Policy Uncertainty and the Cost of Delaying Reform: A Case of Aging Japan

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Abstract

In an economy with aging demographics and a generous pay-as-you-go social security system established decades ago, reform to reduce benefits is inevitable without a major increase in taxes. Often times, however, there is uncertainty about the timing and structure of reform. This paper explicitly models policy uncertainty associated with a social security system in an aging economy and quantifies economic and welfare effects of uncertainty as well as costs of delaying reform. Using the case of Japan, that faces the severest demographic and fiscal challenges, we show that uncertainty can significantly affect economic activities and welfare. Delaying reform or reducing the scope of it involves a sizeable welfare tradeoff across generations, in which middle to old-aged individuals gain the most at the cost of young and future generations.

Keywords: Pension reform, policy uncertainty, aging demographics, fiscal sustainability, Japanese economy.
JEL Classification: E20, H55, J11

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1 Introduction

Almost all developed countries are facing a major fiscal challenge as they go through demographic aging. In many countries the social security system had been established before the major improvement in longevity and a rise in life expectancy during the last decades. They will also experience a rise in the number of retirees and recipients of social security benefits as baby boom generations born after the War successively reach the retirement age. Rising medical expenditures also pose a challenge in an aging economy through an expansion of public health insurance programs. In a country where major reform has not yet happened, it is perceived that the current system needs some change sooner or later so that the government remains solvent. What is, however, not known is when a change will happen and what structure it will take. This paper explicitly models uncertainty associated with the timing and structure of pension reform in an aging economy. We consider the case of Japan in simulations, which will face the most significant and rapid transformation of the demographic structure throughout the century. The framework, however, can be used to analyze any economy with similar challenges.

The vast literature exists that analyzes fiscal policies and social security reform using a dynamic general equilibrium model of overlapping generations. The seminal work of Auerbach and Kotlikoff (1987) developed a multi-period life-cycle model with perfect foresight to simulate social security reform in the U.S. by computing transition paths between steady states. Numerous papers followed, incorporating in a dynamic macro model a range of important microeconomic factors that help us better understand effects of social security reform, such as earnings uncertainty, imperfect insurance and precautionary savings, borrowing constraint, preference heterogeneity, international capital flows, etc.[1] There is also a growing literature focused on the Japanese economy using a general equilibrium framework such as Braun and Joines (2015), Kitao (2015a) and İmrohoroğlu et al. (2015).

All of the papers above assume that individuals know the policy in a steady state or the sequence of it during the transition in advance. We do, however, face a significant degree of uncertainty in the future of social security policy especially in an economy going through a major demographic transition. We make optimal decisions subject to unknown policy innovations, which typically are not insurable in the market and can have a major impact on our lifetime utility.

There are studies that attempt to measure policy uncertainty and volatilities and assess the impact on economic activities. The literature has grown especially after the recent financial crisis. Baker et al. (2015) build an index of policy uncertainty and find that a rise in uncertainty foreshadows declines in economic activities using data from the U.S. and 12 other countries. Fernández-Villaverde et al. (2013) estimate tax and spending processes for the U.S. and use a DSGE model to identify a large adverse effect of innovations on economic activity.[2]

[1] Contributions in the literature include İmrohoroğlu et al. (1995), De Nardi et al. (1999), Conesa and Krueger (1999), Huggett and Ventura (1999), Attanasio et al. (2007), Nishiyama and Smetters (2007), İmrohoroğlu and Kitao (2012) and Kitao (2014).

[2] Other papers in the literature include Bi et al. (2013) and Luttmer and Samwick (2015). Auerbach

There are, however, surprisingly few papers that explicitly model policy uncertainty in a life-cycle model with heterogeneous agents so that uncertainty in age and state-specific redistributive policies can be analyzed to quantify economic and welfare effects across generations and heterogeneous individuals. Auerbach and Hassett (2007) use a two-period overlapping generations model to study optimal fiscal policy when there is time-varying lifetime uncertainty and the government is constrained from making frequent changes in fiscal policies.

Caliendo, Gorry, and Slavov (2015) (hereafter CGS) and Bütler (1999) are two other papers that build a life-cycle model to quantify effects of uncertainty associated with a pension system and they are perhaps the closest to our paper in the structure of the model and questions to analyze. CGS advance the literature by incorporating uncertainty in terms of the timing and structure of pension reform in a model of heterogeneous individuals. They find that the welfare cost of policy uncertainty is minimal for those with enough saving but can be much larger for non-savers. There are several differences between CGS and our paper. One major difference is that we build a general equilibrium model in which factor prices are determined in equilibrium. We identify sizeable changes in individuals' saving and labor associated with policy innovations, which induce a shift in factor prices and affect individuals' welfare. Our model endogenizes labor supply, which CGS assume as exogenous. CGS also set the fiscal variables based on the estimates on the sustainability of the social security system. We instead assume that pension benefits will be reduced by different degrees as a result of reform and at the same time adjust another fiscal variable so the government budget constraint is satisfied in each year along the transition. Depending on the timing and the structure of the reform, the fiscal burden that the government eventually has to bear in future and throughout the transition will change significantly and it is intensified in an aging economy. Lastly, CGS is focused on the effects of policy uncertainty under a given demographic structure but we explicitly model aging demographics that evolve over time, which is the source of uncertainty and defines the required fiscal adjustments along the transition.[3]

Bütler (1999) studies a life-cycle model with uncertainty about the timing of pension reform. The focus is on effects of uncertainty in the short-run and for that reason factor prices are assumed exogenously fixed and demographics are time-invariant. The model is calibrated to the Swiss economy and pension system. She finds that there can be a substantial rise in saving and labor supply before reform and that uncertainty increases the volatility of individuals' behavior.

Gomes, Kotlikoff, and Viceira (2012) also investigate effects of policy uncertainty but they do so from a different angle. In the model, benefits may or may not be reduced by 30% when individuals reach age 65. They compare welfare effects across ages in which individuals know whether the reform will indeed occur or not. Under each scenario uncertainty is whether the reform does or does not happen and the focus is on the welfare cost of early vs late resolution of uncertainty. Gomes et al. (2012) focus on when

and Hassett (2002) provide a review of earlier work on effects of fiscal policy uncertainty on business cycles.

[3]Other differences are that we assume that the time is discrete and CGS use continuous time and that we take the model to the Japanese data and CGS analyze the U.S. policy.

to resolve uncertainty, which differs from uncertainty in terms of reform timing and structure that our paper focuses on. They find that early resolution will improve welfare though the magnitude is relatively small in the range of 0.02% to 0.29% in consumption equivalence under the baseline preference specification, when the resolution occurs at age 35 rather than 65.

None of these papers with a life-cycle and policy uncertainty, including CGS, Bütler (1999) and Gomes et al. (2012), takes into account effects of changing demographics and they are assumed to be time-invariant. Our focus is different and we study uncertainty in social security policy and fiscal challenges associated with and driven by aging demographics. Due to the changing demographic structure, it becomes increasingly costly to finance transfer expenditures under a status-quo financing scheme and a delay of necessary reform exacerbates the imbalance when an old-age dependency ratio continues to rise. A fiscal challenge under aging demographics is one of the major motivations to study policy uncertainty in this paper, which distinguishes it from the other studies.

The U.S., Japan and many of developed economies will all face a major shift in demographics and rising public expenditures during the coming decades. The demographic and fiscal problems are the severest in Japan. The old-age dependency ratio, defined as the number of individuals at age 65 and up expressed as a fraction of that of age 20 to 64, was under 40% in 2010, but is projected to reach 60% by 2030 and exceed 80% before 2080. According to a recent survey of "new adults" conducted in Japan, 91% report that they are "uncertain whether they can receive public pension in future" and 37% disagree that "the pension system is sustainable."[4]

The Japanese public pension system was established in early 1960s, when the life-expectancy was around 70. Now the life-expectancy is among the highest in the world, reaching 81 for male and 87 for female in 2014. Although the pension fund carries large assets accumulated while revenues from pension premium exceeded the total payout, the system is essentially a pay-as-you-go program and benefits do not explicitly depend on the balance of the pension fund or self-financed by an individual's own contribution. Given the expected surge in the number of retirees and a decline in collected taxes during the next several decades, the first major reform to adjust benefits downward to reflect a rise in longevity and a fall in the number of the insured was implemented in 2004. The adjustment, however, called "macroeconomic slide" embedded in the reform is subject to enough inflation in order to avoid a decline in nominal benefits and has been triggered only once in 2015, out of fifteen years since the implementation of the reform.

There is uncertainty as to the effectiveness of the macroeconomic slide in the economy with a history of low inflation observed during the last decades. Whether it takes the form of existing macroeconomic slide or something else, there is little question among the nation that some kind of reform is needed, which involves a reduction in benefits. It is, however, uncertain when reform will occur and how large, if any, a reduction in benefits will have to be so the system is sustainable in the long-run. Building a framework to understand the roles played by such policy uncertainty and quantifying economic and welfare effects of uncertainty and potential delays in the implementation of reform can provide a useful guidance for policy makers and researchers engaged in the study of

[4]Source: http://www.macromill.com/r_data/20150108shinseijin/

policy changes not only in the short-run but also in the medium and long-run.

The rest of the paper is organized as follows. Section 2 presents the model and section 3 discusses parametrization of the model. Numerical results are presented in section 4 and section 5 concludes.

2 Model

We will first describe the model and equilibrium without policy uncertainty. We then discuss how the baseline model will be modified to accommodate policy uncertainty and multiple possible transition paths under different policy realizations.[5]

2.1 Economic environment

Demographics: The economy is populated by overlapping generations of individuals, who enter the economy at age $j = 1$ and face an uncertainty about life-span. The maximum age is J years. Individuals of age j at time t survive until the next period $t+1$ with probability $s_{j,t}$. Assets left by the deceased are distributed as a lump-sum transfer denoted as b_t to all surviving individuals. n_t denotes the growth rate of the size of a new cohort entering the economy.

Individuals' preferences: Individuals derive utility from consumption and leisure in each period and maximize the sum of discounted utility over the lifetime. A period utility function is denoted as $u(c_j, h_j)$, where c_j and h_j denote an individual's consumption and labor supply at age j, respectively, and individuals discount future utility by a subjective discount factor β .

Technology: Firms are competitive and produce output Y_t, using aggregate capital K_t, labor supply L_t and technology Z_t, according to an aggregate production function

$$Y_t = Z_t K_t^{\alpha} L_t^{1-\alpha}. \tag{1}$$

α denotes the share of capital in production and capital depreciates at constant rate δ. The interest rate r_t^k and wage rate w_t are set in a competitive market.

Endowments and medical expenditures: Each individual can allocate a unit of disposable time to market work and leisure every period. Earnings in period t are denoted as $y_t = \eta_j h w_t$ and consist of three parts, η_j, age-specific deterministic productivity, h, endogenously chosen hours of work and w_t, the market wage.

[5]The baseline model without policy uncertainty is similar to Kitao (2014), Kitao (2015a) and Kitao (2015b). The model, however, does not endogenize an extensive margin of labor supply as in Kitao (2014), uninsurable idiosyncratic productivity shocks as in Kitao (2015a) or different types of assets as in Kitao (2015b). We chose to abstract from these features of the model since the computation of the model with policy uncertainty is highly intensive with multiple potential transition paths of the economy taken into account in individuals' optimal decisions. These extensions are left for future research.

As in Kitao (2015a), we assume that there are two types of medical expenditures that individuals face each period, expenditures for health care $m^h_{j,t}$ and long-term care $m^l_{j,t}$. Total out-of-pocket expenditures of an individual are given as $m^o_{j,t} = \lambda^h_{j,t} m^h_{j,t} + \lambda^l_{j,t} m^l_{j,t}$, where fractions $\lambda^h_{j,t}$ and $\lambda^l_{j,t}$ of each type of expenditures represent a copay of the two insurance programs. The rest of the expenditures are covered by public health and long-term care insurances. M_t denotes total national medical expenditures, which consist of out-of-pocket expenses paid by individuals and a part paid by the government M^g_t, given as

$$M^g_t \;=\; \sum_j \left[(1-\lambda^h_{j,t})m^h_{j,t} + (1-\lambda^l_{j,t})m^l_{j,t}\right]\mu_{j,t},$$

where $\mu_{j,t}$ denotes the number of individuals of age j at time t.

Government: The government runs a pay-as-you-go public pension system and individuals at and above retirement age j_R receive pension benefits $ss_t(e)$, determined as a function of each individual's career earnings, denoted by an index e. The benefits consist of basic pension, which is independent of past earnings and a part that is related to the index e.

The government levies taxes on earnings at a proportional rate τ^l_t, income from capital rented to firms at τ^k_t, interest rate earned on government debt at τ^d_t, and consumption at τ^c_t. The government also issues debt D_{t+1} and pays interest r^d_t to debt holders. Revenues are used to pay for government purchases of goods and services G_t, payment of the principal and interest on debt D_t, public pension benefits, and health and long-term care insurance benefits M^g_t. As in Kitao (2015a) and Braun and Joines (2015), we assume that individuals allocate a fraction ϕ_t of assets to government debt and the rest to firms' capital. Therefore after-tax gross return on each unit of individuals' savings net of taxes is given as $R_t = 1 + (1-\tau^k_t)r^k_t(1-\phi_t) + (1-\tau^d_t)r^d_t\phi_t$.

The government budget constraint in each period is given as

$$\begin{aligned} & G_t + (1+r^d_t)D_t + S_t + M^g_t \\ &= \sum_x \left\{\tau^l_t y_t(x) + [\tau^k_t r^k_t(1-\phi_t) + \tau^d_t r^d_t \phi_t](a_t(x)+b_t) + \tau^c_t c_t(x)\right\}\mu_t(x) + D_{t+1}, \end{aligned} \tag{2}$$

where S_t denotes total pension benefits $\sum_x ss_t(x)\mu_t(x)$ and $\mu_t(x)$ represents the measure of individuals in state x at time t as defined below.[6]

2.2 Individuals' problem

Individuals can trade one-period riskless asset a_t, which is a composite of an investment in firms' capital and holdings of government debt and pays after-tax gross interest R_t as defined above. Borrowing against future income and transfers is not allowed and assets of an individual cannot be negative.

[6] As we describe in section 3, labor income tax τ^l_t is set in the initial steady state to satisfy the government budget constraint (2). Thereafter, consumption tax τ^c_t adjusts to balance the budget and τ^l_t is fixed at the value determined in the initial steady state.

A state vector of an individual $x = \{j, a, e\}$ consists of j age, a assets, and e an index of cumulated earnings that affects each individual's pension benefits. Individuals choose the optimal path of consumption, saving and labor supply to maximize life-time utility. The problem is solved recursively and the value function $V(x)$ is defined as follows.

$$V(j, a, e) = \max_{c,h,a'} \{u(c, h) + \beta s_j V(j + 1, a', e')\}$$

subject to

$$\begin{aligned}
&(1 + \tau^c)c + a' = R(a + b) + (1 - \tau^l)y + ss(e) - m_j^o \\
&y = \eta_j hw \\
&a' \geq 0 \\
&e' = \begin{cases} f(e, y) & \text{for } j < j_R \\ e & \text{for } j \geq j_R \end{cases}
\end{aligned}$$

The index of cumulated earnings e evolves according to the law of motion $e' = f(e, y)$ until individuals reach normal retirement age j_R. The pension benefit $ss(e)$ is zero for individuals below age j_R.

2.3 Equilibrium definition

We now define the competitive equilibrium of our model.[7] Given a set of demographic parameters $\{s_{j,t}\}_{j=1}^J$ and $\{n_t\}$, medical expenditures $\{m_{j,t}^h, m_{j,t}^l\}_{j=1}^J$, and government policy variables $\{G_t, D_t, \tau_t^k, \tau_t^d, \tau_t^l, ss_t, \lambda_{j,t}^h, \lambda_{j,t}^l\}$, a competitive equilibrium consists of individuals' decision rules $\{c_t(x), h_t(x), a_{t+1}(x)\}$ for each state vector x, factor prices $\{r_t^k, w_t\}$, consumption tax $\{\tau_t^c\}$, accidental bequests transfer $\{b_t\}$, and the measure of individuals over the state space $\{\mu_t(x)\}$ such that:

1. Individuals solve optimization problems defined in section 2.2.

2. Factor prices are determined in competitive markets.

$$\begin{aligned}
r_t^k &= \alpha Z_t \left(\frac{K_t}{L_t}\right)^{\alpha-1} - \delta \\
w_t &= (1 - \alpha) Z_t \left(\frac{K_t}{L_t}\right)^{\alpha}
\end{aligned}$$

3. Total lump-sum bequest transfer equals the amount of assets left by the deceased.

$$b_t \sum_x \mu_t(x) = \sum_x a_t(x)(1 - s_{j,t-1})\mu_{t-1}(x)$$

[7] In the definition presented above, we assume that the government budget constraint is satisfied by an adjustment of consumption tax. The definition can be easily modified for the case where labor income tax is adjusted to balance the government budget.

4. The markets for labor, capital and goods all clear.

$$K_t = \sum_x \left[a_t(x) + b_t\right] \mu_t(x) - D_t$$
$$L_t = \sum_x \eta_j h_t(x) \mu_t(x)$$
$$\sum_x c_t(x)\mu_t(x) + K_{t+1} + G_t + M_t = Y_t + (1-\delta)K_t$$

5. Consumption tax τ_t^c satisfies the government budget constraint (2).

3 Calibration

This section presents parametrization of the model. The frequency of the model is annual and the unit of the model is an individual, who represents a household as head. We first compute an equilibrium that approximates the Japanese economy in 2010, which we call as initial steady state, built as a starting point for the computation of transition dynamics.[8] As explained below, we calibrate some parameters outside of the model independently and other parameters in the initial steady state equilibrium so that the model approximates key features of the economy in 2010.

Demographics: We assume that individuals become economically active and start making economic decisions at age 20 and live up to the maximum age of 110. Conditional survival probability $s_{j,t}$ and growth rate of a new cohort n_t are based on projections of the National Institute of Population and Social Security Research (IPSS), which are available up to 2060. We assume that survival rates will remain constant at the 2060 level thereafter. The growth rate n_t is negative during the projection period due to persistently low fertility rates and we set the growth rate at -1.2% between 2010-2080 based on the projections. We assume that the growth rate will gradually rise after 2080 and converge to 0% by 2150.

Preferences and technology: A period utility function takes the form,

$$u(c,h) = \frac{\left[c^{\gamma}(1-h)^{1-\gamma}\right]^{1-\sigma}}{1-\sigma}.$$

The parameter γ determines the preference weight on consumption relative to leisure and we set the value at 0.352 so that individuals at age 20 to 64 spend 40% of disposable time for market work on average. σ is related to risk aversion, which is set to 3.0, implying relative risk aversion of 1.70, and the intertemporal elasticity of substitution at 0.59.

[8]Note that we use actual age-distribution of 2010 in computing the initial steady state so that the demographic structure in the initial and subsequent years is accurately captured in the model. The population is not stationary in 2010 and aggregate statistics are computed using the actual age distribution.

Discount factor β is set to 1.0209, so that the capital-output ratio in the initial steady state is 2.5, as estimated by Hansen and İmrohoroğlu (2013).

Based on Hayashi and Prescott (2002), the share of capital in the production is set at 0.36 and depreciation rate at 0.089. The level of technology Z_t is assumed to grow at 1% each year based on the estimates in 2000s. The initial level of productivity is set for normalization so that average earnings is unity in the initial steady state.

Endowments and medical expenditures: Labor productivity η_j is calibrated based on age-specific wage data from the Basic Survey on Wage Structure (BSWS) in 2010. Wage data of male workers are used to approximate the wage profile of household heads in the model. We assume $\eta_j = 0$ for individuals above the retirement age.

Data on medical expenditures over the life-cycle are taken from the Ministry of Health, Labour and Welfare (MHLW). We assume that per-capita expenditures grow at the same rate as the growth rate of the economy. Copay rates of health insurance $\lambda^h_{j,t}$ vary by age; 30% below age 70, 20% at 70-74 and 10% at 75 and above. Copay rate of long-term care insurance $\lambda^l_{j,t}$ is 10% regardless of recipients' age. We assume that the copay rates are time invariant.

Public pension system: The government operates pay-as-you-go pension system, which provides benefits $ss(e)$ once an individual reaches the retirement age j_R of 46 (65 years old). Benefits are determined as a function of the average earnings e of each individual through his career. The law of motion for the earnings index is given as

$$e' = f(e, y) = e + \frac{\min(y, \bar{y})}{N_w}, \tag{3}$$

where y is the new earnings data and N_w is the number of working periods, which we set to 45 years, from age 20 to 64. The cap for counted earnings $\bar{y}$ is set at 10.44 million yen, based on the maximum annual earnings used to compute the earnings index in the Japanese pension system.

The benefits are determined according to the function

$$ss(e) = \overline{ss} + \rho \cdot e,$$

where $\overline{ss}$ represents the basic pension, the first tier of the Japanese pension system, and the amount of payment does not depend on an individual's past earnings. The average basic pension benefits received by retirees in 2010 was 655,000 yen and the parameter is set to this value. The parameter ρ is set at 0.303 to match total pension expenditures at 10% of GDP in 2010.[9]

[9] The formula implies the gross replacement rate, defined as the ratio of average pension benefits to average earnings, of 39.6% and the net replacement rate, the ratio of average pension benefits to after-tax average earnings, of 59.5%.

Government expenditures, debt and taxes: Government expenditures account for 20% of GDP in 2010, including expenditures for health and long-term care insurance, based on the National Accounts of Japan (SNA). We set the ratio G_t/Y_t to match the data. Government debt D_t is set at 100% of GDP, based on the net debt outstanding in 2010. We set the interest rate on government debt r_t^d at 1%, the average real interest rate on 7-year government bond in 2000s. The fraction ϕ_t of individuals' assets allocated to government debt is determined in each period so that the ratio D_t/Y_t is 100%.

Consumption tax rate is set at 5% in the initial steady state, which represents the economy in 2010. After 2010, consumption tax rate is adjusted to balance the government budget of each year. Capital income tax rate is set at 40%, in the range of estimates of effective tax rates in the literature. Tax rate on interest income from government debt is 20%.

In order to balance the government budget in the initial steady state, we set the labor income tax rate at 33.5%. The labor income tax rate is fixed during the transition and the government budget is balanced through an adjustment of consumption taxes. Labor income tax in our model includes all taxes and premium imposed on earnings, in particular premium for employer-based pension program and medical insurance programs.

4 Numerical results

In this section we will present main numerical results. First we will study effects of uncertainty about the timing of reform and discuss fiscal and welfare costs of policy uncertainty and those of delaying reform. In doing so, we will first compute a baseline transition, in which there is no policy uncertainty, and use the dynamics as a benchmark in the comparison. Second, we will study the cost of uncertainty in both the timing and structure of reform.

4.1 Uncertainty in reform timing

In computing transition dynamics, we let the economy start from the initial steady state as described above, which approximates the economy of 2010. Then the economy makes a transition to another steady state, which we call a final steady state, while the demographics evolve as predicted by the IPSS and a fiscal variable is adjusted along the way so that the period budget constraint of the government is satisfied every year.

In the first exercise, we assume that reform to reduce pension benefits is inevitable and everyone is aware that the reform will happen in future. The exact timing, however, of the reform is uncertain, while people know how large the benefit cut will be. In section 4.2, we introduce uncertainty in both the timing and structure of reform.

If the "macroeconomic slide" embedded in the pension reform of 2004 in Japan works as expected, the replacement rate will decline by about 20% eventually, according to the government report (*Zaisei Kensho* 2014). Various studies, however, have argued that a benefit cut of such a magnitude will not be enough to control a rapid rise in government expenditures and that a major increase in taxes would still be inevitable to balance the budget.[10] Therefore we consider reform that would reduce benefits by an additional 20% on top of the decline through a successful macroeconomic slide, resulting in a 36% reduction of benefits in total ($0.36 = 0.2 + (1 - 0.2) \times 0.2$).[11] We assume that individuals expect that the reform will happen not too far in the future and before the mid-century and that they anticipate three possible timings of 2020, 2030 or 2040, with an equal likelihood. Once the reform begins, the benefit schedule will shift down gradually and the total reduction of 36% will be completed in thirty years after the onset of the reform.[12]

We chose to simulate the transition based on the reform to reduce benefit by a given percentage and to raise taxes to absorb the residual costs, which people appear to think is likely to happen at some point in future, based on various surveys and a general tone in the policy discussion and public sentiments. An alternative theoretical exercise would be to simulate a transition where taxes are fixed and benefits are reduced in each year by an amount necessary to balance the government budget. Another scenario would be to adjust the retirement age over time. These scenarios are studied in Kitao (2014) under the assumption that there is no policy uncertainty. One could also assume that the debt will be exogenously raised to some level though the borrowing alone would not be enough to finance the demographic transition as argued by Braun and Joines (2015), for example, and we would have to assume that multiple fiscal variables adjust during the transition to make the system sustainable. We chose to focus on a simpler adjustment by a consumption tax, which will support for the most likely scenario of reducing benefits.

In summary, there are three different potential paths of transition depending on the realized timing of the reform. Initially, until individuals learn in 2020 whether the reform begins that year or not, there is only one path. From 2020 to 2030, there will be two paths, one in which the reform has already begun in 2020 and the other in which reform is yet to happen and can occur in either 2030 or 2040. In the latter case, individuals will know in 2030 whether the reform starts that year or in 2040. For convenience, we call the three paths as Path 1, Path 2 and Path 3, respectively, in what follows.

As a point of reference, we use transition dynamics in which there is no uncertainty about the timing of reform. Under this certainty scenario, the same reform will be implemented in 2020, that is, benefits will be gradually reduced by the same fraction as in other scenarios over the same 30-year period. We will also consider below a no-uncertainty scenario in which reform begins in 2030, instead of 2020. The year 2030 is the expected timing of reform under the uncertainty case and welfare effects of only uncertainty itself, rather than uncertainty and possibility of delaying the reform can be explicitly analyzed. We call the dynamics under this scenario as the baseline transition without uncertainty. We summarize transition paths that we consider below.

- Transition without uncertainty (baseline path)
- Transition with uncertainty

[10] See, for example, Braun and Joines (2015) and Kitao (2015a).

[11] In section 4.2 we add a scenario in which benefits will be reduced by only 20%.

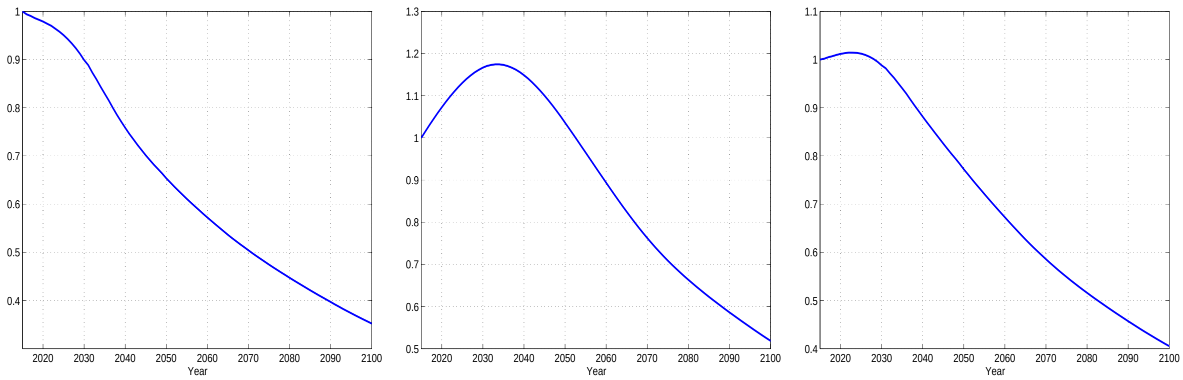
[12] We set the distribution of possible timings of reform in arbitrarily given discrete years of 2020, 2030 and 2040, and this could generalized to occur in any year between 2020 and 2040, for example, if we had a greater computational capacity to handle many more potential transition paths. We conjecture, however, that the main results of the analysis will remain under a finer grid setting.

Path 1 (2010 -): reform begins in 2020

Path 2 (2020 -): reform begins in 2030

Path 3 (2030 -): reform begins in 2040

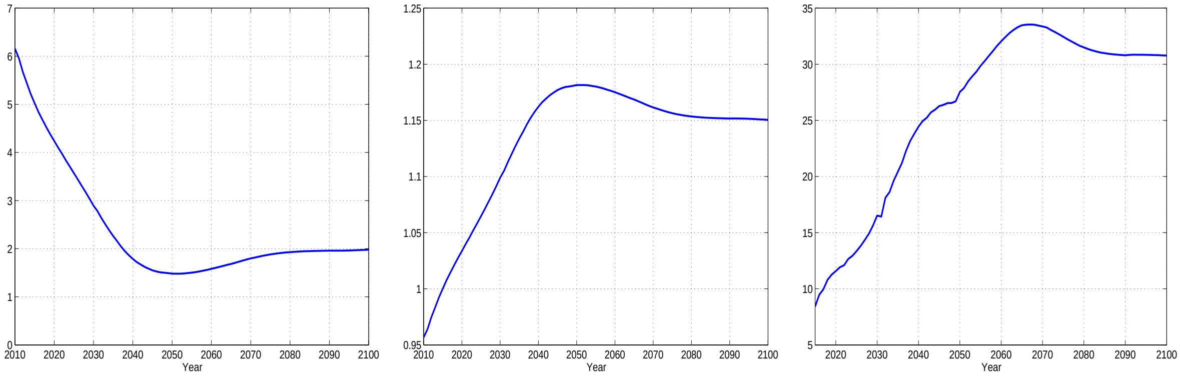
Transition without uncertainty: Before we study effects of policy uncertainty and costs of delaying reform, we will briefly review features of the baseline transition without uncertainty, which will be used as a basis of comparison. Figure 1 shows the path of aggregate variables under the no-uncertainty case. As shown in Figure 1(a), labor supply will decline sharply as many individuals from the two baby boom generations successively reach the retirement age and leave the labor force, at the same time as the cohorts born when fertility rates were very low enter the labor force. Aggregate capital rises initially as individuals have stronger incentives to save for a longer retirement period, but eventually the effects become dominated by the decline in population. Output falls to about 40% of the level in 2015 as shown in Figure 1(c).



(a) Labor supply (b) Capital (c) Output

Figure 1: Baseline path without uncertainty (1): aggregate variables normalized by the value in 2015

Since the aggregate capital rises while labor supply declines during initial decades of the transition, the capital-labor ratio will sharply increase, leading to a rapid decline in interest rate, as shown in Figure 2(a). The path then becomes almost flat after 2040s as the decline in capital will catch up with the fall in labor supply. The wage rate will move in the opposite direction and increase by more than 15% by 2040. The consumption tax rate, which balances the government budget each year, will rise sharply as age-related expenditures for pension and health and long-term care insurance programs rise and tax revenues decline. The tax rate will reach the peak of 33% in 2060s as shown in Figure 2(c).



(a) Interest rate (%)

(b) Wage (normalized by the value in 2015)

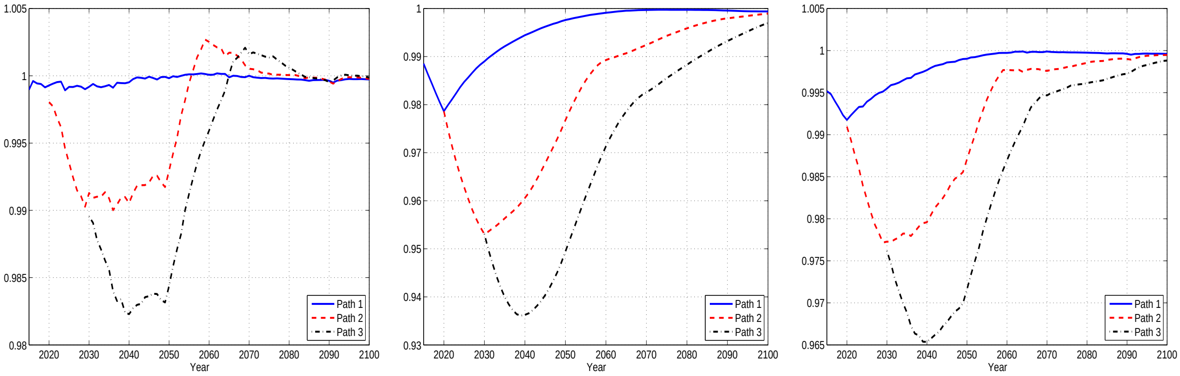
(c) Consumption tax (%)

Figure 2: Baseline path without uncertainty (2)

Transition with timing uncertainty: Next we will study the transition dynamics, in which the timing of the reform is uncertain as described above. Figure 3 shows the transition of aggregate variables under the three paths, expressed as the ratio to the level of the same variables under the baseline transition without uncertainty in each year.

As shown in Figures 3(a) and 3(b), each time individuals learn that the reform is not taking place that year and will occur later, labor supply and capital both decline, relative to the case in which the reform has been implemented. Compared to Path 1, where the reform occurs in 2020, labor supply under Path 2 and 3 will be lower by about 1% by 2030. If the reform does not occur in 2030, the labor supply will decline further by about another percentage point by 2040. Figure 3(b) shows that the difference in capital will be even larger. Under Path 2, capital is lower by more than 3.5% in 2030 compared to the baseline transition without uncertainty and by more than 6% under Path 3 in 2040. Note that even under Path 1, in which the reform takes place in 2020, the same year as in the baseline case ex-post, the aggregate capital is lower by about 1 to 2% for more than two decades than under the baseline transition. The high chance that the reform takes place later gives disincentives to save even before 2020. Although the capital starts to "catch up" with the baseline after people learn that the reform takes place in 2020 under Path 1, it takes several decades to reach the same level as the baseline transition.

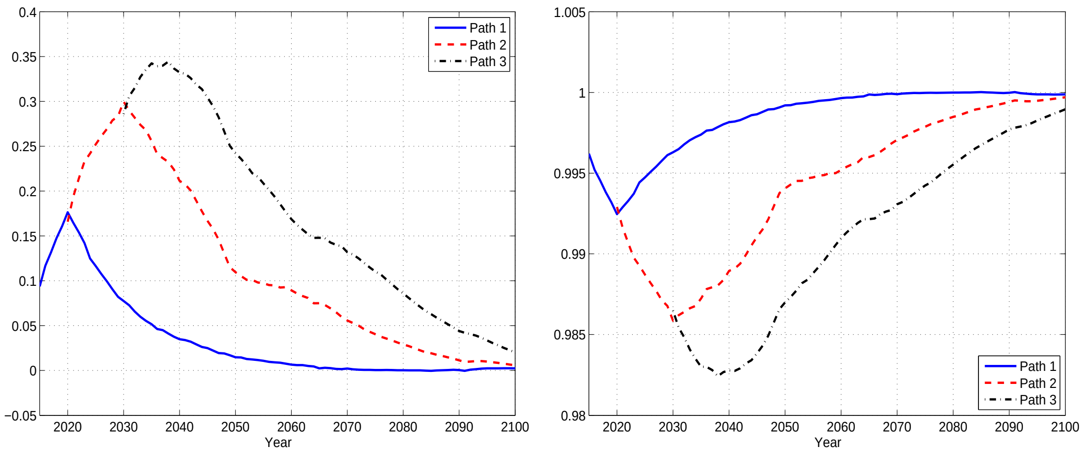
A delay of the reform gives major disincentives for both saving and work, since the later the reform takes place, the higher their expected receipt of pension benefits from the government after retirement, and individuals are not urged to work and save as much for retirement.



(a) Labor supply (b) Capital (c) Output

Figure 3: Paths with uncertainty in reform timing (1): aggregate variables expressed as ratios to those in the baseline transition without uncertainty

Since the capital declines by more than labor, interest rates will be higher and wages will be lower under the paths with later reform, as shown in Figure 4, which displays the difference in interest rate and wages relative to the baseline transition without uncertainty. The decline in the wage will also add to disincentives to work when the reform is postponed to later years. Note that even under Path 1, since the capital will be lower by 1 to 2% as discussed above and it takes many years for the amount of aggregate capital to recover to the baseline level, factor prices also deviate from those under the baseline scenario for an extended period.

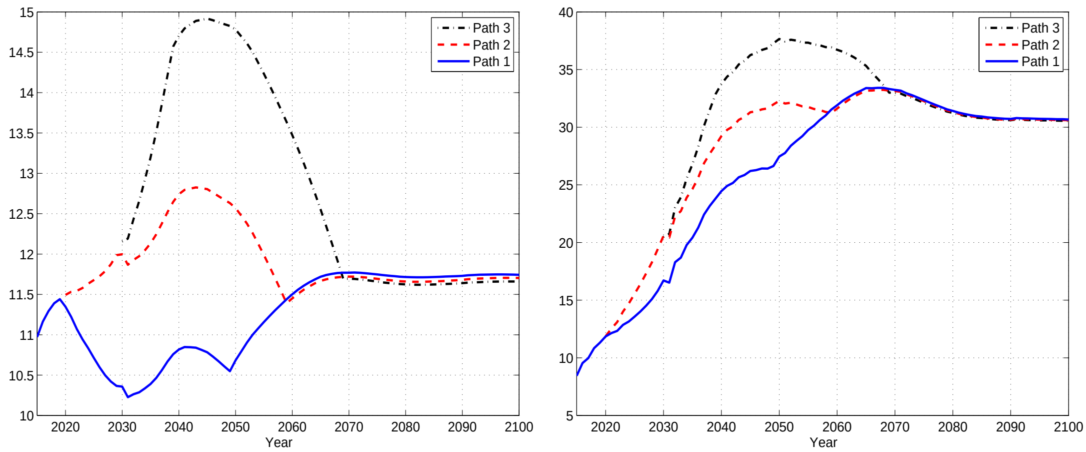


(a) Interest rate (% difference to benchmark) (b) Wage (ratio to benchmark)

Figure 4: Paths with uncertainty in reform timing (2): factor prices

Figure 5(a) shows the transition dynamics of total pension expenditures as a fraction of aggregate output under the three paths. When the reform takes place in 2020 under Path 1, pension expenditures will not show a major rise in the middle of the century as in the other two paths since benefits per individual will decline faster than the rise in the number of recipients. When we wait till 2030 or 2040 to start the reform, pension expenditures will rise relative to output and peak at about 13% and 15% of GDP, respectively, in mid 2040s and continue to stay at higher levels during the following few decades.

As shown in Figure 5(b), consumption tax rates that will cover rising expenditures are significantly higher when the reform is pushed from 2020 to 2030 or 2040 and the difference will reach over 5% and 10% in late 2040s under Path 2 and 3, respectively.



(a) Pension expenditures (as % of GDP)

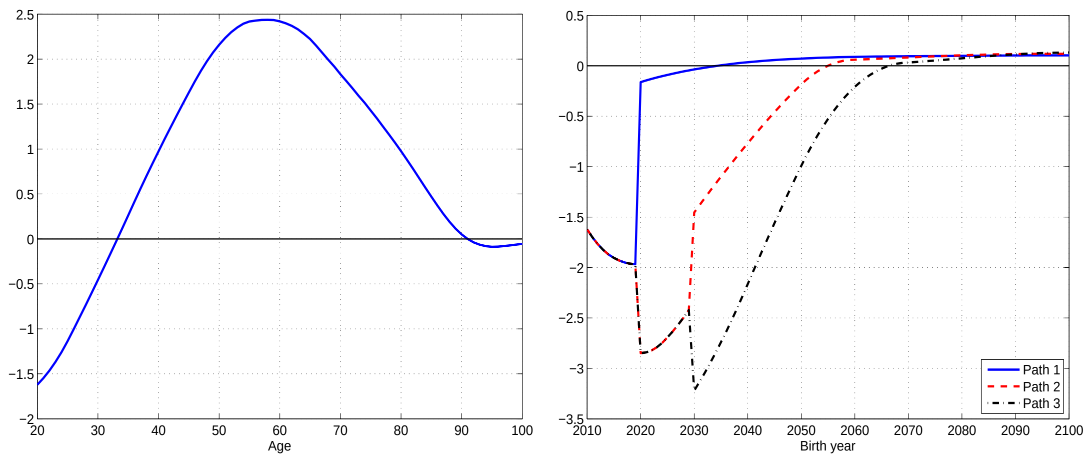
(b) Consumption tax (%)

Figure 5: Paths with uncertainty in reform timing (3): fiscal variables

Welfare effects of uncertainty in reform timing: Now we analyze welfare effects of uncertainty in reform timing. Four factors which individuals take as exogenous and that directly influence their life-time utility are changes in consumption taxes, wage, interest rate and expected pension benefits for a given level of past earnings. Reform that occurs later implies higher consumption taxes and lower wages, which are not desirable for individuals, but at the same time it implies higher interest rate and higher expected pension benefits for a given level of past earnings, which are desirable. Anticipating all of these factors that are exogenous for individuals, they re-optimize and adjust work hours as well as the life-cycle consumption and wealth, which also affect their welfare ex post. The net effect depends on states of an individual and which factors dominate others for a particular individual.

In order to quantify welfare effects, we compute consumption equivalent variation (CEV). We ask each individual in the baseline transition without uncertainty how much increase (or decrease) in consumption across all possible states is needed so that he will be indifferent between the baseline transition and the transition that involves policy uncertainty. If the CEV for an individual in the baseline economy is 2.0%, for example, it means that he prefers the economy with uncertainty and needs to be compensated with a rise in consumption by 2.0% so his expected life-time utility is the same in both economies. We compute the CEV for individuals at each age in the initial year of 2010 and also for future generations. For the latter, the CEV is computed for a "new-born" individual at age 20 who just enter the economy and for each possible transition path that can be realized.

Figure 6(a) shows welfare effects on individuals at each age, who are alive in 2010, the initial year of the transition. The economy with uncertainty is preferred by individuals above mid-30s and the gain is the largest for middle-aged individuals at late-50s and early 60s. Compared to the baseline economy, in which pension benefits will start to be reduced in 2020 for sure, there is a good possibility, 2/3, that the reform is postponed by either 10 or 20 years in the economy with policy uncertainty. Individuals in 50s and 60s will benefit from the delay in reform, since they would expect to receive a higher level of benefits. For example, those at age 60 in 2010 will have their benefits reduced starting at age 70 in the baseline, but under the regime with uncertainty, the event will not happen until age 80 or 90 with a total probability of 2/3. They will also benefit from higher returns on their retirement savings as the interest rate will be higher when the reform happens later. These benefits offset negative effects from higher consumption taxes for middle-aged and old individuals and they do not suffer much from lower wages as retirement is around the corner.



(a) Welfare effect on current generations by age in 2010

(b) Welfare effect on future generations by the year individuals enter the economy at age 20

Figure 6: Welfare effect of uncertainty in reform timing vs the case with reform starting in 2020 without uncertainty : consumption equivalent variation (%)

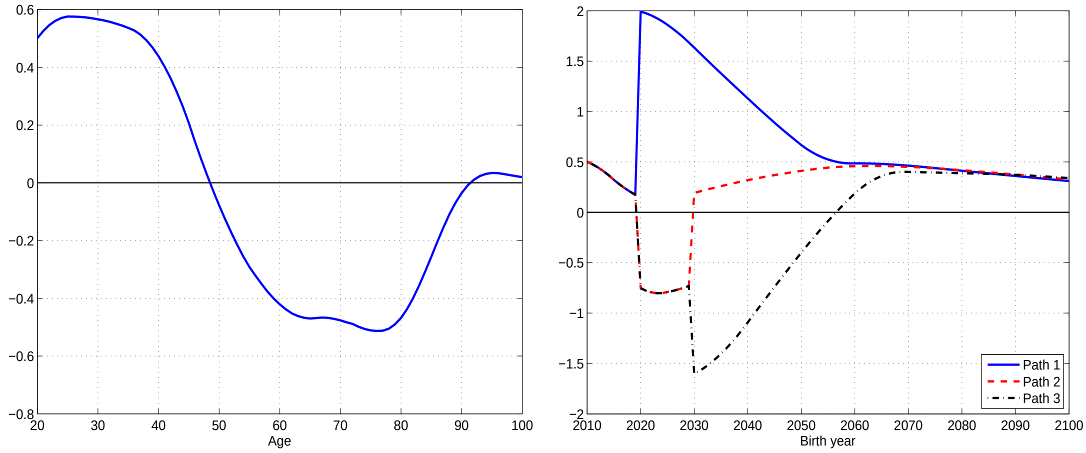
Younger individuals, however, will be better off if reform occurs sooner and does so without uncertainty. Although the downward shift of the pension schedule is not great news, they have enough time to accumulate savings and prepare for retirement years. Since the increase in savings and aggregate capital would dominate the rise in aggregate labor supply when the reform happens sooner, the wage rate would be much higher, which benefits young individuals. A major rise in wages also helps increase the expected pension benefits due to an increase in the earnings index and partially offsets the benefit reduction due to the reform. Lower consumption tax when the reform happens sooner also helps during long remaining years of their life.

These observations also apply for individuals who enter the economy in future as shown in Figure 6(b). A further delay of the reform implies an even larger loss relative to the transition with no reform uncertainty. Even under Path 1, where, ex post, the policy is the same as in the baseline transition and the reform starts in 2020, the welfare loss can amount to a negative 2% in consumption equivalence for generations that enter the economy in around 2020. Those who enter the economy in 2030 and find the reform occur at the latest timing of 2040 would be significantly worse off and the welfare loss amounts to more than 3% in CEV.

The analysis demonstrates a stark welfare tradeoff across generations through a delay in pension reform. Pushing the timing of reform as far as possible is in the interest of middle and old-aged individuals but it comes with deteriorating welfare of young and future generations.

In order to isolate effects of uncertainty itself, from effects of a delay of the reform, Figure 7 shows welfare effects of the same transition with uncertainty, but the CEV is computed using a different baseline transition, in which the reform takes place in 2030 without uncertainty, instead of 2020. The expected timing of the reform is 2030 under both transition paths, but one does not involve uncertainty and the other one does.

Figure 7(a) shows consumption equivalence for current generations relative to the baseline transition with the reform in 2030. The magnitude of welfare effects is smaller compared to the effects shown in Figure 6(a) and the shape and the signs of the welfare changes are also very different. A pure effect of adding uncertainty is a rise in savings and higher capital, which implies a lower interest rate and higher wages. These effects will favor the young and hurt the old. For example, those at age between 20 and 30 in 2010 would benefit from higher wages for many years to come and the gain is 0.5 to 0.6% in terms of consumption equivalence. Those who are close to retirement will face lower return on their retirement savings, while they do not have many years to enjoy the higher wage. They will also have to save enough by cutting back consumption in case the reform starts sooner than expected in 2020 with a 1/3 chance. As shown in Figure 7(b), future generations prefer an early implementation of the reform.



(a) Welfare effect on current generations by age in 2010 (b) Welfare effect on future generations by the year individuals enter the economy at age 20

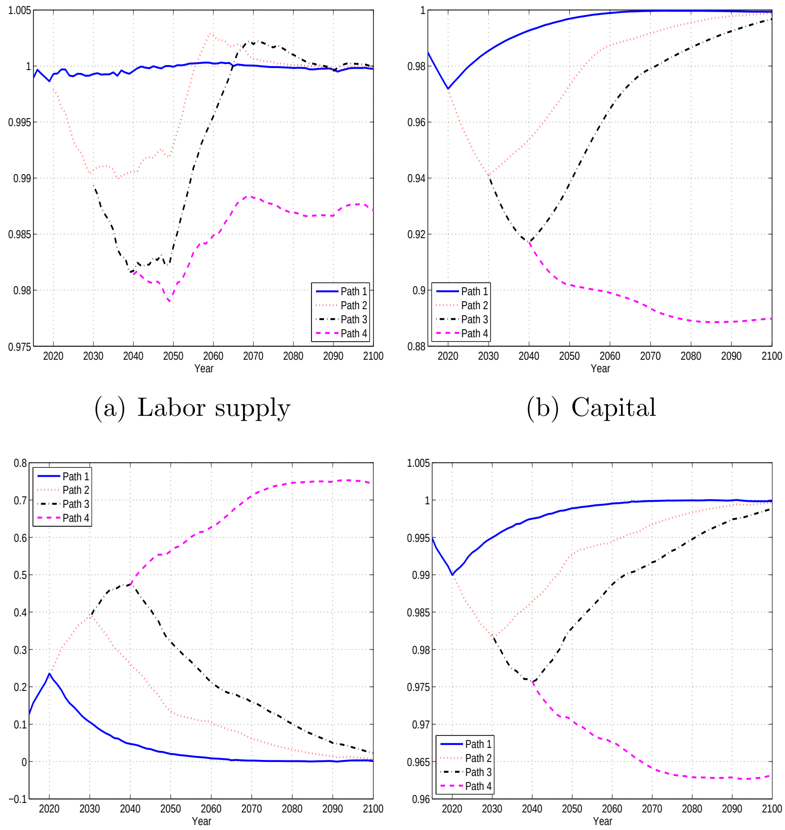
Figure 7: Welfare effect of uncertainty in reform timing vs the case with reform starting in "2030" without uncertainty : consumption equivalent variation (%)

4.2 Uncertainty in reform timing *and* policy

Next we consider a different form of uncertainty, in which the final pension scheme is uncertain. On top of the three paths we studied above, we add a scenario in which there is in fact no reform to reduce the benefits beyond 20% as embedded in the 2004 pension reform. There is a reduction, but under this scenario benefits are reduced in a much smaller scale compared to the scenario to cut them by 36%. As before, there are three possible timings of the reform in 2020, 2030 and 2040 and to these we add another scenario in which benefits are reduced by only 20% in the end.

If no reform has occurred in 2020 or 2030, individuals will learn in 2040 whether there is reform in that year or not. We call the transition path under the latter scenario as Path 4, in which there is no aggressive reform and benefits will be reduced only by 20% rather than 36%, starting in 2040.

As shown in the top two panels of Figure 8, aggregate labor supply and aggregate capital will be permanently lower under Path 4 than in the other three paths where the reform takes place eventually. By 2100, labor supply will be lower by 1.3% than in the baseline economy and capital is lower by more than 10%. As the capital continues to fall after 2040, wage rate keeps declining until 2070s and will reach 3.7% below the baseline level by 2100.

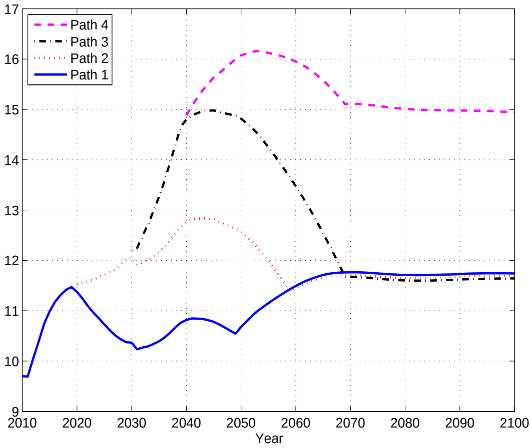


(a) Labor supply (b) Capital

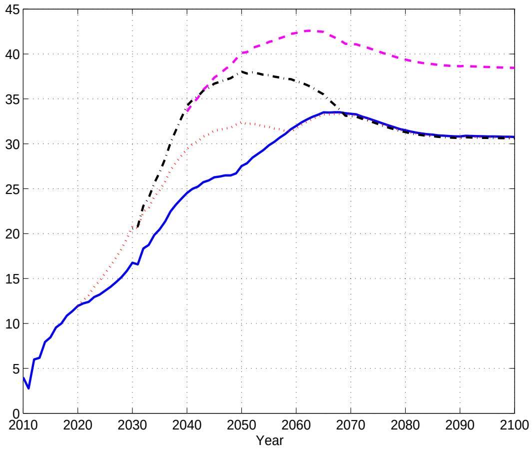
(c) Interest rate (d) Wage

Figure 8: Paths with uncertainty in timing and policy (1): aggregate variables expressed as ratios to the benchmark without uncertainty except for the interest rate which is expressed as difference in percentage points.

Figure 9 shows that pension expenditures relative to aggregate output will continue to rise until early 2050s under Path 4 and stay at around 15% of GDP after 2070, which is much higher than the level under the three reform paths. As a result, consumption tax needs to be permanently higher to balance the budget and stays at 38% until the end of the century, while the tax rates will be below 31% under the three other paths in 2100.



(a) Pension expenditures (as % of GDP)



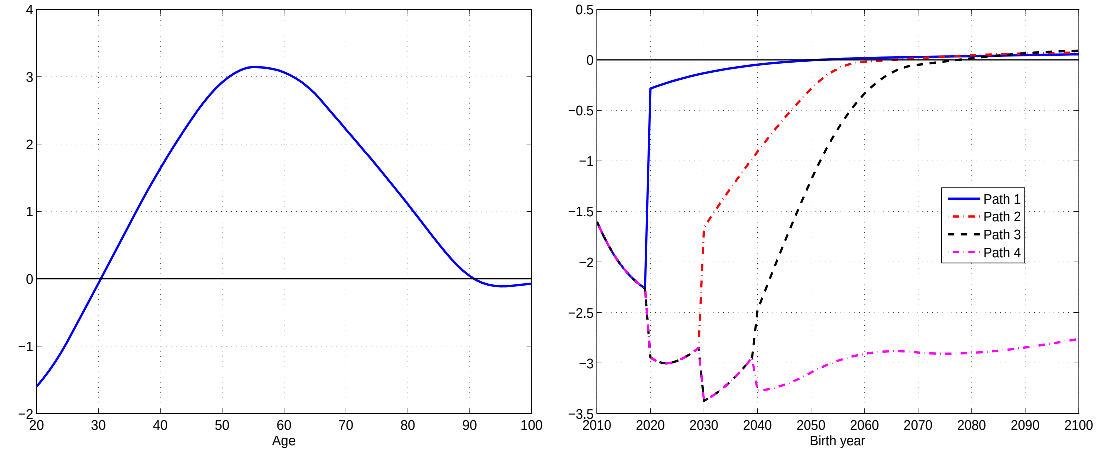
(b) Consumption tax (%)

Figure 9: Paths with uncertainty in timing and policy (2): fiscal variables

Welfare effects of uncertainty in reform timing *and* structure: Next we study welfare effects of uncertainty in reform timing and the final shape of the policy itself. Consumption equivalent variations for current and future generations are shown in Figure 10. We use the baseline transition path where the reform takes place in 2020 for sure as a reference point, and the numbers in the figure are comparable to those in Figure 6 presented above, which uses the same benchmark.

The welfare effects for current generations shown in Figure 10(a) resemble those in Figure 6(a). The magnitude, however, of welfare gains for middle-aged and old individuals are different and shifted upwards, now with the possibility that the aggressive reform never takes place. The welfare gain, for example, of individuals was 2.4% in CEV for those in late 50s, but it is 3.1% with a 1/4 likelihood of no reform. The added chance that benefits will stay higher forever will be favored by many current generations and especially those close to the retirement age.

The gain, however, of current generations come traded against larger losses for future generations as shown in 10(b). The scenario of no reform implies much higher consumption taxes and lower wages for many decades to come and they hurt future generations.



(a) Welfare effect on current generations by age in 2010

(b) Welfare effect on future generations by the year individuals enter the economy at age 20

Figure 10: Welfare effect of uncertainty in reform timing and policy vs the case with reform starting in 2020 without uncertainty : consumption equivalent variation (%)

5 Conclusion

Given the rising number of social security recipients and an increase in the old-age dependency ratio, we are aware that reform to reduce transfers will be inevitable without a major increase in taxes. We do, however, not know when and how it will happen. The paper quantifies economic and welfare effects associated with policy uncertainty and possibilities of a delay in reform implementation and demonstrates welfare consequences that differ across generations. Depending on the year of reform and a type of reform, aggregate capital and labor supply will shift as individuals' saving and work incentives respond to policy innovations. These reactions induce an evolution of factor prices and affect different generations differently. Postponing reform to reduce benefits also implies a rise in future taxes, transferring the cost of demographic transition from old to young and future generations. To the best of our knowledge this is the first paper that builds a general equilibrium life-cycle model of an aging economy, in which individuals make optimal decisions taking into account uncertainty about the future social security system.

This paper focuses on social security system reform driven by aging demographics, but there are different types of uncertainty that affect our life-cycle decisions, such as the future of health insurance system and corresponding taxes. Another type of uncertainty is associated with demographics themselves, which the current paper takes as given based on official projections. Future growth of longevity and fertility rates can only be estimated and their innovations may have a large impact on micro and macro economy. These issues are left for future research.

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