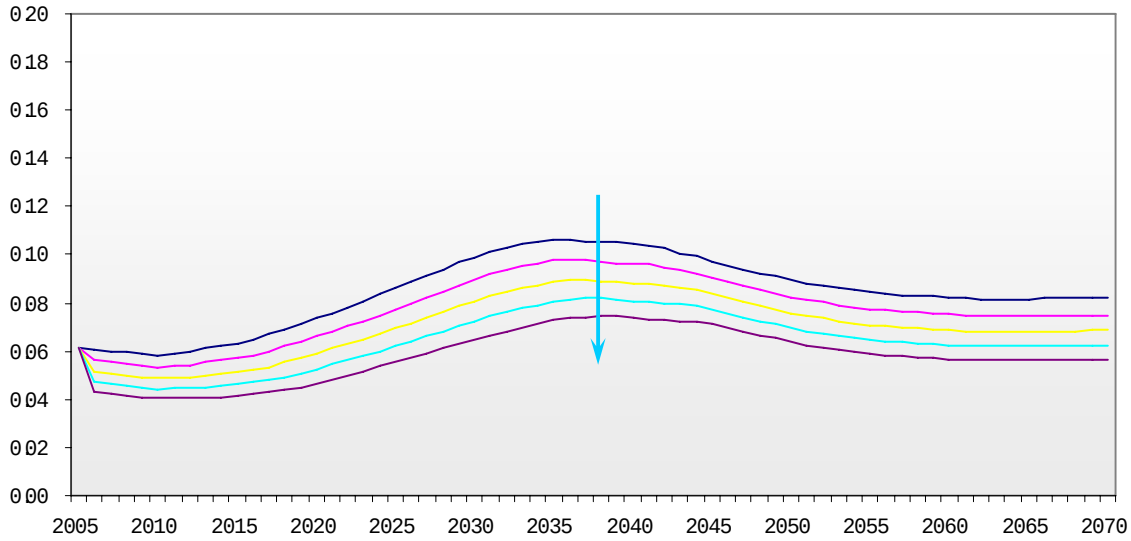

Figure 4. Social security tax rate

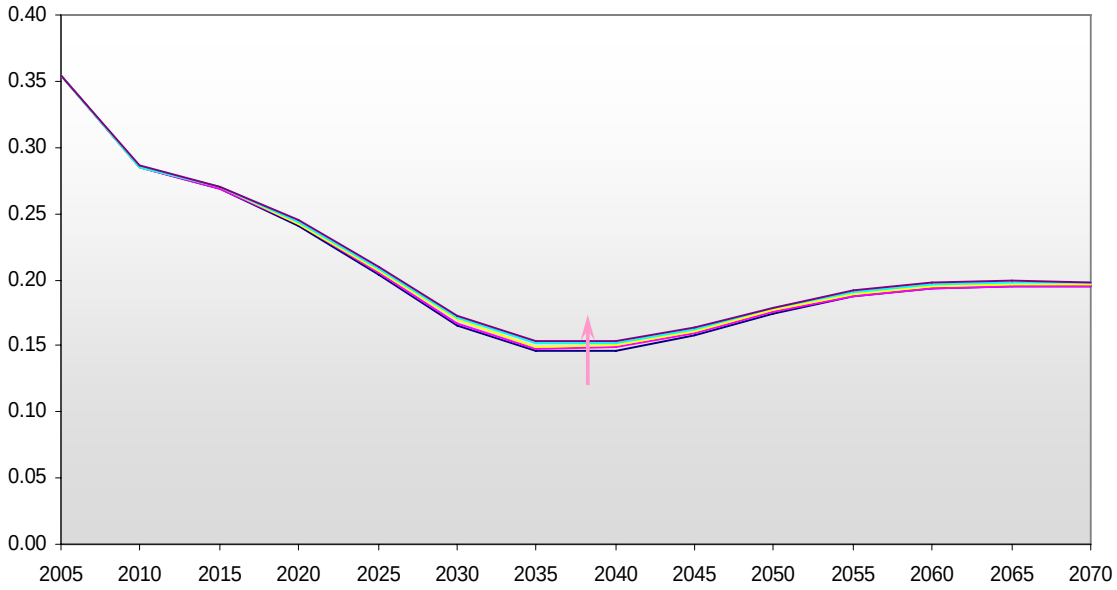

Figure 5. Gini coefficient (Income)

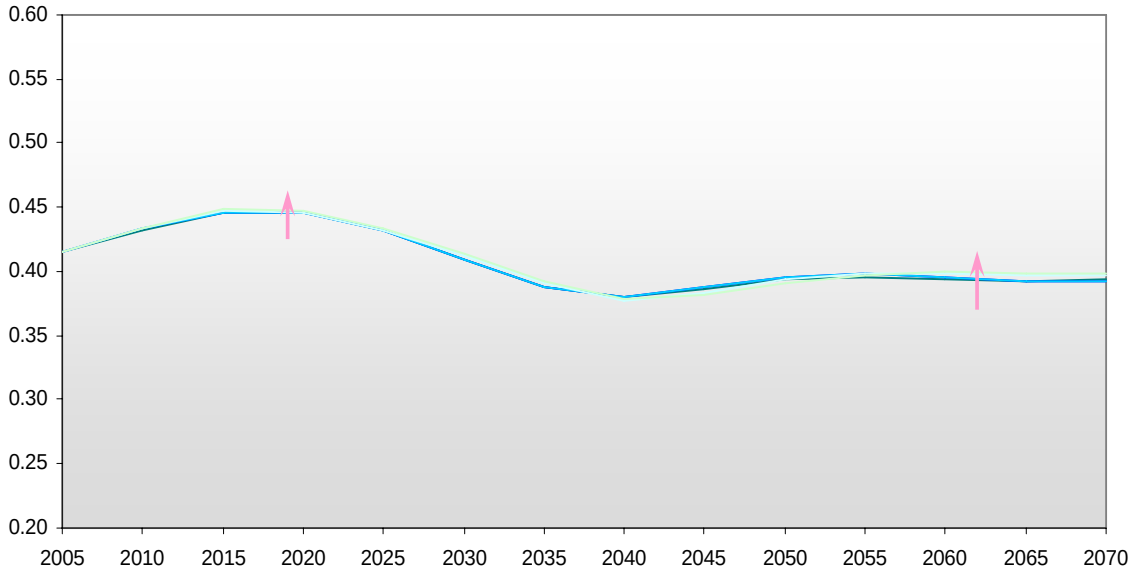

Figure 6. Gini coefficient (Asset)

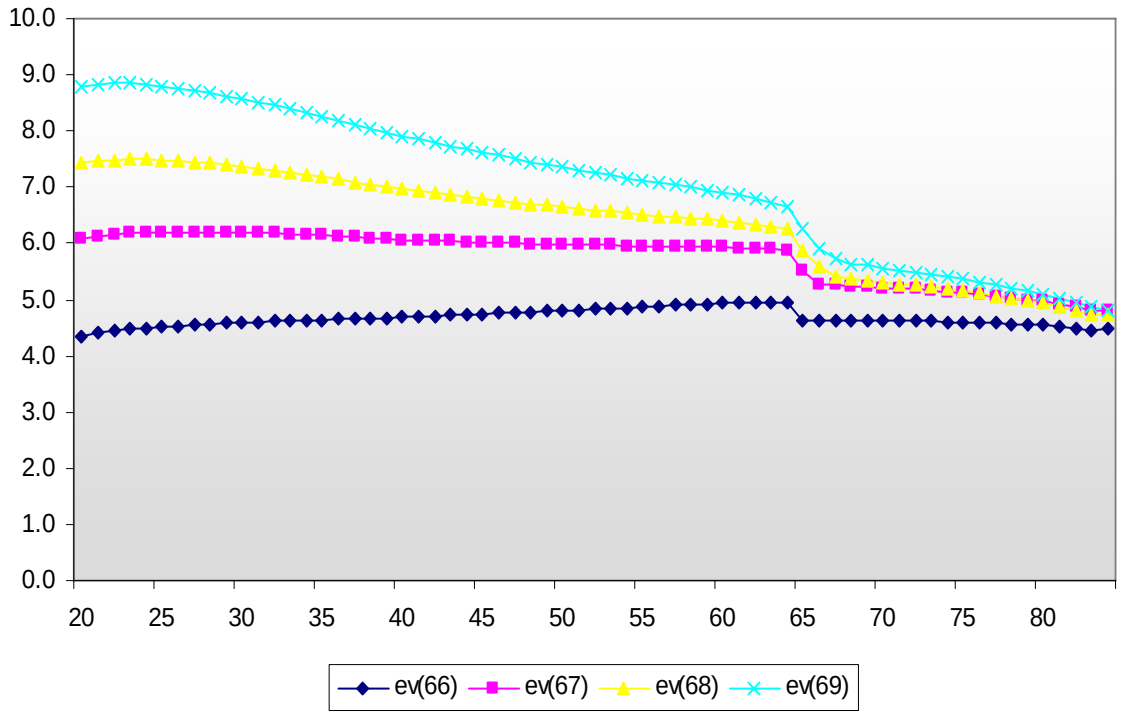

Figure 7. Equivalent Variations

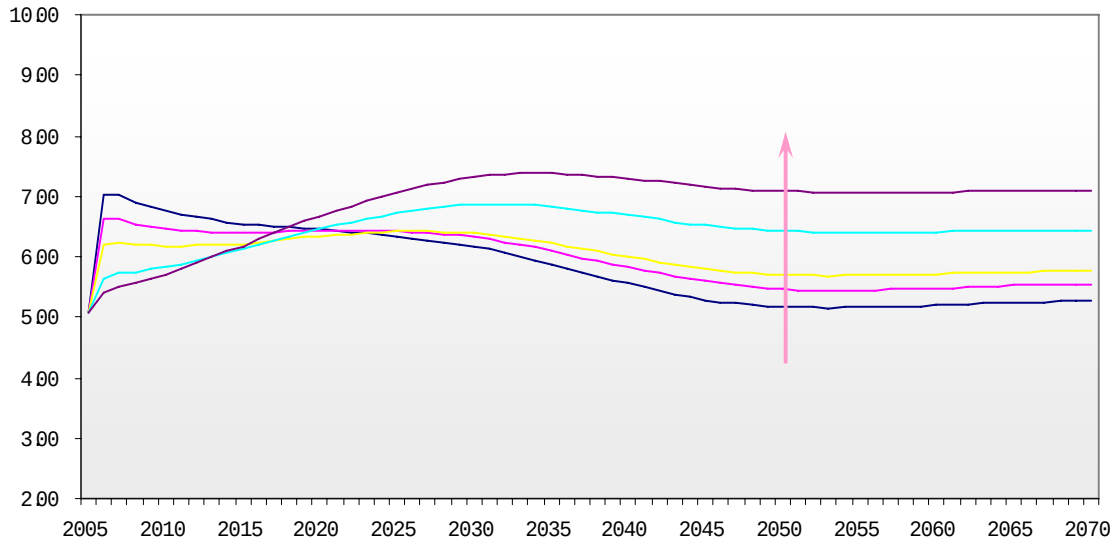

Figure 8. Simulation results of reducing the pension benefit: Capital/Labor Ratio

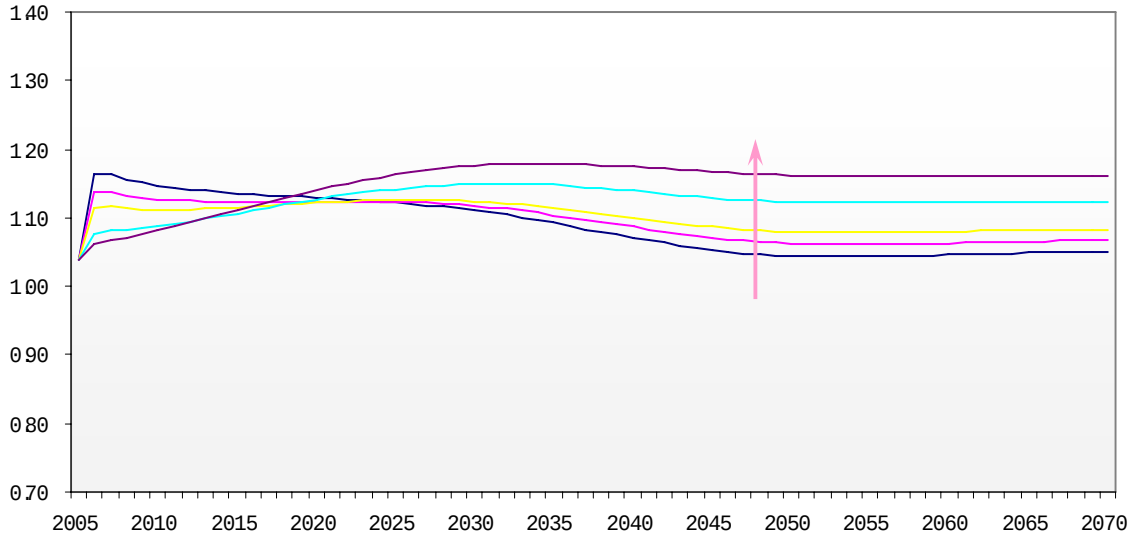

Figure 9. Simulation results of reducing the pension benefit: Wages

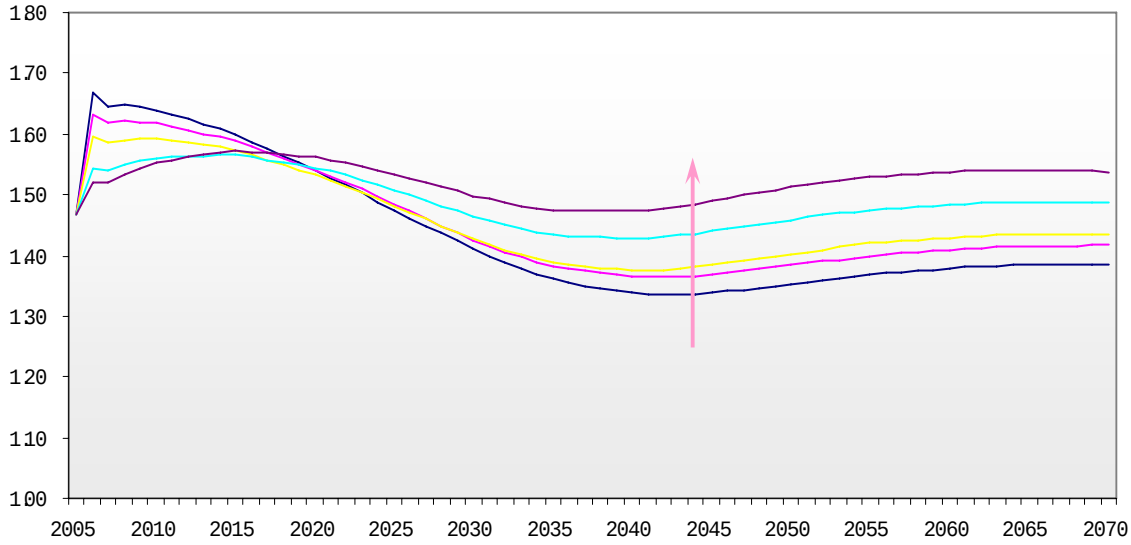

Figure 10. Simulation results of reducing the pension benefit: Per Capita GRP

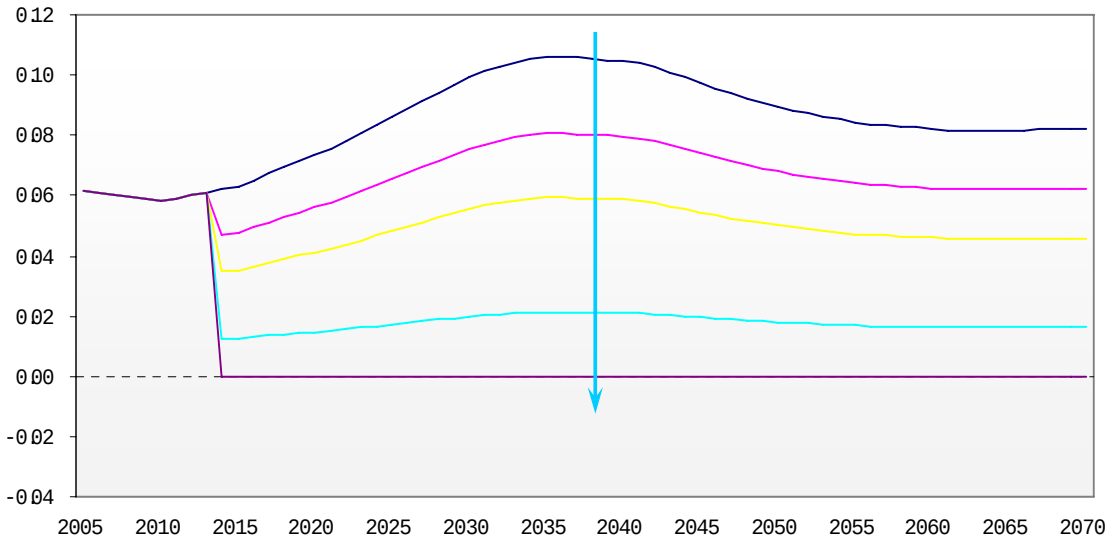

Figure 11. Simulation results of reducing the pension benefit: Social Security Tax Rate

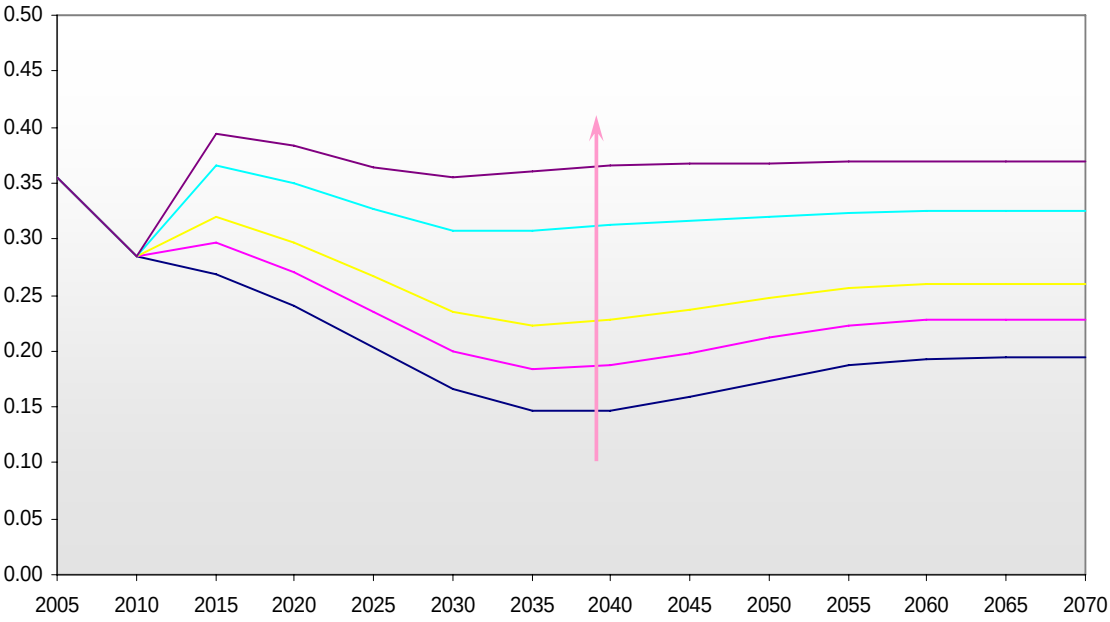

Figure 12. Simulation results of reducing the pension benefit: Income Gini Coefficient

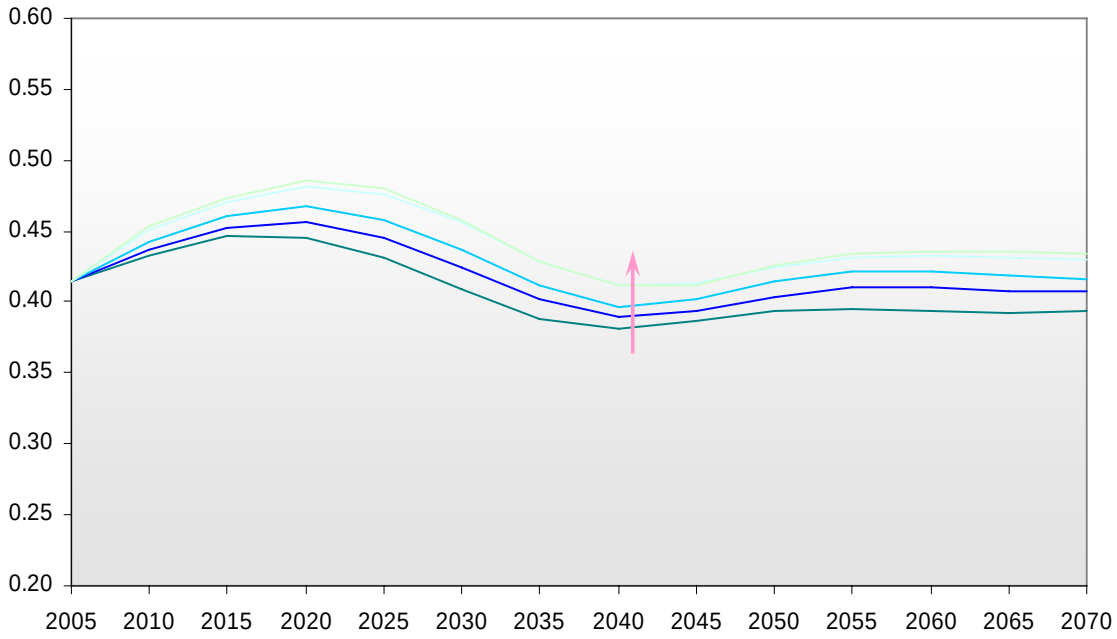

Figure 13. Simulation results of reducing the pension benefit: Asset Gini Coefficient

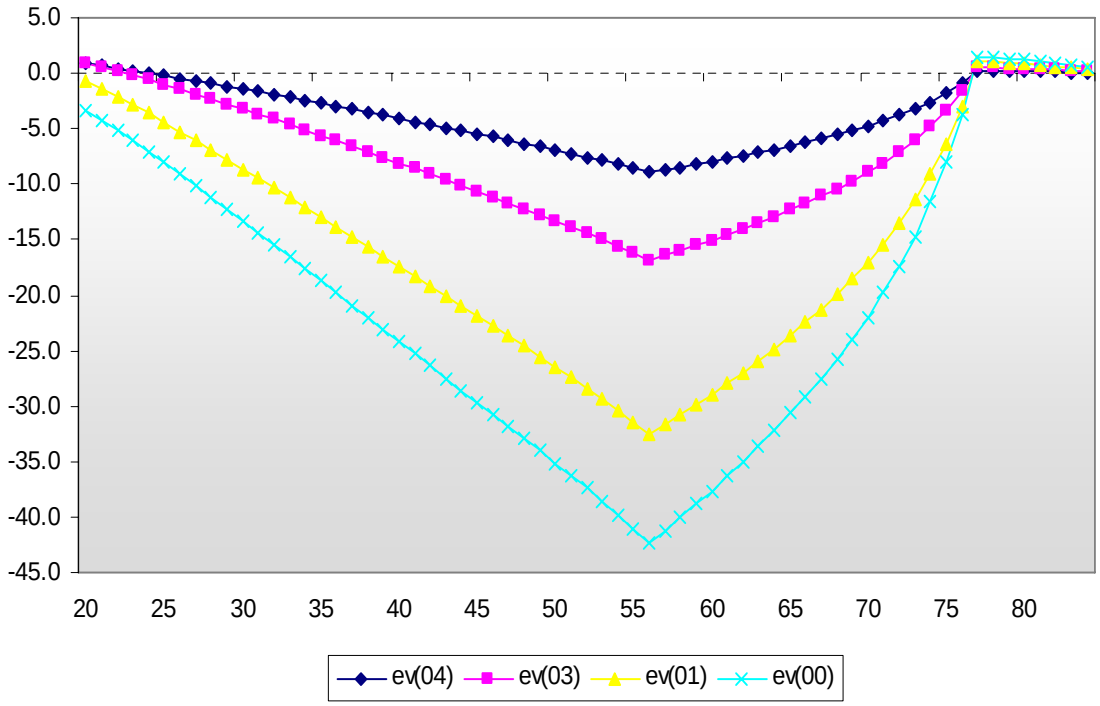

Figure 14. Simulation results of reducing the pension benefit: Equivalent Variations

Table 1. Immigration and Pension Reforms

Share of Immigration	Replacement rate					
	0%	10%	20%	30%	40%	50%
0.0%	-75.48	-74.91	-74.45	-74.30	-74.42	-74.68
0.6%	-75.54	-74.79	-74.11	-73.77	-73.59	-73.60
1.2%	-76.66	-76.21	-75.49	-74.84	-74.44	-74.72
1.8%	-77.39	-76.75	-75.90	-75.43	-75.18	-75.37

Table 2. Immigration and Retirement age

Share of Immigration	Retirement age				
	65	66	67	68	69
0.0%	-74.42	-73.82	-73.24	-72.69	-72.19
0.6%	-73.60	-73.02	-72.51	-72.03	-71.58
1.2%	-73.92	-73.35	-72.81	-72.33	-71.88
1.8%	-75.18	-74.50	-74.10	-73.37	-72.98

Table 3. Effects on Wage (Chicago)

Year	Aging population	Aging population and retirement out-migration			
		Very low	Low	Medium	High
2010	16.41	-0.11	-0.04	-0.02	-0.28
2020	14.52	-0.37	-0.35	-0.25	-0.17
2030	12.71	-0.68	-0.71	-0.59	-0.50
2040	8.69	-0.76	-0.83	-0.74	-0.71
2050	5.98	-0.65	-0.79	-0.84	-0.86
2060	6.08	-0.62	-0.79	-0.82	-0.86
2070	6.59	-0.70	-0.89	-0.91	-0.98

Table 4. Effects on Gross Regional Product (Chicago)

Year	Aging population	Aging population and retirement out-migration			
		Very low	Low	Medium	High
2010	15.26	-0.17	-0.56	-1.01	-0.94
2020	8.53	-0.90	-1.75	-3.10	-4.39
2030	-1.35	-1.90	-3.34	-5.65	-7.83
2040	-9.07	-2.12	-3.85	-6.67	-9.31
2050	-11.21	-1.51	-2.98	-5.49	-7.93
2060	-11.09	-1.35	-2.79	-5.24	-7.62
2070	-10.61	-1.37	-2.81	-5.22	-7.57

Table 5. Effects on Per Capita GRP (Chicago)

Year	Aging population	Aging population and retirement out-migration			
		Very low	Low	Medium	High
2010	16.98	0.29	0.05	-0.20	0.08
2020	9.86	0.71	0.36	-0.33	-0.96
2030	0.64	1.39	0.92	-0.13	-1.13
2040	-4.57	2.08	1.55	0.25	-0.99
2050	-3.52	2.21	1.83	0.67	-0.51
2060	-1.66	2.13	1.70	0.51	-0.71
2070	-1.08	2.09	1.66	0.52	-0.67

Table 6. Effects on GNP Share (Chicago)

Year	Aging population	Aging population and retirement out-migration			
		Very low	Low	Medium	High
2010	2.94	2.94	2.93	2.91	2.92
2020	2.94	2.91	2.89	2.85	2.81
2030	2.94	2.88	2.84	2.77	2.71
2040	2.93	2.87	2.82	2.73	2.66
2050	2.93	2.88	2.84	2.77	2.70
2060	2.93	2.89	2.84	2.77	2.70
2070	2.93	2.89	2.84	2.77	2.70

Table 7. Effects on Wage (ROUS)

Year	Aging population	Aging population and retirement out-migration			
		Very low	Low	Medium	High
2010	16.77	0.01	0.00	0.00	0.01
2020	15.04	0.01	0.01	0.01	0.00
2030	13.27	0.02	0.01	0.01	0.00
2040	7.57	0.02	0.02	0.01	0.00
2050	6.78	0.01	0.00	-0.01	-0.01
2060	6.99	0.02	0.01	0.00	0.00
2070	7.54	0.00	0.00	-0.01	-0.01

Table 8. Effects on Gross Regional Product (ROUS)

Year	Aging population	Aging population and retirement out-migration			
		Very low	Low	Medium	High
2010	16.52	0.01	0.02	0.03	0.03
2020	9.89	0.03	0.05	0.10	0.13
2030	-0.07	0.06	0.10	0.17	0.23
2040	-7.60	0.07	0.12	0.20	0.28
2050	-9.74	0.04	0.08	0.15	0.22
2060	-9.54	0.04	0.09	0.15	0.22
2070	-9.08	0.03	0.07	0.14	0.21

Table 9. Effects on Per Capita GRP (ROUS)

Year	Aging population	Aging population and retirement out-migration			
		Very low	Low	Medium	High
2010	18.26	-0.01	0.00	0.01	-0.01
2020	11.24	-0.02	-0.01	0.01	0.03
2030	1.95	-0.04	-0.03	0.00	0.02
2040	-3.03	-0.06	-0.05	-0.01	0.02
2050	-1.92	-0.08	-0.07	-0.04	-0.01
2060	0.05	-0.06	-0.05	-0.02	0.01
2070	0.61	-0.07	-0.06	-0.03	0.00

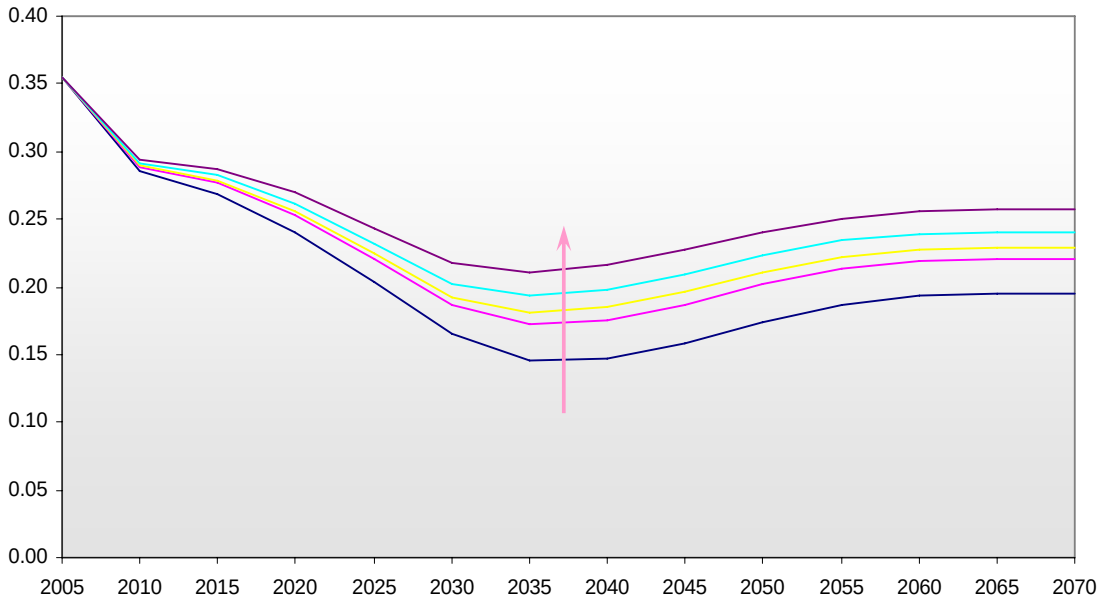

Figure 15. Income Gini Coefficent (Chicago)

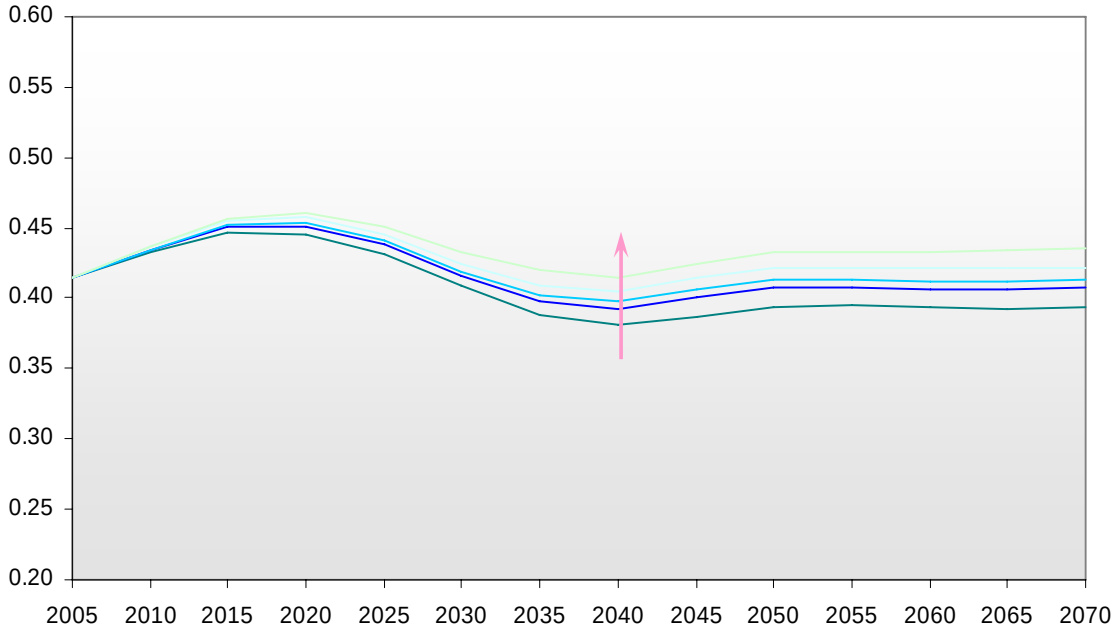

Figure 16. Asset Gini Coefficent (Chicago)

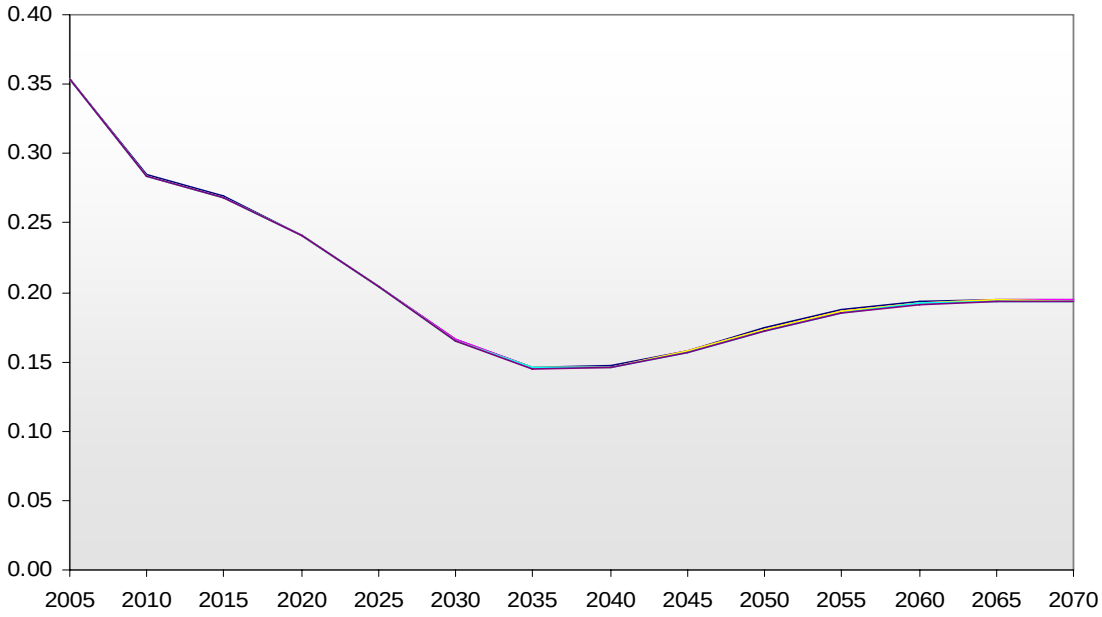

Figure 17. Income Gini Coefficent (ROUS)

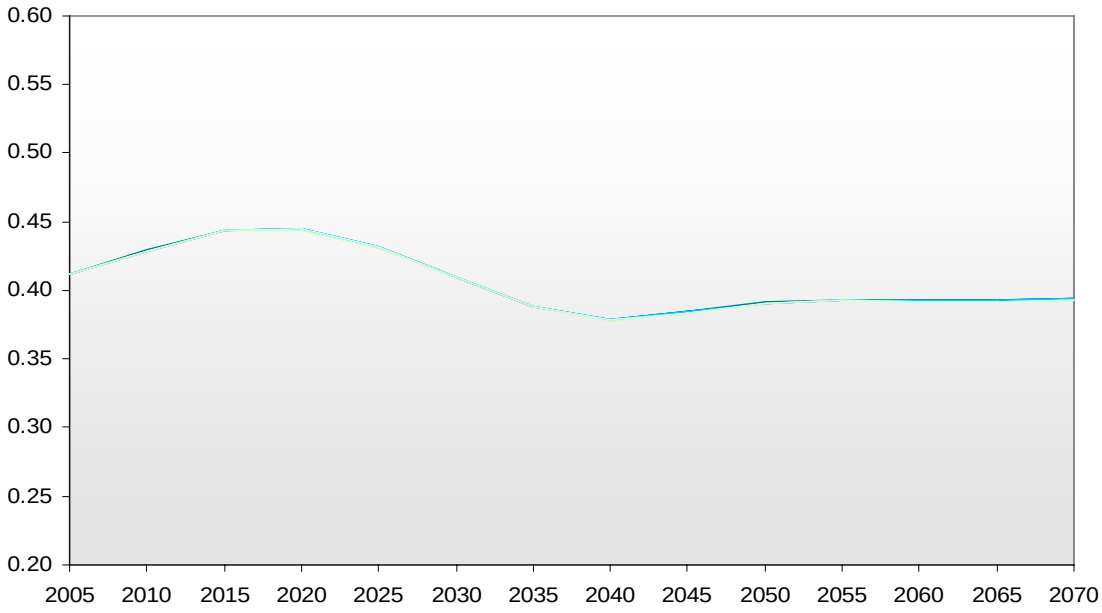

Figure 18. Asset Gini Coefficent (ROUS)