Economic Theory (2007) 32: 87–104
DOI 10.1007/s00199-006-0200-9

SYMPOSIUM

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The Japanese saving rate between 1960 and 2000: productivity, policy changes, and demographics

Received: 26 February 2006 / Revised: 13 December 2006 / Published online: 2 March 2007

Abstract In this paper, we use an overlapping generations model to study the factors generating the saving rate in Japan between 1960–2000. The model economy allows for observed aging of the population, total factor productivity (TFP), and fiscal policy to affect the national saving rate. Our calibrated general equilibrium setup generates saving rates that are reasonably similar to the data during this period. Our counterfactual experiments indicate that observed TFP growth rates are the main reason for both the secular decline and the two humps in the saving rate during 1960–2000.

Keywords Saving rate · Japan · Overlapping generations · Calibration

JEL Classification Numbers E21 · E32

1 Introduction

The Japanese saving rate has declined from an average of 20% in the 1960s to about 5% in the late 1990s. This decline, however, was hardly monotonic. There were two pronounced humps in the saving rate during early 1970s and late 1980s to early 1990s. Between 1960 and 2000 there have been considerable changes in demographics, fiscal policy and the growth rate of total factor productivity (TFP) in Japan. For example, lifetime expectancy increased from 71 to 79 and the population growth rate declined from almost 5% to zero between 1960 and 2000. In addition,

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the social security replacement rate, which was about 17% up until the early 1970s, thereafter increased to about 40%. There has also been a gradual increase in the capital income tax rate and a decline in the TFP growth rate in the same period. This paper examines the quantitative impact of these changes on the Japanese saving rate between 1960 and 2000.

Given the demographic changes taking place in many countries, the impact of aging on the saving rate has been a focus of several papers. For example, Ando and Moro (1995) use the National Survey of Family Income and Expenditure conducted by the Statistics Bureau of the Japanese government and examine the period 1985–2090 in Japan under different fertility assumptions. They conclude that the saving to income ratio initially will increase slightly due to the declining fertility rate and then decrease as the proportion of older individuals in the population goes up. Kotlikoff et al. (1996) perform an accounting exercise decomposing the U.S. net national saving rate into its public versus private components. They argue that the growth in Social Security, Medicare and Medicaid benefits was responsible for the decline in the U.S. net national saving rate as these programs redistributed resources from young generations with low consumption propensities toward older generations with high consumption propensities. Summers and Carroll (1987) attribute the decline in the U.S. net national saving rate to the secular decline in the net private saving rate, which in turn, seems to be due to improvements in the well-being of the elderly through social insurance programs, and new financial instruments that have eased the self-insurance needs of households.

In order to study the Japanese saving rate between 1990 and 2000, Braun et al. (2004) use an overlapping generations model calibrated to Japanese data. They find that the combined effects of demographics and slower total factor productivity growth can explain the declines in the saving rate. Their model also predicts low saving rates over the next few decades. Chen et al. (2006) show that changes in the TFP growth rate can account for the pattern of Japan's saving rate over the 1960–2000 period. That paper, however, used a dynastic construct and hence was unable to assess the role of changes in fertility, life expectancy, or the social security system on Japan's savings pattern.

In this paper, we use an overlapping generations setup to quantitatively assess the importance of these various factors. Our finding is that these changes, each of which was significant in Japan in the 1960–2000 period, are quantitatively unimportant in accounting for Japan's saving rate over this period; changes in Japan's TFP growth rate remain the most important factor accounting for the Japanese saving rate. Our setup is a calibrated general equilibrium model populated with overlapping generations of households that incorporates potentially important public institutions such as social security so as to be able to address the relative importance of the size of the retirement benefits over time, as well as actual time paths of Japanese TFP growth rates and government fiscal policy instruments.[1] Individuals in the model face mortality risk and borrowing constraints, and may live a maximum

[1] Our approach follows the recent work that uses general equilibrium models to address short run issues, pioneered by Ohanian (1997) and Kehoe and Prescott (2002). Related work includes Cooley and Ohanian (1997), Cole and Ohanian (2002, 2004), and all the papers in the 2002 special issue of *Reivew of Economic Dynamics,* entitled 'Great Depressions of the 20th Century'.

of 65 periods. Private annuity markets and credit markets are closed by assumption. Until the mandatory retirement age, agents in this economy work an exogenously given number of hours and accumulate assets to provide for old age consumption. After retirement agents receive social security benefits that are financed by a payroll tax. The return on asset holdings and the wage rate are determined by the profit maximizing behavior of a firm with a constant returns to scale technology. We specify the optimization problem of the individual as a finite-state, finite-horizon dynamic program and use numerical methods to solve for it. We calibrate the model to Japanese data for the 1960–2000 period. We conduct deterministic simulations to quantify the effects of changes in the social security system, demographics, and the growth rate of TFP on the saving rate. The benchmark simulation takes the actual capital stock in 1960 as the initial condition and uses the time series path of the observed social security replacement rate, population growth rate, and survival probabilities while keeping the tax rates on labor and capital as well as the depreciation rate equal to their long-run averages. We carry out counterfactual experiments to assess the relative contributions of all these factors. Our results indicate that the annual movements and the secular decline in the saving rate between 1960 and 2000 are mostly due to the observed path of the TFP growth rate in this time period.

The paper is organized as follows. Section 2 presents the model. Data and calibration issues are discussed in Sect. 3, and the quantitative findings are presented in Sect. 4. Concluding remarks are given in Sect. 5.

2 An overlapping generations model

2.1 The environment and demographics

At each date $s = 0, 1, \ldots,$ a new generation of individuals is born. We denote the growth rate of newborn individuals from time $s-1$ to time s by η_s. They face long but random lives, work until the mandatory retirement age of j_R, and might live through maximum possible age J. Life-span uncertainty is described by $\psi_{j,s}$, the conditional survival probability that an individual of age-j at time s survives to age $j+1$ at time $s+1$. We assume $\psi_{J,s} = 0$ for all $s \geq 0$.

Let $N_{j,s}$ denote the measure of age-j individuals at time s. The law of motion for $N_{j,s}$ is given by:

$$N_{1,s+1} = N_{1,s}\left(1+\eta_s\right),$$
$$N_{j+1,s+1} = N_{j,s}\psi_{j,s}, \quad j = 2, 3, \ldots, J, \;\; s \geq 0.$$

As a result, the cohort shares of age-j individuals at time s, $\{\mu_{j,s}\}_{j=1}^{J}$, are computed as

$$\mu_{j,s} = \frac{N_{j,s}}{\sum_{i=1}^{J} N_{i,s}}, \tag{1}$$

where $\sum_{i=1}^{J} N_{i,s} = N_s$ is the population size at time s.

In an economy with a stationary demographic structure, the cohort shares, $\{\mu_j\}_{j=1}^{J}$, are given by

$$\mu_j = \frac{\psi_{j-1}}{(1+\eta)}\mu_{j-1}, \quad \text{where} \sum_{j=1}^{J} \mu_j = 1. \tag{2}$$

2.2 Technology

There is a representative firm with access to a constant returns to scale Cobb–Douglas production function with deterministic total factor productivity A_s:

$$Y_s = A_s K_s^{\alpha} H_s{}^{1-\alpha}, \tag{3}$$

where K_s and H_s are aggregate capital and labor inputs at time s, respectively, and α is capital's output share. TFP grows at the rate $g_s{}^{1/(1-\alpha)} > 0$.

The aggregate capital stock evolves according to the law of motion:

$$K_{s+1} = (1 - \delta_s)K_s + X_s,$$

where X_s is aggregate gross investment and δ_s is the rate of depreciation of capital at time s.

The stand-in firm rents capital and hires labor from the households in competitive spot markets at the rates r_s and w_s, respectively, and maximizes its profits. This yields the condition that factor prices equal their marginal productivities:

$$\begin{aligned} r_s &= \alpha A_s \left(\frac{K_s}{H_s}\right)^{\alpha-1}, \\ w_s &= (1-\alpha) A_s \left(\frac{K_s}{H_s}\right)^{\alpha}. \end{aligned} \tag{4}$$

2.3 Households

A household who is i years old at time s solves the following problem:

$$\max \sum_{j=i}^{J} \beta^{j-i} \left[\prod_{k=i}^{j} \psi_{k,t-i+k}\right] u(c_{j,s})$$

subject to a sequence of budget constraints over the remaining lifetime

$$(1 + \tau_c)c_{j,s} + a_{j+1,s+1} = R_s a_{j,s} + (1 - \tau_{h,s} - \tau_{n,s})w_s \varepsilon_j h + b_{j,s} + \ell_s, \tag{5}$$

where β is the subjective discount factor, $c_{j,s}$ is consumption of an age-j individual at time $s = t + j - i$, where t denotes the birth year of the individual. Asset holdings at the beginning of age j at time s are given by $a_{j,s}$. They earn the interest rate (net of taxes and depreciation) $R_s = [1 + (1 - \tau_{a,s})(r_s - \delta_s)]$. The wage rate at time s is denoted by w_s.We assume that individuals exogenously supply h hours for market activities. Labor in efficiency units at age j is given by $\varepsilon_j h$. The tax rates on consumption, capital income, and labor income are denoted by τ_c, $\tau_{a,s}$, and $\tau_{h,s}$, respectively. $b_{j,s}$ denotes social security benefits received by an age-j individual at time s, to be described later, and $\tau_{n,s}$ is the payroll tax for social security at time s. Benefits $b_{j,s}$ are a fraction θ_s of average lifetime earnings. Each individual receives a lump-sum transfer from the government ℓ_s.

Note that we allow for some of the tax rates and the rate of depreciation δ_s to vary over time.[2]

Several models of Japanese saving behavior and household tenure choice have relied on financial imperfections.[3] In line with this tradition, we assume that individuals face borrowing constraints

$$a_{j,s} \geq 0, \quad \text{all } j, s, \tag{6}$$

with $a_{1,s} = a_{J,s} = 0$ for all s. Note that we have a representative individual for each cohort. Furthermore, we do not allow for annuity markets.[4]

We use recursive tools to solve the individual's perfect foresight decision problem. Let $V_{j,s}(a_{j,s})$ denote the value function of an age-j individual at time $s = t + j - 1$. We compute the value functions for $j = 1, 2, \ldots, J$, and $s = 0, 1, \ldots,$ using

$$V_{j,s}(a_{j,s}) = \max_{\{c_{j,s}, a_{j+1,s+1}\}} \left\{ u(c_{j,s}) + \beta \psi_{j,s} V_{j+1,s+1}(a_{j+1,s+1}) \right\} \tag{7}$$

subject to (5) and (6).

2.4 Social security

Social security benefits are given by

$$b_{j,s} = \begin{cases} 0 & \text{for } j = 1, 2, \ldots, j_R - 1, \\ b_{j_R, t+j_R-i} & \text{for } j = j_R, j_R + 1, \ldots, J. \end{cases}$$

The pension received by a new retiree at time $t + j_R - i$ is calculated as

$$b_{j_R, t+j_R-i} = \theta_s \frac{1}{j_R - 1} \sum_{j=1}^{j_R-1} w_{t+j-i} h \varepsilon_j (1+g)^{j_R - j},$$

where θ_s is the replacement rate. Note that the retirement benefit received by an individual is constant throughout the individual's lifetime. However, successive cohorts receive successively larger benefits reflecting the rate of TFP growth.

We assume that the system is unfunded so that the payroll tax is selected to equate the total benefits to total taxes collected for each time period. Total

[2] At each date s there are J cohorts alive. We take the distribution of wealth over these cohorts at date $s = 0$ as a given initial condition and allow the individuals to optimize their remaining lifetime utility conditional on their accumulated asset level.

[3] For example, see Hayashi et al. (1988) and the recent empirical work by Wakabayashi and Horioka (2005). Our numerical results indicate that borrowing constraints play a quantitatively small role in our setup.

[4] The lack of annuity markets can explain the hump-shape in the age-consumption profile over the life cycle. See for example Hansen and İmrohoroğlu (2005).

benefits paid at time $s = t + j_R - i$ are equal to $\sum_{j=j_R}^{J} \mu_{j,s} b_{j,t+j_R-i} = b_{j_R,t+j_R-i} \sum_{j=j_R}^{J} \mu_{j,s}(1+g)^{j_R-j}$. The social security tax rate, $\tau_{n,s}$, is given by

$$\tau_{n,s} = \frac{b_{j_R,t+j_R-i} \sum_{j=j_R}^{J} \mu_{j,s}(1+g)^{j_R-j}}{w_{t+j_R-i} h \sum_{j=1}^{j_R-1} \mu_{j,s}\varepsilon_j}. \tag{8}$$

2.5 Government

In addition to the unfunded social security system, the government needs to finance its per capita purchases, G_s, by taxing consumption, labor income, and capital income. As the government is the residual claimant to the assets of households who die in the period, it also has this source of income to finance its expenditures. We require period-by-period budget balance which necessitates a (per capita) lump-sum transfer ℓ_s.

$$\tau_c \sum_{j=1}^{J} \mu_{j,s} c_{j,s} + \tau_{h,s} \sum_{j=1}^{J} \mu_{j,s} w_s \varepsilon_j h + \tau_{a,s} \sum_{j=1}^{J} \mu_{j,s}(r_s - \delta_s) a_{j,s}$$
$$+ \sum_{j=1}^{J-1} (1 - \psi_{j,s}) a_{j+1,s} \mu_{j,s} N_{s-1}/N_s = G_s + \ell_s. \tag{9}$$

2.6 Aggregation

Aggregate variables are computed in the usual way by obtaining the weighted average of different cohorts' decision rules, using the population weights determined by our demographic assumptions. For example, (per capita) aggregate capital and labor inputs are given by:

$$K_s/N_s = \sum_{j=1}^{J} \mu_{j,s} a_{j,s}. \tag{10}$$

$$H_s/N_s = \sum_{j=1}^{J} \mu_{j,s} \varepsilon_j h. \tag{11}$$

The detrended steady state saving rate, $\widetilde{sav}$, and time-varying saving rates, sav_t, are given by:

$$\widetilde{sav} = \frac{(\gamma n - 1)\widetilde{k}}{\widetilde{y} - \widetilde{\delta k}}, \tag{12}$$

$$sav_t = \frac{Y_t - G_t - C_t - \delta_t K_t}{Y_t - \delta_t K_t}. \tag{13}$$

2.7 Recursive competitive equilibrium

A *government policy* consists of $\left\{G_s, \tau_c, \tau_{a,s}, \tau_{h,s}, \tau_{n,s}, \theta_s, \ell_s\right\}_{s=s_1}^{s_2}$, where s_1 and s_2 are some initial and final dates. An *allocation* is given by a sequence of decision rules $\left\{A_{j+1,s+1}(a), C_{j,s}(a)\right\}_{j=1}^{J}$ over $[s_1, s_2]$. A *price system* is a sequence of pairs $\{w_s, r_s\}_{s=s_1}^{s_2}$. For a given government policy, a *Recursive Competitive Equilibrium* is an *allocation* and *price system* such that

- the allocation solves the dynamic program (7) for all individuals, given the price system and government policy,
- the allocation maximizes firms' profit by satisfying (4),
- the allocation and government policy satisfy the government's budget constraint (9) given the price system,
- the social security system is unfunded, that is (8) satisfied,
- the factor markets clear, and,
- the commodity market clears

$$C_s + X_s + G_s = Y_s.$$

3 Data and calibration

We calibrate the model (both for steady state calculations and the 1960–2000 period) to the Japanese economy using data provided by Hayashi and Prescott (2003). The capital share parameter, α is set to its average value over this period. The subjective discount factor is set to 0.999 which results in a capital output ratio of 2 at the final steady state. The period utility function is given by

$$u(c) = \frac{c^{1-\sigma} - 1}{1 - \sigma}$$

with risk aversion parameter $\sigma = 1.5$.

For the steady state calculations we set the values for the share of government purchases, G_s/Y_s, the depreciation rate δ_s, tax rates on capital income, $\tau_{a,s}$, labor income, $\tau_{h,s}$, and consumption, τ_c, equal to their long-run averages. We set the growth rate of TFP to 2%, which is the long run average of Japanese TFP growth rate between 1960 and 2000.

The maximum number of model periods that an agent is alive is 65 and households retire at period $j_R = 45$. This maps into an economy in which individuals are born as 21 year old workers, and, conditional on survival, retire at age 65 and live to be 85 years old. The growth rate of the population, η_s, at the steady state is set to 0.6%, which is roughly the average growth rate of age-21 individuals between 1960 and 2000. The survival probabilities $\{\psi_i\}_{i=1}^{65}$ at the steady state are taken to be the average of the age specific survival probabilities in 1990 and 2000, which are described below. Age-efficiency profiles, $\{\varepsilon_j\}_{j=1}^{j_R}$, are obtained from Braun et al. (2004). The exogenous market hours, h, is set equal to 37.5 which is the average weekly market hours per individual in Japan between 1960 and 2000.

In order to explore the impact of the demographic transition on the saving rate, we need to specify the entire sequences of exogenous parameters the agents are facing from 1960 through the steady state. Starting from 2001, we assume that all fiscal parameters are set to their sample averages from the 1960 to 2000 period. We use various Japanese data sources, as described below, to compute the initial cohort shares, $\{\mu_{j,1960}\}$, at 1960, the fertility rates between 1960 and 2000, $\{\eta_s\}_{s=1960}^{2000}$, and the annual survival probabilities between 1976 and 2000. We linearly interpolate the age-specific survival probabilities for years between 1960 and 1975, based on the corresponding data for selected years 1960, 1965, 1970 and 1975.[5] For 2001 and beyond, we assume that the age-specific survival probabilities are fixed at their average values during the 1990–2000 period. We assume that the fertility rates rise from their value of -0.0056 in 2000 to their steady state value of 0.006 in 62 years, and remain at this value thereafter. Note that the demographic transition essentially takes place in the 1970–2000 period and only very small changes to the population growth rates take place beyond 2000. After 2000, all fiscal policy parameters, the TFP growth rate, and the conditional survival probabilities are constant at their steady-state levels, and the only change is the rate of population growth, which is very small.

We assume that the steady state is reached 65 periods after all exogenous parameters are fixed at their steady-state values, in the year 2128. If the factor prices were exogenous, then the convergence to the steady-state would be exact since our agents live a maximum of 65 periods. However, since the factor prices are endogenous in our setup, they continue to vary over time toward their steady-state values after 65 periods. Allowing for a longer transition period to the steady state has no impact on the quantitative characterization of the 1960–2000 Japanese economy.

Since our main question is to examine the determinants of the saving rate in Japan between 1960–2000, our simulations take the actual capital output ratio in 1960 as the initial condition. As expected the initial saving rate is sensitive to the K/Y in the initial period. Hayashi and Prescott (2003) estimate of the capital stock results in a K/Y of 0.77 if foreign capital is included and 1.12 if foreign capital is excluded. We take 1.12 as a starting value for 1960.[6] We use the data for the

[5] Following Braun et al. (2004), the initial cohort shares are computed using (1), and the fertility rate η_s is computed as

$$\eta_s = \frac{N_{1,s+1} - N_{1,s}}{N_{1,s}}.$$

Finally, we compute the survival probabilities $\{\psi_{j,s}\}_{j=1}^{J}$, $s = 1976, \ldots, 2000$, according to

$$\psi_{j,s} = 1 - \text{death}_{j,s}/N_{j,s}.$$

The data source for age specific population size $\{N_{j,s}\}_{j=1}^{J}$ is the *Annual Report on Current Population Estimates* by the Statistics Bureau of the Ministry of Internal Affairs and Communication. Age specific death numbers between 1976 and 2000 are taken from the Vital Statistics by the Ministry of Health, Labor and Welfare. Various Life Tables in Japan provide the death numbers in five-age intervals for years 1960, 1965, 1970 and 1975. We use a cubic spline to interpolate the age specific survival probabilities, assuming the survival probability of the middle age in each age interval is equal to the average survival probability of that age interval.

[6] We also need to assume an initial distribution of assets among age groups in order to start our simulations. In our benchmark results we use a uniform distribution of assets. We also experiment with a hump-shaped distribution that is generated endogenously at the steady state. The results are not sensitive to this feature of the model.

Table 1 Steady State

α	Capital share	0.363
β	Discount factor	0.999
σ	Risk aversion	1.5
η	Growth rate of pop.	0.006
g	TFP growth rate	0.02
G_s/Y_s	Share of government	0.14
τ_h	Labor income tax rate	0.107
τ_c	Consumption tax rate	0.056
τ_a	Capital income tax rate	0.35

actual time path of TFP growth and demographics in while keeping the depreciation rate, share of government purchases, and the tax rate on capital income equal to their steady state values during this time period for our benchmark experiment.[7] We approximate the replacement rate for social security from Oshio and Yashiro (1997) who indicate that it was equal to 17% for 1961–1973, 35% between 1974 and 1979 and 40% afterwards.

Table 1 summarizes the steady state calibration:

4 Results

We start this section by characterizing the equilibrium transition path using our benchmark calibration. Later we conduct several counterfactual experiments to examine the relative importance of changes in demographics and changes in the growth rate of TFP in explaining the secular movements in the Japanese saving rate.

4.1 Properties of the model economy

Figure 1 presents the observed saving rate and the simulated saving rate for the benchmark economy where the time series data for the TFP growth rates and demographic variables are used. Notice that the model economy generates a saving rate that is reasonably close to the data. The model is able to capture the main fluctuations as well as the secular decline that took place in the saving rate in this time period. The main discrepancy between the model and the data occurs in late 1970s and early 1980s where the model predicted saving rates are higher than the observed saving rates.[8]

In Figure 2 we display the after tax net real return to capital and the detrended output that are generated by the model and compare them with the data. From the first panel we can observe that the model generates high interest rates until mid-1970s after which there is a general decline. Model generated output that is displayed in the second panel captures the data reasonably well.

[7] In our later experiments we introduce the time series data for all of these variables one at a time. The tax rates are obtained from Mendoza et al. (1994) and cover the period 1965–1996. We have assumed the 1960–1964 period tax rates on capital income to equal the value in 1965 and 1997–2000 tax rates to equal the value in 1996.

[8] With a lower initial capital-output ratio of 0.77, the simulated saving rate starts 5% points higher in 1960. By 1969 the differences between the two series practically disappear.

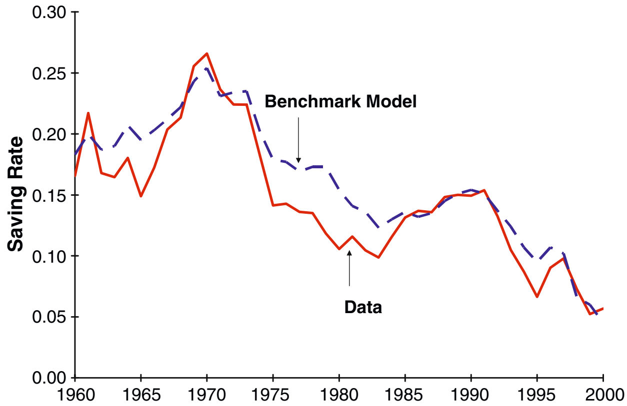

Fig. 1 The Japanese saving rate: data and the model

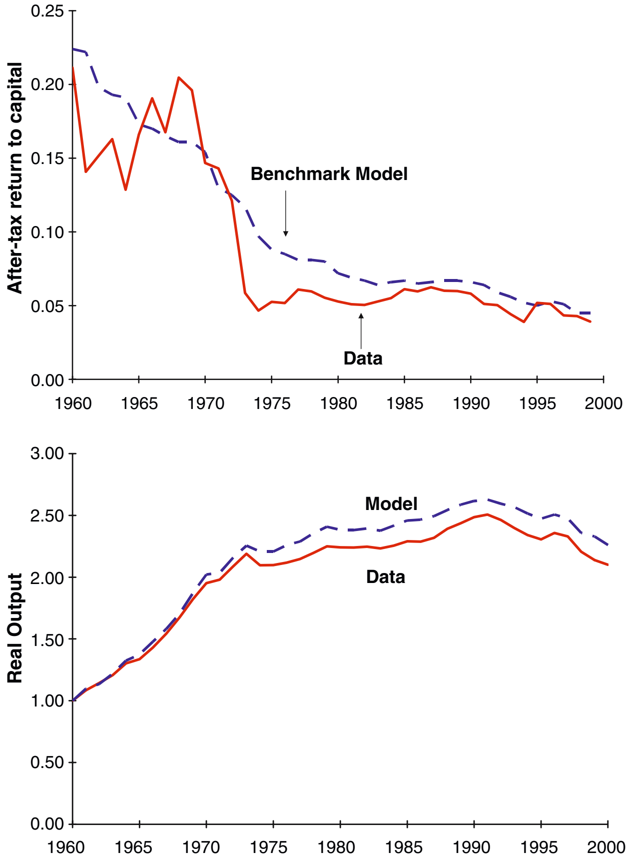

Fig. 2 Additional properties

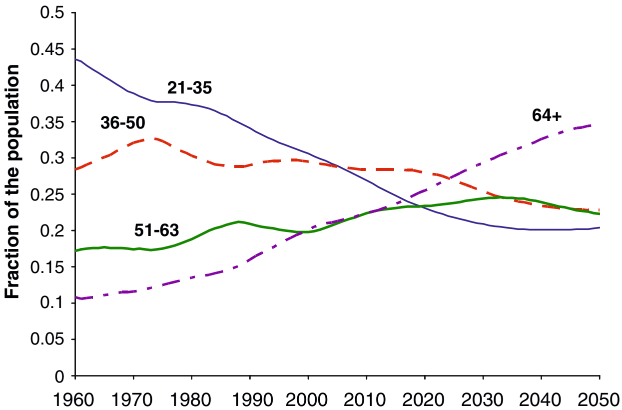

Fig. 3 Population shares

As explained in the calibration section, the benchmark economy uses time series data for the changes in demographics, TFP growth and social security replacement rates. In Japan both of the components of demographics, the survival probabilities and the population growth rate, have been changing significantly in this time period. The lifetime expectancy in Japan increased from 71 to 79 and the fertility rate declined from 0.139 to −0.01 between 1960 and 2000. In Fig. 3 we display the time path of the cohort shares of the population that are implied by the survival probabilities and the fertility rates that we have used in the model. The cohort shares are for individuals in four age groups, 21–35, 36–50, 51–63, and 64^+ between 1960 and 2050. During this time period, the model-generated share of the 21–35 group is declining and the share of the 64 and older generation is increasing significantly. These trends are very similar to the actual population projections in Japan. In fact, if these demographic trends continue, the share of the 64^+ age group is expected to be higher than the 21–35 age group after 2010.

Changes in the population growth rate and survival probabilities affect the aggregate saving rate through two channels: the composition of the population and the individual saving rates. In the first panel of Fig. 4 we display the saving rates as a percent of disposable income for these age groups in 1985, 1990, 1995, and 2000 that are generated by our model economy. The age groups that constitute the majority of the savings in this framework are the 35–50 and 51–63 years old. Our simulations report a decline in the saving rates of all the age groups in this time period. These findings are consistent with the results obtained by Bosworth et al. (1991) who provide data for household saving rates grouped by the age of the household in Japan for early 1970s, early 1980s and late 1980s. Their results indicate that there has been a secular decline in saving rates of all age groups in Japan. A similar observation can be made in the second panel of Fig. 4 which displays the cross sectional saving rates by age where all age groups in 2000 have lower saving rates compared to earlier years.

Ando and Moro (1995) provide detailed data of the saving rate for different demographic groups in Japan in 1985. The categories include families, single male head of households (HH) and single males. In our framework, while we calibrate to the properties of the entire economy, households act as if they do not have

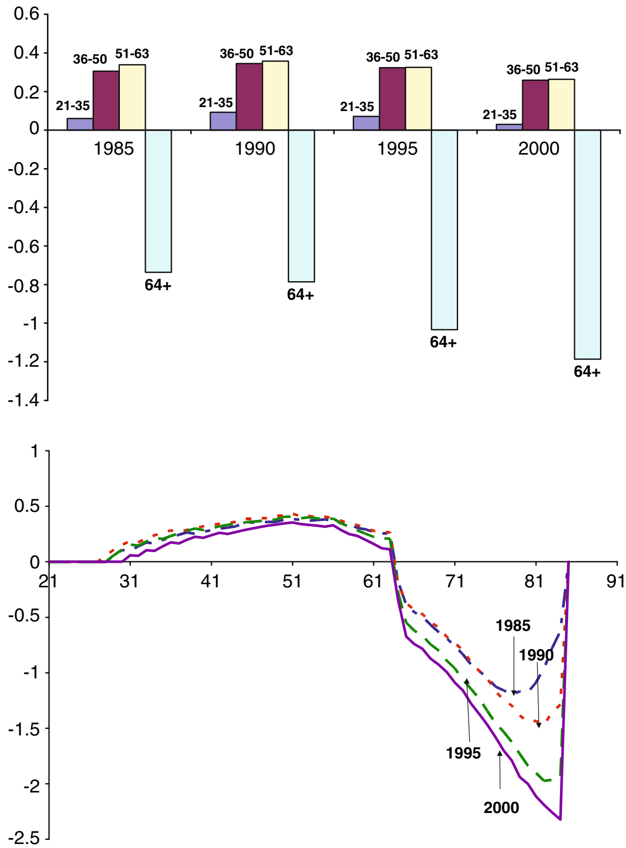

Fig. 4 Cross sectional saving rates

families. Consequently, it may be useful to compare model generated saving rates for different age groups to the observed saving rates for all three categories. For example, since our OLG model does not have intentional bequests, individual over 60 dissave sufficiently fast to exhaust all their savings by the terminal age. In addition, since there is mandatory retirement at age 65 in the model, all agents after that age dissave. In the Ando and Moro (1995) data provided in Table 2, while families and heads of households display positive saving rates, single males do not seem to save after age 70. Up to age 60, the model generated saving rate looks more similar to the saving rate data reported for single male head of the household.

4.2 Counterfactual experiments

4.2.1 Demographics

There are two components of demographics that play a role in our results: changes in survival probabilities and the population growth rate. In Fig. 5, we examine the

Table 2 Saving rates for demographic groups

	1985 Data			Model
	Families	Single male HH	Single males	
≤ 29	0.041	−0.061	0.218	0.000
30–39	0.108	0.144	0.370	0.186
40–49	0.119	0.194	0.415	0.326
50–59	0.136	0.225	0.421	0.363
60–69	0.176	0.248	0.303	−0.164
≥ 70	0.194	0.137	0.005	−0.907

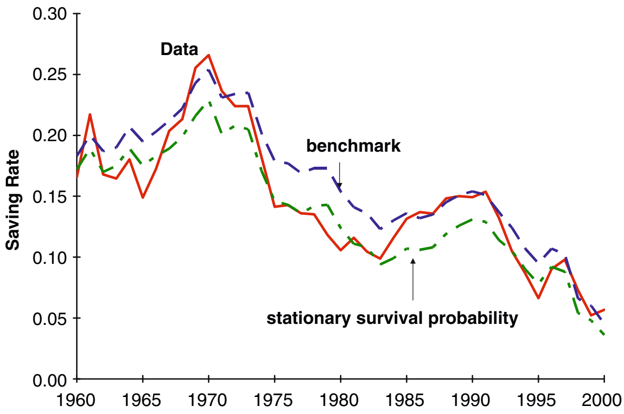

Fig. 5 Role of survival probabilities

impact of the changes in the survival probabilities alone by generating saving rates under two different vectors of survival probabilities. The series labeled 'benchmark' uses the actual survival probabilities that are observed in Japan in this time period. The series labeled 'stationary survival probabilities' assumes that the survival probabilities that were present in the 1960–2000 period had remained constant. In other words, this experiment demonstrates the impact of the increase in the survival probabilities on the saving rates in Japan. With longer expected lifetime in the benchmark calibration households save more to insure against living longer that expected. This effect causes the saving rate for the benchmark case to be higher than the saving rate with constant survival probabilities all through this time period. In the early 1960s the differences are small since both series are generated using very similar survival probabilities. However, the differences are as high as 3% points in the 1970s and 1980s.[9]

In order to isolate the effect of the decrease in the population growth rate on the saving rate we compare the saving rate in the benchmark model (where the

[9] We have assumed the same steady state survival probabilities in generating both of these series in order to isolate the impact of the changes in the survival probabilities during the 1960–2000 period. This is why the two series converge to each other at the end of the period.

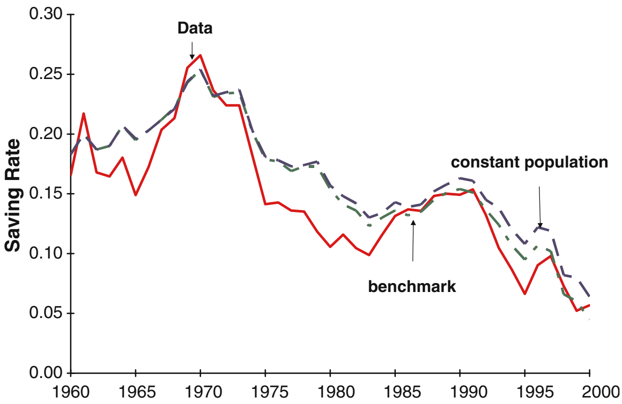

Fig. 6 Role of population growth

population growth rate is taken from the Japanese data which has been experiencing a decline starting in the 1980s) to the one generated under the assumption of a constant population growth rate of 2%, which is labeled 'constant population growth' in Fig. 6. Declining population growth present in the benchmark case results in lower saving rates of 1–2% points between 1990 and 2000. Before 1990s the effects are not significant.

4.2.2 Social security benefits

During the 1960–2000 period, there is a significant increase in the generosity of the social security program. In particular, the social security replacement rate which is 17% until 1973 increases to 35% between 1974 and 1979 and to 40% after 1979. In order to measure the impact of the increase in the generosity of the Japanese retirement system on the saving rate, we computed two equilibria, one with the replacement rate equal to zero percent, and the second with the replacement rate equal to 40% for the entire period including beyond 2000. In Fig. 7 we display saving rates for two age groups who are the main savers in this framework, for 1990 versus 2000, under these two social security replacement rates. In the $RR = 0$ case there is no social security whereas in the $RR = 40$ case social security benefits replace 40% of the annual labor income of an individual. The results indicate that both age groups would save less with social security. For example, the 36–50 years old and 51–63 years old would lower their saving rates by about 5 and 10% points, respectively, during either year, under social security. When we compare across different years we see that in 2000 when the national saving rate is relatively low, the saving rates for both age groups are lower under both social security experiments. For the no social security case the saving rate of 36–50 years is lower by 8% points in 2000.

These results suggest that while social security is important in the determination of the saving rates, its role in impacting the aggregate saving rate in Japan in this

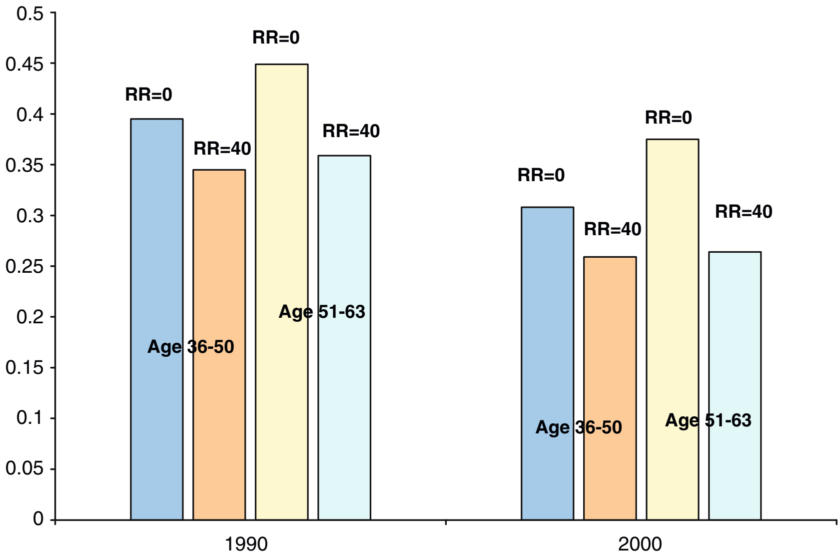

Fig. 7 Role of social security

time period is smaller compared to the role of other factors such as demographics and TFP growth.

4.2.3 TFP Growth versus all other variables

In order to isolate the role of the TFP growth rate better we conduct the following experiment. In Fig. 8 we display 2 panels. In each panel, the series labeled "all constant" represents the saving rate generated in an economy where all the exogenous variables are set to their long run averages. This experiment isolates the impact of the initial capital output ratio. In the first panel, the saving rate labeled "all except TFP growth" adds the time series path of all the exogenous variables except the TFP growth rate into the model. The comparison between the two simulated saving rates in this panel highlight the impact of all the exogenous variables (demographics, taxes, and depreciation) other than the TFP growth rate.[10] In the second panel, we reverse the experiment and add only the observed TFP growth rates into the model (keeping demographics, taxes, and depreciation constant at their steady state levels). The comparison of the two simulated series now shows the importance of the fluctuations in the TFP growth rate in generating the saving rate. For example, the two experiments reveal that the decline in the saving rate in the 1980s and late 1990s are mostly due to the impact of the TFP growth rate in the economy while the increase in the saving rate in the 1970s is due to both the impact of TFP and demographics.

[10] Further examination of the series "all except TFP growth" reveals that the time series data on taxes and depreciation are responsible for the small fluctuations observed in that saving rate. Demographic variables alone cause the overall increase in the saving rate compared with the "all constant" case.

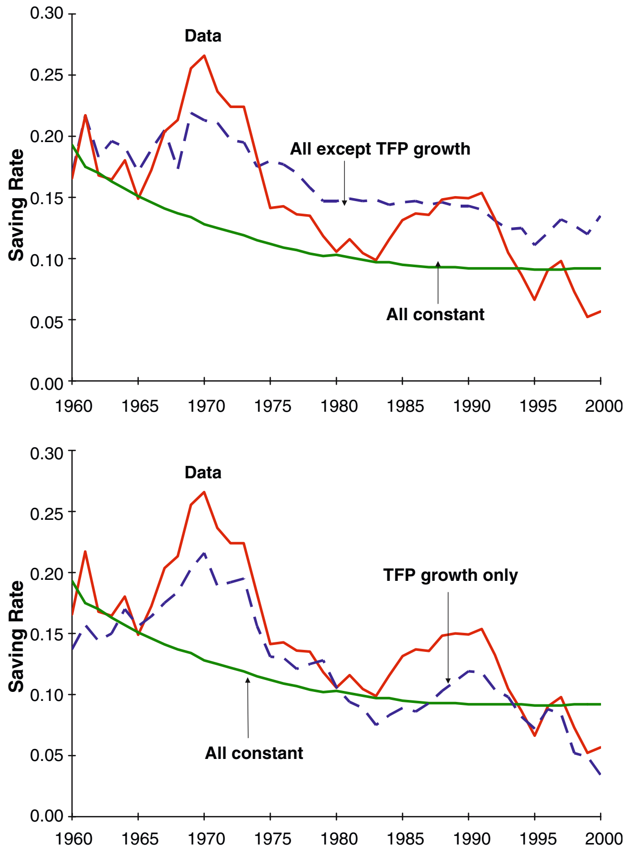

Fig. 8 TFP versus all others

5 Conclusions

In this paper we examine the time path of the saving rate generated by an overlapping generations model that is calibrated to the Japanese economy for the 1960–2000 time period. Our model is populated by 65 period lived individuals who face borrowing constraints. We start the simulations at an initial time period that mimics the economic conditions in Japan in 1960. In our benchmark experiment, we feed in the observed paths of the TFP growth rate, social security replacement rate, population growth rate, and the time-varying survival probabilities in Japan in this period. The equilibrium transition path generated by the benchmark economy is capable of generating saving rates that resemble the data. Next, we conduct counterfactual experiments to isolate the impact of several factors such as the social security system, demographics, and total factor productivity growth on the saving behavior. Our results suggest that the growth rate of TFP played an important role in generating some of the major fluctuations in the Japanese saving rate during 1960–2000.

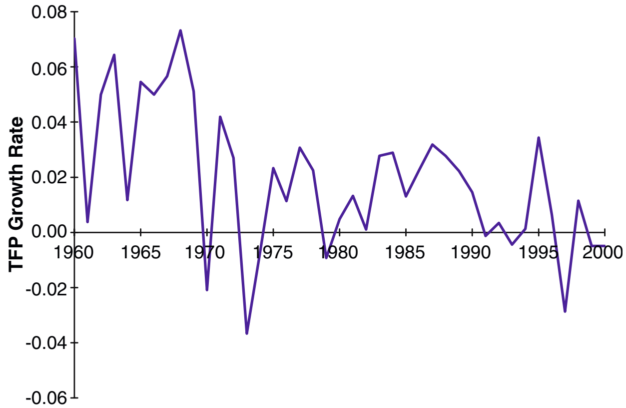

Fig. 9 TFP growth rate

Appendix

Figure 9 displays the TFP growth rate in Japan between 1960–2000.

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