The Japanese Saving Rate

By Kaiji Chen, Ayşe İmrohoroğlu, and Selahattin İmrohoroğlu*

There have been substantial differences between the Japanese and U.S. saving rates in the last 40 years, which have motivated extensive research in this area (see Figure 1).[1]

Despite much work, economists have not been able to quantitatively account for the differences in saving rates. In an earlier work, Lawrence J. Christiano (1989) 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. Fumio Hayashi et al. (1988) find that 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 the 1970s. Other factors that may be specific 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.[2] There does not appear to be a consensus on the importance of any of these factors.[3]

In this paper, we show that changes in the total factor productivity (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.

We use a one-sector, neoclassical growth model with an infinitely lived representative household facing complete markets, and calibrate the economy to Japanese data provided by Hayashi and Edward C. Prescott (2002) for the 1956–2000 period. We conduct deterministic simulations taking the actual capital stock in 1956 as an initial condition.[4] We take the actual time paths of the population growth rate, the tax rate on capital income, the depreciation rate, the 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. Once we introduce the time path of the TFP growth rate, however, the model generated saving

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[1] Hayashi (1988) provides a comprehensive dataset which 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 of the United States. Second, government investment is explicitly accounted for in Japan, whereas in the U.S. all government purchases are classified as government consumption.

[2] See Charles Yuji Horioka (1990) for a survey.

[3] More recently, R. Anton Braun et al. (2005) find that the combined effects of demographics and slower TFP growth can explain the observed decline in the saving rate after the 1990s.

[4] 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 Harold L. Cole and Lee E. Ohanian (1999) and Timothy S. Kehoe and Prescott (2002).

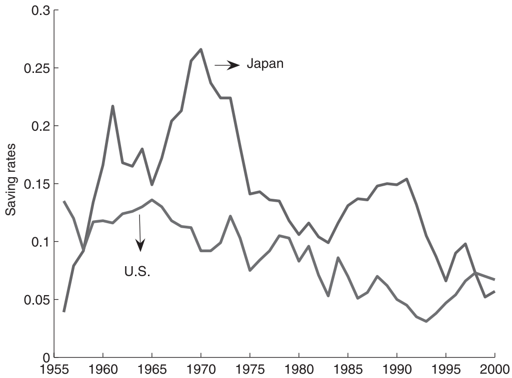

FIGURE 1. NET NATIONAL SAVING RATES

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 United States in the late 1960s and early 1970s. We conclude 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.

The paper is organized as follows. Section I presents the model. Calibration and computational issues are discussed in Section II, and the quantitative findings are presented in Section III. Concluding remarks are given in Section IV. The Data Appendix contains the data sources.

I. The Growth Model

We use the Cass-Koopmans growth model to generate the quantitative results. Our setup assumes a closed economy in which there is no difference between investment and saving.[5]

A. *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 θ. The growth rate of the TFP factor is $\gamma_t - 1$, where $\gamma_t = (A_{t+1}/A_t)^{1/(1-\theta)}$. 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 and δ_t is the depreciation rate of capital at time t.

B. *Households*

There is a stand-in household with N_t working-age members at date t.[6] The size of the household evolves over time exogenously at the rate $n_t - 1$, where $n_t = N_{t+1}/N_t$. 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

$$C_t + X_t \leq w_t H_t + r_t K_t - \tau_t(r_t - \delta_t)K_t - \pi_t,$$

$$t = 0, 1, \ldots, \text{ given } K_0 > 0,$$

where $c_t = C_t/N_t$ is household consumption per member, T is time endowment per member, $h_t = H_t/N_t$ is hours worked per member, β is the subjective discount factor, α is the share of leisure in the utility function, τ_t is the tax rate on capital income, w_t is the real wage, π_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.

C. *Government*

There is a government that taxes income from capital (net of depreciation) and uses the

[5] 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.

[6] We are focusing on symmetric allocations within the family.

proceeds to finance an exogenously given stream of government purchases G_t. A lump-sum tax π_t is used to ensure that the government budget constraint is satisfied each period: $G_t = \tau_t(r_t - \delta_t)K_t + \pi_t$.

II. 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

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

$$s_t = \frac{Y_t - G_t - C_t - \delta_t K_t}{Y_t - \delta_t K_t}. \tag{2}$$

We calibrate the model economy using data provided by Hayashi and Prescott (2002). There are four parameters that are time invariant throughout our analysis. These are the capital share of output, θ, the subjective time discount factor, β, total discretionary hours in a week, T, and the share of leisure in the utility function, α. We set θ equal to 0.363 using the sample average of the GNP share of capital over the 1956–2000 period. The subjective discount factor is set to 0.96327 so that the capital-output ratio is two at the steady state. We calibrate $\alpha = 1.45$ to obtain an average labor input of 44 to match the average aggregate hours in the Japanese data between 1956 and 2000.[7] Total discretionary hours in a week are taken to be 105.

A. *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.[8] The data used in the calibration are provided in the Appendix. The tax rates are obtained from Enrique G. Mendoza et al. (1994) and cover the 1965–1996 period.[9] We take the initial capital-output ratio in 1956 equal to 1.37.[10]

B. *Calibration of the Steady State*

For the computation of the steady state, we set the exogenous variables equal to their sample averages.[11] The resulting values are G/Y = 14 percent, δ = 10 percent, and τ = 35 percent. We set the growth rate of TFP to 2 percent, and the growth rate of the population, n, to 1.1976 percent.[12] Between 2000 and the steady state,

[7] Aggregate labor input is 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.

[8] 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 θ 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. Since the saving rate in Japan between 1956 and 1960 shows dramatic changes, however, 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.

[9] 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.

[10] 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.

[11] 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.

[12] With $\theta = 0.362$, the growth rate of the TFP factor is 3.15 percent.

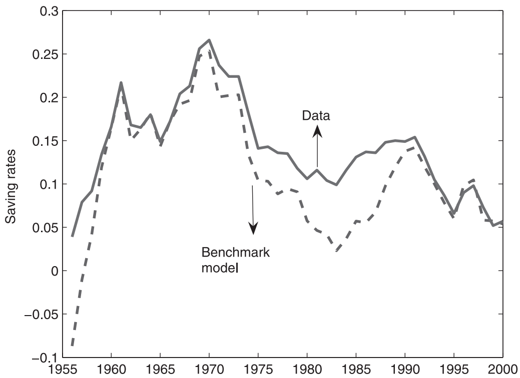

FIGURE 2. BENCHMARK ECONOMY

we assume that all exogenous variables take their steady state values.

III. 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 secular movements in the empirical Japanese saving rate reasonably well.[13] For example, during the 1965–1974 period, the benchmark model accounts for 91 percent of the saving rate on average. The main discrepancies between the simulated and the actual data are in the late 1970s, and in the 1980s when the saving rates generated by the model are smaller than those in the data.[14] In general, periods with high TFP growth are associated with high saving rates.[15] The saving rates generated by the model in the initial periods are much smaller than the actual saving rates. This result is due mainly to the very high depreciation rates reported by Hayashi and Prescott (2002) for these time periods.[16] 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.

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 the 1956–2000 period. The series labeled "Constant TFP growth" in Figure 3 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.[17] Next, 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, from growth rates above 2 percent in the 1960s to less than 1 percent by 1999. To isolate its impact we present the series labeled "Population growth" representing the model-generated saving rate that results when the actual time series data for the population growth

[13] We checked the sensitivity of our results to the TFP measure employed by using an alternative measure provided by Dale W. Jorgenson (2003). The simulated saving rate with this measure is also able to capture the secular movements in the Japanese saving rate.

[14] 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 the late 1970s and 1980s.

[15] 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.

[16] The capital-output ratio and the after-tax rate of return to capital generated by the model are reasonably successful in mimicking the data. The labor input generated by the model, however, 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. Given the separable period utility function, however, the effects of 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.

[17] This corresponds to the Christiano (1989) experiment that led him to conclude that the neoclassical growth model could not explain the Japanese saving behavior.

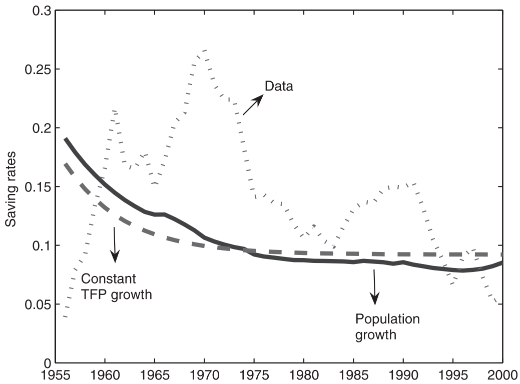

FIGURE 3. THE EFFECTS OF POPULATION GROWTH

rate are used to generate the saving rate in the model where all other variables are set equal to their long-run averages.

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 percent. For example, while the average saving rate in the model with constant TFP and population growth rate is 9.2 percent in the 1990s, it is 8 percent 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. Changes in the population growth rate do not, however, 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, 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.

The average capital income tax rate that is used in generating the saving rate in the constant growth case is 35 percent. 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 result in higher saving rates. After 1980, the capital income tax rate continues to increase, reaching 50 percent 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-percent 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 the 1965–1974 period accounts for 27 percent of the gap between the actual saving rate and the saving rate generated by constant growth. For the same period, the TFP growth rate accounts for 55 percent of the gap.[18]

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 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?[19] We carry out

[18] The observed saving rate during the 1965–1974 period is 21 percent. The model with constant depreciation and tax rates results in an average saving rate of 10 percent for this period. Incorporating the time series data for the depreciation rate alone increases the average saving rate to 13 percent.

[19] 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 1960s and early 1970s, while both countries experience a decline in growth rates in the 1973–1982 period.

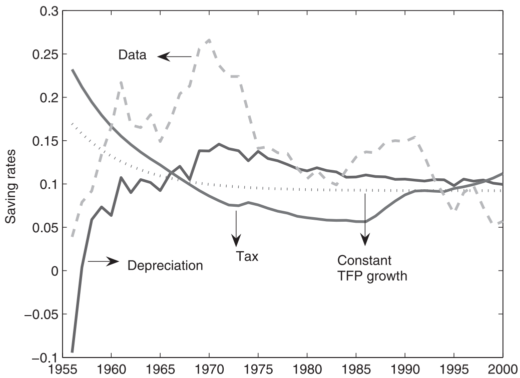

FIGURE 4. THE EFFECTS OF DEPRECIATION AND TAX RATE

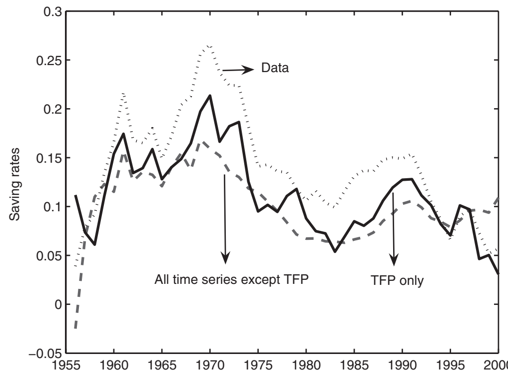

FIGURE 5. MAIN DETERMINANTS OF THE SAVING RATE

this experiment by feeding the U.S. TFP growth rates into our model where the preference parameters, as well as all the other exogenous variables, are 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 of the United States 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.[20]

A. *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 percent, while getting hit with the actual TFP growth rates every period.[21] After 2000, the growth rate is assumed to be 2 percent; thus, as individuals get closer to this period, their expectations get closer to the realizations that take place after 2000. For the periods starting in 1956, however, they are always forming their decision rules based on the "naive" expectation of 2-percent TFP growth. This model generates the saving rate labeled "nonchanging 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 percent, such as between 1956 and 1961 when the actual average TFP growth rate was 5 percent, or in the early 1970s when the TFP growth rate actually declined. This exercise demonstrates the extent to which expectations may play a role in these findings.

IV. 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 tax rate on capital income

[20] In Chen et al. (forthcoming) 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.

[21] 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.

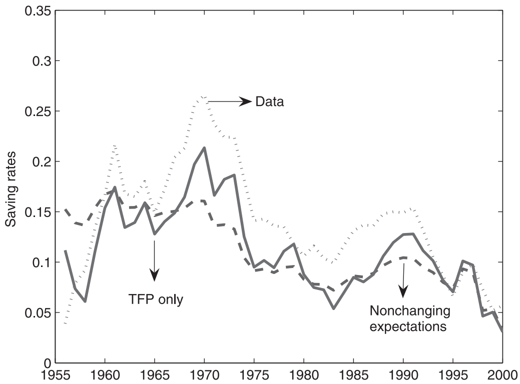

FIGURE 6. ROLE OF EXPECTATIONS

that prevailed in this time period. We decompose the effect of each one of these factors and conclude that 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 United States 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, Stephen L. Parente and Prescott (2000) argue that the high TFP growth rate observed in postwar Japan was partly due to the breakup of Japan's bureaucratic complex after the war. Jonathan Eaton and Samuel Kortum (1997) argue that manufacturing productivity growth in Japan between 1950 and 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 United States, 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.

DATA APPENDIX

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, which give rise to their TFP measure. In calculating TFP for the United States, we follow the same procedure. Data on TFP, A_t, depreciation rate, δ_t, and government share in output, G_t/Y_t, are taken from Hayashi and Prescott (2002). The capital income tax rate is obtained from Mendoza et al. (1994). Table A1 presents the data for the exogenous variables.[22]

[22] 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.

TABLE A1—EXOGENOUS VARIABLES

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

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