

# The Japanese Saving Rate

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Despite much work economists have not been able to quantitatively account for the differences in the Japanese and U.S. saving rates after World War II. In this paper, we show that the use of actual Japanese Total Factor Productivity growth rates in a standard growth model generates saving rates that are reasonably similar to the Japanese data between 1956-2000.

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# 1 Introduction

There have been substantial differences between the Japanese and U.S. saving rates in the last forty years, as displayed in Figure 1, that have motivated extensive research in this area.<sup>2</sup>

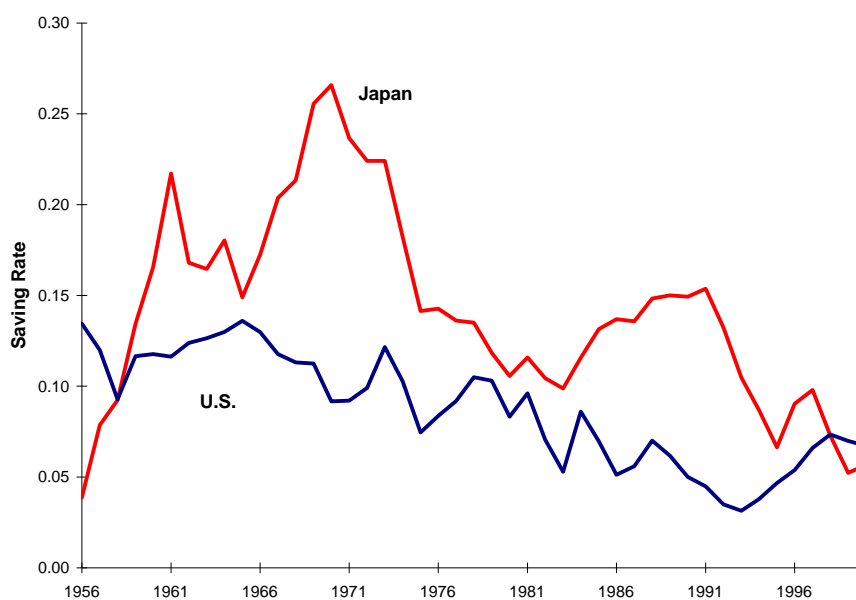


Figure 1: Net national saving rates

Despite much work economists have not been able to quantitatively account for the differences in saving rates. In an earlier work, Christiano (1989)

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<sup>2</sup>Hayashi (1989) provides a comprehensive data set that corrects for differences in accounting and measurement standards between the two countries. Two major differences are noted. First, Japanese National Income and Product accounts report depreciation based on historical cost as opposed to the replacement cost as in the U.S. Second, government investment is explicitly accounted for in Japan, where as in the U.S. all government purchases are classified as government consumption.

shows that a relatively low initial capital intensity alone is not sufficient for the standard neoclassical model to generate saving rates that come close to replicating Japan's saving rates. Hayashi, Ito, and Slemrod (1989) find that the housing finance institutions and tax policy do not offer a complete explanation of the large gap between the average U.S. and Japanese saving rates in 1970s. Other factors that may be peculiar to Japan, such as differences in preferences, the bonus system, high housing prices, high educational costs and high marriage costs are also considered in the literature.<sup>3</sup> There does not appear to be a consensus on the importance of any of these factors.<sup>4</sup>

In this paper, we show that changes in the TFP growth rate alone can generate most of the secular changes in the Japanese saving rate. In the context of a standard growth model, fluctuations in the TFP growth rate change the household's incentive to save. The observed humps in the saving rate in this period are basically due to relatively high TFP growth rates resulting in high saving rates as households enjoy temporarily high interest and wage rates. In the long run, as the Japanese TFP growth rate converges to its steady state, which is in line with the U.S. TFP growth rate, the saving rate declines.

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<sup>3</sup>See Horioka (1990) for a survey.

<sup>4</sup>More recently Braun, Ikeda, and Joines (2004) find that the combined effects of demographics and slower total factor productivity growth can explain the observed decline in the saving rate after 1990s.

We use a one-sector, neoclassical growth model with infinitely-lived representative households facing complete markets and calibrate the economy to Japanese data provided by Hayashi and Prescott (2002) for the 1956-2000 period. We conduct deterministic simulations taking the actual capital stock in 1956 as an initial condition.<sup>5</sup> We take the actual time paths of the population growth rate, tax rate on capital income, the depreciation rate, share of government expenditures in GNP, and the TFP growth rate for that time period. We show that when a constant TFP growth rate is assumed the neoclassical growth model generates a saving rate that does not resemble the data well. However, once we introduce the time path of the TFP growth rate, the model generated saving rate can mimic the actual saving rate reasonably well. In addition, the changes observed in the depreciation rate and the tax rate on capital income also contribute to the annual movements in the saving rate. Our results also indicate that if Japan had faced the U.S. TFP during this period as well as a relatively high initial capital stock, the average saving rate in Japan would have been much closer to that of the U.S. in the late sixties and early seventies. We conclude that differences in preferences or other factors peculiar to Japan are not needed to understand

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<sup>5</sup>Our approach is in line with the recent use of the one-sector growth model to explain ‘Great Depressions’. In particular, we follow the methodology of Cole and Ohanian (1999) and Kehoe and Prescott (2002).

the differences in the Japanese and U.S. saving rates.

The paper is organized as follows. Section 2 presents the model. Calibration and computational issues are discussed in Section 3, and the quantitative findings are presented in Section 4. Concluding remarks are given in Section 5. An appendix contains the data sources.

## 2 The Growth Model

We use the Cass-Koopmans growth model to generate the quantitative results. Our set up assumes a closed economy in which there is no difference between investment and saving.<sup>6</sup>

### 2.1 Technology

There is a stand-in firm with a constant returns to scale Cobb-Douglas production function  $Y_t = A_t K_t^\theta (H_t)^{1-\theta}$ , where  $Y_t$  is aggregate output,  $A_t$  is total factor productivity,  $K_t$  is aggregate capital, and  $H_t$  is aggregate hours at time  $t$ . The output share of capital is  $\theta$ . The growth rate of the TFP factor is  $\gamma_t - 1$  where  $\gamma_t = \left(\frac{A_{t+1}}{A_t}\right)^{1/(1-\theta)}$ . The capital stock evolves according to the law of motion,  $K_{t+1} = (1 - \delta_t)K_t + X_t$ , where  $X_t$  is aggregate investment

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<sup>6</sup>The comparison between the saving and investment data in Japan demonstrates that treating Japan as a closed economy until the mid-1970s is not an unrealistic assumption. After that period Japanese saving is larger than domestic investment, reflecting the current account surpluses for this time period.

and  $\delta_t$  is the depreciation rate of capital at time  $t$ .

## 2.2 Households

There is a stand-in household with  $N_t$  working-age members at date  $t$ .<sup>7</sup> The size of the household evolves over time exogenously at the rate  $n_t - 1$  where  $n_t = \frac{N_{t+1}}{N_t}$ . In this framework the representative household maximizes

$$\sum_{t=0}^{\infty} \beta^t N_t (\log c_t + \alpha \log(T - h_t))$$

subject to

$$C_t + X_t \leq w_t H_t + r_t K_t - \tau_t (r_t - \delta_t) K_t - \pi_t, \quad t = 0, 1, \dots, \quad \text{given } K_0 > 0,$$

where  $c_t = C_t/N_t$  is per member household consumption,  $T$  is time endowment per member,  $h_t = H_t/N_t$  is hours worked per member,  $\beta$  is the subjective discount factor,  $\alpha$  is the share of leisure in the utility function,  $\tau_t$  is the tax rate on capital income,  $w_t$  is the real wage,  $\pi_t$  is a lump sum tax and  $r_t$  is the rental rate of capital at time  $t$ . Households are assumed to own the capital stock,  $K_t$ , and rent it to businesses.

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<sup>7</sup>We are focusing on symmetric allocations within the family.

### 2.3 Government

There is a government that taxes income from capital (net of depreciation) and uses the proceeds to finance an exogenously given stream of government purchases  $G_t$ . A lump sum tax  $\pi_t$  is used to ensure that the government budget constraint is satisfied each period:  $G_t = \tau_t(r_t - \delta_t)K_t + \pi_t$ .

## 3 Calibration and Computations

Our computational strategy is to start from the actual Japanese capital-output ratio in 1956 and use a shooting algorithm to numerically compute the equilibrium transition path of the macroeconomic aggregates generated by the model as it converges to a final steady state. To do this, first we obtain the equilibrium conditions for the economy and detrend them. The detrended steady state saving rate,  $\tilde{s}$ , and time-varying saving rates,  $s_t$ , are given by:

$$\tilde{s} = \frac{(\gamma n - 1)\tilde{k}}{\tilde{y} - \tilde{\delta}\tilde{k}}, \quad (1)$$

$$s_t = \frac{Y_t - G_t - C_t - \delta_t K_t}{Y_t - \delta_t K_t}. \quad (2)$$

We calibrate the model economy using data provided by Hayashi and Prescott (2002). There are 4 parameters that are time invariant throughout

our analysis. These are the capital share of output,  $\theta$ , the subjective time discount factor,  $\beta$ , total discretionary hours in a week,  $T$ , and the share of leisure in the utility function,  $\alpha$ . We set  $\theta$  equal to 0.362 using the sample average of the GNP share of capital over the period 1956-2000. The subjective discount factor is set to 0.963 so that the capital-output ratio is 2 at the steady state. We calibrate  $\alpha = 2.41$  to obtain an average labor input of 31.63 to match the average aggregate hours in the Japanese data between 1956-2000.<sup>8</sup> Total discretionary hours in a week are taken to be 105.

**Calibration of the 1956-2000 period:** In our benchmark simulation, we use the actual time series data between 1956-2000 for the exogenous variables: TFP growth rate, population growth rate, depreciation rate, share of government purchases in GNP, and capital income tax rate.<sup>9</sup> The data used in the calibration are provided in the Appendix. The tax rates are obtained from Mendoza, Razin, and Tesar (1994) and cover the period 1965-

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<sup>8</sup>Aggregate labor input is obtained as the product of average weekly hours worked and the employment rate where the latter is taken as the ratio of total number of employed workers and working age population.

<sup>9</sup>The TFP series taken from Hayashi and Prescott (2002) is calculated as

$$A_t = Y_t/K_t^\theta(H_t)^{1-\theta},$$

where the capital share  $\theta$  is set to 0.362,  $Y_t$  is *GNP*,  $K_t$  is the nongovernment capital stock, and  $H_t$  is aggregate hours worked. In this framework investment consists of domestic private investment and the current account surplus. Their TFP series starts in 1960. However, since the saving rate in Japan between 1956 and 1960 shows dramatic changes, we calculate the Japanese TFP (assuming that the missing labor input between 1956 and 1959 is equal to its 1960 value) and report our results on the saving rate starting from 1956.

1996.<sup>10</sup> We take the initial capital-output ratio in 1956 equal to 1.37.<sup>11</sup>

**Calibration of the Steady State:** For the computation of the steady state we set the exogenous variables equal to their sample averages.<sup>12</sup> The resulting values are  $G/Y = 15\%$ ,  $\delta = 10\%$ , and  $\tau = 35\%$ . We set the growth rate of TFP to 2%, and the growth rate of the population,  $n$ , to 1.2%.<sup>13</sup> Between 2000 and the steady state, we assume that all exogenous variables take their steady state values.

## 4 Results

We start by displaying the findings from our benchmark economy where we use the actual Japanese time series data for all the exogenous variables: TFP growth rate, population growth rate, share of government expenditures in GNP, depreciation rate, and capital income tax rate. Figure 2 shows the actual saving rates in Japan and saving rates generated by the model, labeled ‘Benchmark Model’. The model generated saving rate seems to capture the

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<sup>10</sup>We assume that the tax rate on capital income for the 1956-1964 period equals its value in 1965 and that the 1997-2000 tax rates equal the value in 1996.

<sup>11</sup>As expected the initial saving rate is sensitive to the  $K/Y$  in the initial period. Hayashi and Prescott’s (2002) estimate of the capital stock results in a  $K/Y$  of 0.77 if foreign capital is included and 1.37 if foreign capital is excluded. We take 1.37 as a starting value for 1956.

<sup>12</sup>Our quantitative results for the 1956-2000 period are not sensitive to the steady state values chosen. For example, using the averages for all the exogenous variables from the last 20 years as the steady state values produces similar results.

<sup>13</sup>With  $\theta = 0.362$ , the growth rate of the TFP factor is 3.15%.

secular movements in the empirical Japanese saving rate reasonably well.<sup>14</sup> For example, during 1965-1974 the benchmark model accounts for 91% of the saving rate on average. The main discrepancies between the simulated and the actual data are in the late 1970s, and the 1980s where the saving rates generated by the model are smaller than those in the data.<sup>15</sup> In general, periods with high TFP growth are associated with high saving rates.<sup>16</sup> The saving rates generated by the model in the initial periods are much smaller than the actual saving rates. This result is mainly due to the very high depreciation rates reported by Hayashi and Prescott (2002) for these time periods.<sup>17</sup> Starting the economy with a higher capital output ratio simply shifts the saving rate in 1956 down without having a big impact on the secular movements observed in this simulation.

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<sup>14</sup>We checked the sensitivity of our results to the TFP measure employed by using an alternative measure provided by Jorgenson (2003). The simulated saving rate with this measure is also able to capture the secular movements in the Japanese saving rate.

<sup>15</sup>Until the mid-1970s the time paths of Japanese saving and investment data are very similar. After 1970s investment is smaller than saving. The model generated saving rates are lower than both the actual saving and investment rates in late 1970s and 1980s.

<sup>16</sup>The intuition behind the impact of a higher TFP growth rate on the saving rate follows from permanent income theory. A favorable TFP shock provides an incentive to raise saving as the return to capital is now higher. As a result, the household saves more when TFP growth is higher than average, and saves less (or dissaves) when TFP growth is low.

<sup>17</sup>The capital-output ratio and the after tax rate of return to capital generated by the model are reasonably successful in mimicking the data. However, the labor input generated by the model is not able to capture the general movements in the data. This is due to the large increases in the labor force participation in the data that the model is not able to replicate. However, given the separable period utility function, the effects of the labor behavior on the saving rate are minimal. Similar saving rates are obtained in a version of this model where the labor supply behavior is taken exogenously from the data.

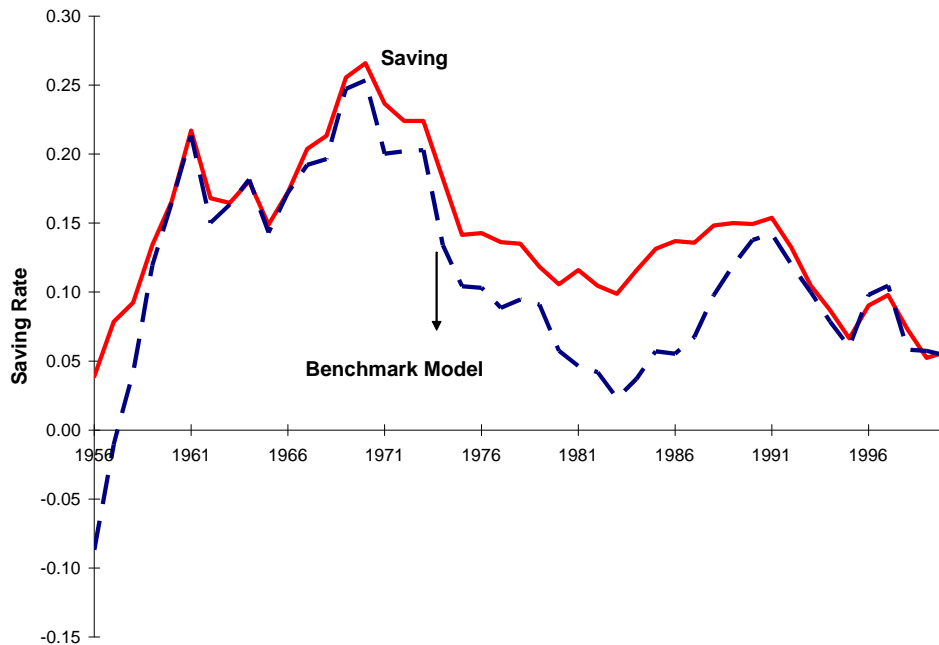


Figure 2: Benchmark Economy

Several of the exogenous variables show significant changes over this time period. In order to isolate the effects of each exogenous variable we first consider an economy where all the exogenous variables are held constant at their long-run averages throughout 1956-2000. The series labeled ‘Constant Growth’ depicts the saving rate from this economy where the TFP growth rate, population growth rate, share of government expenditures in GNP, depreciation rate, and capital income tax rate are constant.<sup>18</sup> Next,

<sup>18</sup>This corresponds to the Christiano (1989) experiment that led him to conclude that the neoclassical growth model could not explain the Japanese saving behavior.

we introduce the actual time series path of one exogenous variable at a time. For example, the population growth rate in Japan shows a significant decline with growth rates above 2% in 1960s to less than 1% by 1999. To isolate its impact we present the series labeled ‘Population’ representing the model generated saving rate that results when the actual time series data for the population growth rate is used to generate the saving rate in the model where all other variables are set equal to their long run averages.

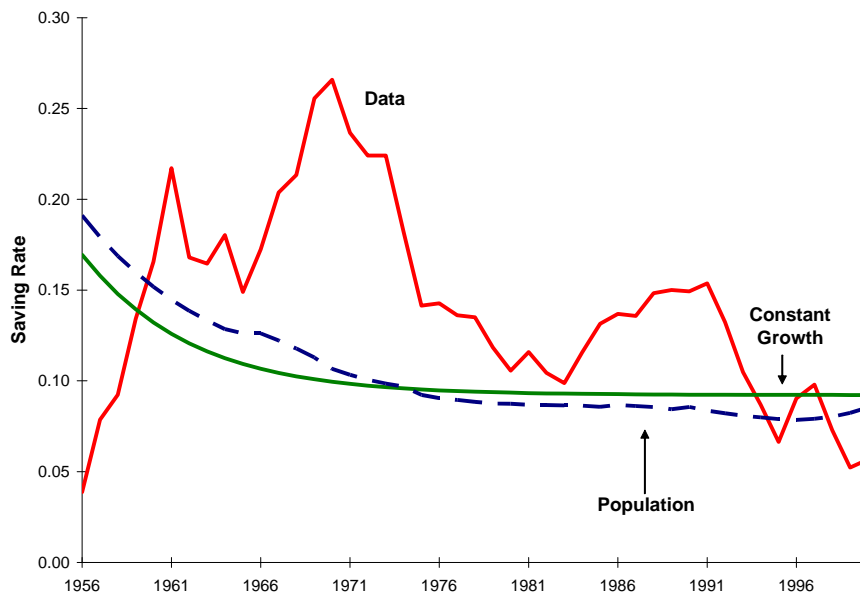


Figure 3: The effects of population growth

Using the time path of the population growth rate results in higher saving rates early on and lower rates toward the end of the period, compared to a constant population growth rate of 1.2%. For example, while the average

saving rate in the model with constant TFP and population growth rate is 9.2% in 1990s, it is 8% with constant population growth. Thus the decline in the population growth rate in the 1990s accounts for about 1.2 percentage points of the decline in the saving rate. However, changes in the population growth rate do not seem to play an important role in the fluctuations observed in the saving rate throughout the entire period.

Next in Figure 4, we introduce the time series data for the depreciation rate and the capital income tax rate one at a time. Both of these series show significant changes over time. As one would expect, the high depreciation rate of the late 1950s and 1960s causes the model generated saving rate which is labeled 'Depreciation' to be lower than the average saving rate initially. The depreciation rate in Japan starts its decline after 1965 causing the saving rate generated by the model to increase after 1965.

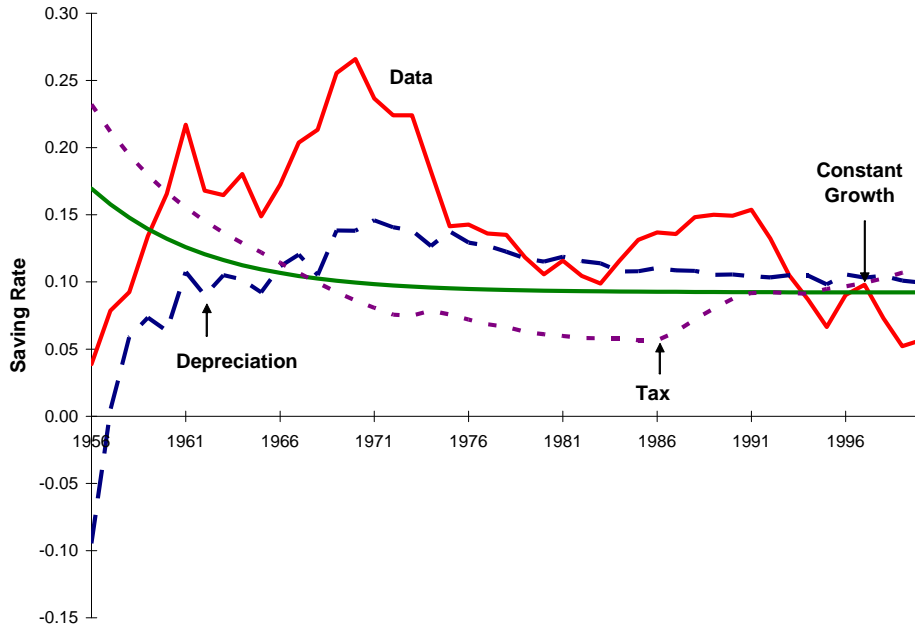


Figure 4: The effects of depreciation and tax rate

The average capital income tax rate that is used in generating the saving rate in the constant growth case is 35%. Adding the time series path for the tax rate generates a saving rate displayed in the series labeled ‘Tax’. Comparing these two series indicates that the lower tax rates in the 1950s results in higher saving rates. After 1980 the capital income tax rate continues to increase reaching 50% in 1988 while the saving rate continues to be lower than the average generated by the constant growth case. After 1988 the tax rate starts declining again causing a slight increase in the saving rate.

In Figure 5, we display the results of two experiments; first, the saving rate generated by the model with the actual time series for TFP growth rate only, labeled ‘TFP only’ and second, the saving rate generated by the model with a constant 2% TFP growth and the time series for population growth rate, depreciation rate, and capital income taxes, labeled ‘All time series except TFP’. It is interesting to note that while the time series behavior of population growth, depreciation rate and capital income taxes do not seem to generate secular movements in the saving rate that mimic the data well when they are introduced one at a time, they result in small humps when introduced simultaneously. Among the exogenous variables that are used, the decrease in the depreciation rate during 1965-1974 accounts for 27% of the gap between the actual saving rate and the saving rate generated by constant growth. For the same period TFP growth rate accounts for 55% of the gap.<sup>19</sup>

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<sup>19</sup>The observed saving rate during 1965-1974 is 21%. The model with constant depreciation and tax rates results in an average saving rate of 10% for this period. Incorporating the time series data for the depreciation rate alone increases the average saving rate to 13%.

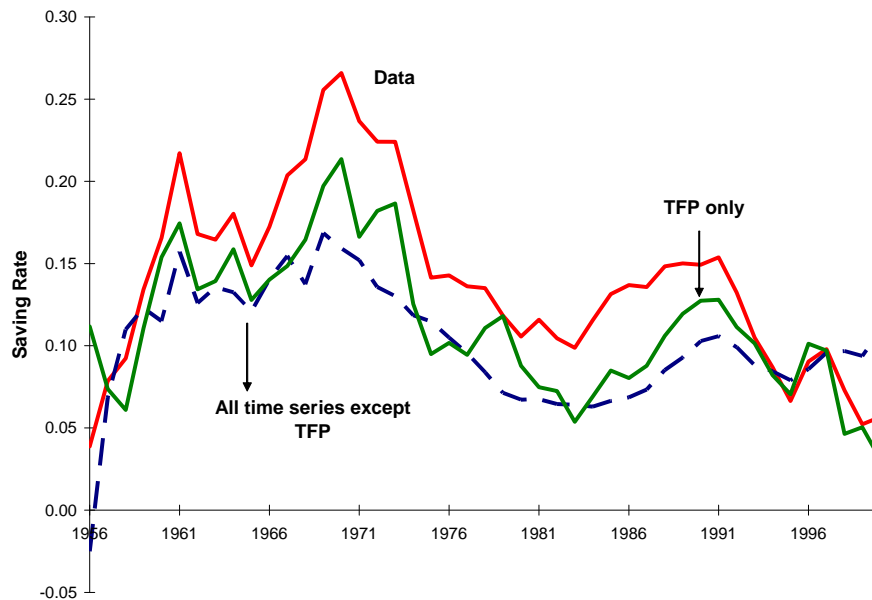


Figure 5: Main determinants of the saving rate

To further evaluate the role of the TFP growth rates in explaining the Japanese saving rate, we conduct a counterfactual experiment where we ask the following question: If the Japanese households were faced with the U.S. TFP during this time period, and a high initial capital-output ratio in 1956, what would the Japanese saving rate look like?<sup>20</sup> We carry out this experiment by feeding in the U.S. TFP growth rates into our model where the preference parameters as well as all the other exogenous variables are

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<sup>20</sup>In order to answer this question we calculate a measure of the U.S. TFP following the methodology in Hayashi and Prescott (2002). The growth rate of TFP in Japan is significantly higher than that of the U.S. in the sixties and early seventies while both countries experience a decline in growth rates in the 1973-1982 period.

calibrated to the Japanese economy. Our results indicate that the average saving rate in Japan during this time period would have been much closer to that in the U.S. if the Japanese were to face U.S. TFP growth rates. In other words, differences in preferences or other factors that are peculiar to Japan are not needed to understand the differences between the Japanese and U.S. savings rate.<sup>21</sup>

#### 4.1 Sensitivity Analysis

So far, we have assumed perfect foresight and conducted deterministic simulations. In this section we relax this assumption and experiment with a simple stochastic version of this model where we make the extreme assumption that households always expect the TFP growth rate to be 2% while getting hit with the actual TFP growth rates every period.<sup>22</sup> After 2000 the growth rate is assumed to be 2%, thus, as individuals get closer to this period, their expectations get closer to the realizations that take place after 2000. However, for the periods starting in 1956, they are always forming

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<sup>21</sup>In Chen, İmrohoroğlu, and İmrohoroğlu (2005) we obtain similar results in an overlapping generations model where the calibration takes into account the changes in the social security system and the demographic structure of Japan in this time period.

<sup>22</sup>We thank Narayana Kocherlakota for suggesting this experiment. In order to isolate the role of expectations about the TFP growth rate, we conduct this experiment in the version of the model where all the other exogenous variables, population growth rate, depreciation rate, share of government purchases, and capital income tax rate are set to their steady state values.

their decision rules based on the ‘naive’ expectation of 2% TFP growth. This model generates the saving rate labeled as ‘non-changing expectations’ in Figure 6. Large discrepancies between the saving rates generated by the deterministic model and the stochastic case occur in periods when the actual TFP growth rate is significantly different from the expected 2%, such as between 1956 and 1961 when the actual average TFP growth rate is 5%, or in the early 1970s when the TFP growth rate is actually declining. This exercise demonstrates the extent to which expectations may play a role in these findings.

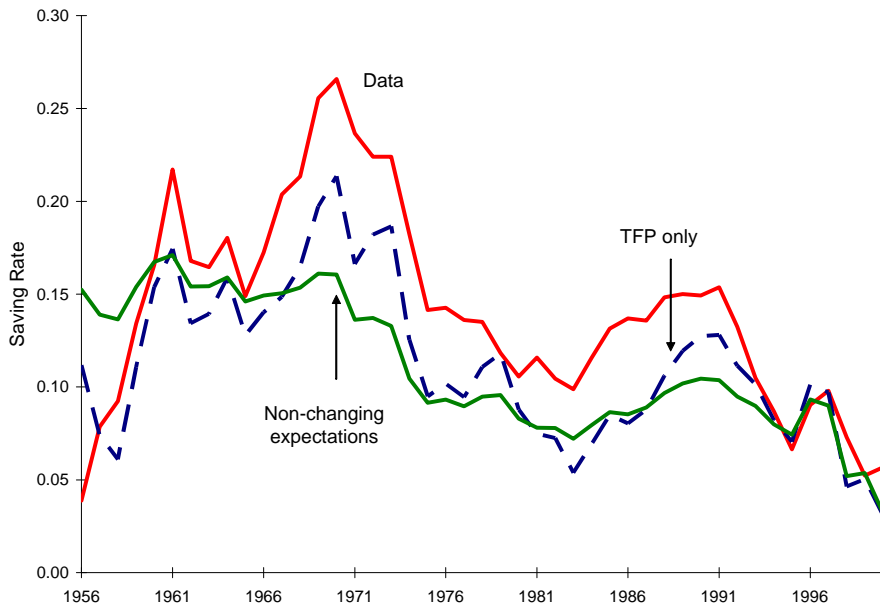


Figure 6: Role of Expectations

## 5 Conclusions

In this paper, we use the standard growth model to understand the factors behind the secular movements in the Japanese saving rate between 1956 and 2000. We calibrate the model economy to Japanese data for this time period and conduct deterministic simulations using the actual TFP growth rate, population growth rate, depreciation rate and the tax rate on capital income that prevailed in this time period. We decompose the effect of each one of these factors and conclude changes in the TFP growth rate in this time period alone can generate most of the secular changes that took place in the Japanese saving rate. We argue that differences in preferences or other factors peculiar to Japan are not needed to understand the differences in the Japanese and U.S. saving rates. In fact, we find that if Japan had faced the U.S. TFP as well as a relatively high initial capital stock, the average saving rate in Japan would have been much closer to that of the U.S. during this period.

We conclude that in order to understand the Japanese saving behavior better, we need to understand the factors behind TFP growth. The rapid growth in TFP experienced by Japan after World War II has been the focus of much research. More recently, Parente and Prescott (2000) argue that the high TFP growth rate observed in postwar Japan was partly due

to the break up of Japan's bureaucratic complex after the war. Eaton and Kortum (1997) argue that manufacturing productivity growth in Japan between 1950-1990 can be explained by a model of international technology diffusion. According to their results, Japan, Germany and France grew fast by adopting technology from the U.S. that was the technological leader at that time. A detailed analysis of the factors behind TFP growth, perhaps by incorporating some of the features discussed above would further enhance our understanding of the Japanese saving behavior.

## 6 Appendix: Data

**TFP Measure:** Hayashi and Prescott (2002) include an extensive description of the methods they use, and the adjustments they make to the Japanese National Income Accounts, that give rise to their *TFP* measure. In calculating *TFP* for the U.S. we follow the same procedure. Data on TFP,  $A_t$ , depreciation rate,  $\delta_t$ , government share in output,  $G_t/Y_t$ , are taken from Hayashi and Prescott (2002). The capital income tax rate is obtained from Mendoza, Razin, and Tesar (1994). Table A1 presents the data for the exogenous variables.<sup>23</sup>

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<sup>23</sup>We present data on the TFP growth rate  $A_t$ , in the last column. Notice that we use the growth rate of TFP factor in the model simulations.

Year	Population Growth Rate	Depreciation Rate	Capital Income Tax	G/Y	Growth rate of TFP
1956	1.0231	0.26	20.43	0.125	1.008
1957	1.0231	0.226	20.43	0.119	1.033
1958	1.0231	0.194	20.43	0.122	1.094
1959	1.0231	0.185	20.43	0.118	1.094
1960	1.0231	0.202	20.43	0.115	1.070
1961	1.0226	0.16	20.43	0.113	1.004
1962	1.0214	0.176	20.43	0.122	1.050
1963	1.0217	0.16	20.43	0.124	1.064
1964	1.0161	0.161	20.43	0.121	1.012
1965	1.0119	0.172	20.43	0.123	1.055
1966	1.0258	0.155	19.50	0.123	1.050
1967	1.0266	0.144	19.59	0.115	1.057
1968	1.0268	0.16	20.00	0.113	1.073
1969	1.0279	0.127	20.94	0.112	1.051
1970	1.0175	0.122	22.31	0.115	0.979
1971	1.0156	0.108	23.99	0.126	1.042
1972	1.0136	0.106	25.34	0.132	1.027
1973	1.0125	0.102	30.23	0.136	0.963
1974	1.0198	0.108	34.94	0.140	0.993
1975	1.0108	0.094	29.64	0.150	1.023
1976	1.0083	0.096	29.60	0.146	1.011
1977	1.0089	0.094	31.15	0.150	1.031
1978	1.0090	0.094	33.20	0.153	1.022
1979	1.0070	0.095	33.10	0.156	0.991
1980	1.0084	0.095	35.98	0.154	1.005
1981	1.0077	0.09	37.30	0.155	1.013
1982	1.0081	0.09	38.25	0.151	1.001
1983	1.0082	0.089	40.29	0.148	1.028
1984	1.0096	0.092	41.45	0.142	1.029
1985	1.0054	0.091	41.25	0.137	1.013
1986	1.0103	0.088	43.26	0.138	1.023
1987	1.0101	0.088	48.75	0.138	1.032
1988	1.0110	0.087	50.70	0.136	1.028
1989	1.0048	0.088	49.67	0.134	1.022
1990	1.0134	0.087	48.47	0.135	1.015
1991	1.0104	0.087	45.91	0.135	0.999
1992	1.0097	0.087	42.65	0.142	1.003
1993	1.0077	0.085	41.45	0.153	0.996
1994	1.0072	0.084	41.51	0.154	1.001
1995	1.0056	0.088	44.30	0.155	1.034
1996	1.0032	0.082	42.61	0.156	1.006
1997	1.0026	0.082	42.61	0.147	0.971
1998	1.0010	0.079	42.61	0.151	1.012
1999	1.0007	0.079	42.61	0.155	0.995
2000	1.0000	0.077	42.61	0.146	0.995

Table A1: Exogenous Variables

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