

**Demographic Density, Per Capita Consumption,  
and the Japanese Saving-Investment Balance**

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DEMOGRAPHIC DESTINY, PER CAPITA CONSUMPTION, AND THE JAPANESE SAVING-INVESTMENT  
BALANCE

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## ABSTRACT

In this paper, we revisit the issue of the impact of demographic change on the Japanese saving-investment balance. Using updated government projections, we show that the ageing of the population under way will steadily lower Japan's saving rate from 31 per cent of GDP today to 20 per cent of GDP in 2040. Japan's investment rate will remain close to its current level of 29 per cent. Thus, Japan's saving-investment balance, or current account, will steadily decrease from its current level and will turn negative in 2025. In addition, we project the impact of demographic change on the evolution of Japanese consumption per capita, or 'living standards.' Despite the population ageing, we project that per-capita consumption will grow until 2010. However, under certain scenarios, consumption per capita falls in most years after 2010.

## **I. Introduction.**

Japan's saving and investment rates are among the highest in the world, and these rates have played a valuable role throughout the postwar period. The high savings has provided the funds needed to finance corporate investment in plant and equipment during the high-growth era of the 1950s, 1960s, and early 1970s, and helped meet capital shortages abroad during the post-1973 era of stable growth. The high investment has allowed Japan to incorporate the latest technologies into its production process, and has raised living standards through better public infrastructure, both in cities and in rural areas. However, there are some who blame Japan's high saving rate for her massive net export surpluses, leading to trade friction with her neighbors. Some also claim that Japanese firms are "overinvesting," that the returns to capital are abysmally low, and that government infrastructure investment is determined mostly by political considerations and inefficiently allocated.

Over the next several decades, Japan's population will be aging rapidly. In 1955, only 5.5 percent of the population was 65 years or older; by 1998, 16.2 percent were elderly. Projections imply large increases in the elderly in the next 20 years; by 2015, 25 percent of the population will be 65 or above. The main reason for this aging is the fall in the total fertility rate (births per family). The total fertility rate was more than 4 before 1949, declining sharply to 2.1 in 1957. It has begun to fall again since 1974 and the current level of 1.4 was reached in 1997. There is still little sign that the total fertility rate has stabilized or has returned to a higher level.

In this paper, we revisit the issue of the impact of demographic change on the Japanese saving-investment balance. There is widespread public belief that this rapid aging of the Japanese population—Japan's demographic destiny—will lead to major shifts in the Japanese saving-investment balance. We show that this belief is largely true. Using updated government

demographic projections, we show that the rapid aging of the population currently underway will steadily lower Japan's saving rate from 31 percent of GDP today to 20 percent of GDP in 2040. Japan's investment rate will remain close to its current level of 29 percent. Thus, Japan's saving-investment balance, or current account, will steadily decrease from its current level, and will turn negative in 2025.

In addition, we project the impact of demographic change on the evolution of Japanese consumption per capita, or "living standards." In carrying out the projections, we adopt two approaches. In the first approach, we assume that consumers are "naive" and base their consumption only on current income. In the second approach, we assume that consumers are "forward-looking" and base their consumption on both current and future income. Thus, in the second approach, consumption can be detached from current income; households adjust their saving to keep consumption growth constant into the future. The two approaches project very different consumption per capita growth rates. For example, under the first approach, the aging population drags down income growth, and consumption per capita declines by close to -2 percent per year between 2010 and 2020. However, under the second approach, households bring their saving rate down to keep their consumption growth rate constant at 1.2 percent per year between 2010 and 2020.

Besides its effect on the saving-investment balance and consumption per capita, Japan's aging population is expected to impose unprecedented stress on the public pension system. As the ratio of the elderly, who receive social security, to the working population rises, payroll tax rates are expected to surge to between 22 and 39 percent of gross annual wages by 2030 (Takayama, 1998, p. 54). Takayama (1998) recommends that social security benefits be cut, and

that the earliest age of pension eligibility be raised. In this paper, we will not directly address the impact of aging on public pensions. However, in several sections, we briefly discuss the impact of aging on the government fiscal balance.

Most of the earlier literature projecting the impact of demographic change on the Japanese saving-investment balance dates back over a decade. Horioka (1991, 1992) estimates that Japanese private saving will become -15 percent by 2020. With regards to government saving, Masson and Tryon (1990) find that between 2000 and 2025, the budget deficit will deteriorate by 1.6 percentage points, owing to increasing pension burdens. Noguchi (1989) finds that the aging will cause the ratio of investment to GDP to decline until 2015, and increase thereafter. The primary reason for the decline is the fall in the working-age population and the resultant decline in the labor force. Noguchi's results further indicate that between 2000 and 2015, the decline in the investment rate will exceed that in the saving rate, but from 2015, the decline in the saving rate will exceed that in the investment rate.

Our paper differs from the earlier literature in the following ways. First, we use the latest data available on official demographic projections and the saving and investment rates. The earlier work was done over a decade ago and the data are correspondingly over a decade old. Second, we allow future population growth rates and support ratios (the ratio of the labor force to the population) to change every five years. The earlier literature assumed future population growth rates that are constant. Our approach, thus, allows for the simulation of more realistic evolutions of the age structure of the population. Finally, while the earlier projections were based on ad hoc behavioral assumptions, our projections are grounded in well-accepted micro-economic behavior.

This paper is organized as follows. In Section II, we briefly review the literature on and past trends in Japanese saving and investment rates. In Section III, we assess the coming burden of the aged on per capita consumption and investment rates, assuming “naive” consumers and no international lending (closed economy). In Section IV, we allow for international lending, and “forward-looking” optimizing households. We simulate this model for realistic parameter values and demographic changes, and study the implications of the model for optimal investment rates, saving rates, consumption growth per capita, and the current account-GDP ratio. Section V concludes.

## **II. Post-war Japanese Saving and Investment.**

It is well-known that the postwar Japanese economy is characterized by very high saving and investment rates. In fact, Japan’s saving rates are among the highest in the world—only Italy, Singapore, and Taiwan have higher saving rates. However, these high Japanese saving and investment rates are primarily a postwar phenomenon—in fact a post-1955 phenomenon. If the period of the Korean War is excluded, Japan’s saving rate did not make it into the double digits until 1955, a full ten years into the postwar period. Thus, we can immediately reject the view that Japan’s high saving rate is the result of cultural factors such as national character or Confucian and Buddhist teachings, because although cultural factors were stronger in the pre-war period, the saving rate was lower.

The trends and fluctuations in Japanese saving and investment rates closely mirror the trends and fluctuations in Japanese GDP. Figure 1 depicts the association between Japanese total

saving and investment rates and the growth in Japanese GDP. For both saving and investment rates, there is clear positive association with the growth in GDP, especially until 1975. The broad trends in postwar Japanese private and government saving rates, investment rates, and the net export surplus-GDP ratios, are depicted in Table 1.<sup>1 2</sup>

The *private saving rate* rose steadily between 1955 and the mid-1970s, peaking (first) in 1978. Subsequently, the rate fell until the early 1990s, when it rose (again) to reach its postwar peak in 1998. There is a voluminous literature that seeks to explain the pattern and level of Japanese postwar private saving.<sup>3</sup> The literature suggests that the most important reason for Japan's high private saving rate is rapid economic growth. The permanent income/life cycle hypothesis can explain the positive impact of income growth on the private saving rate if income growth was faster than expected. This hypothesis may have been valid until the early 1970s. The surge in private saving from the mid-1970s to the early 1980s is related to the two oil crisis in the 1970s. The explanation given is that the oil crisis added further fuel to the already rampant inflation and precipitated a recession, which in turn caused an increase in uncertainty about the

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<sup>1</sup>We depict gross saving and investment. Gross savings includes the depreciation on capital. In this paper, we use "gross", instead of "net" savings because the latter requires data on depreciation. There is enormous controversy regarding the proper measurement of capital depreciation rate in Japan, and the use of "gross" saving allows us to sidestep this controversy (Dekle and Summers, 1991; Hayashi, 1991; Horioka, 1995).

<sup>2</sup>The private sector includes households, private unincorporated non-financial enterprises, and corporations. Corporate saving is small in Japan, and if households "pierce the corporate veil," corporate saving can be considered part of household saving. The government sector includes the central, prefectural, and local governments. Government saving excludes government investment, which are included in total investment.

<sup>3</sup>See Horioka (1990), Dekle (1993), and Hayashi (1998) for a catalogue of reasons for Japan's high private saving.

future and increased the perceived need to save for precautionary purposes. The fall in private saving from the mid-1980s to the early 1990s is because of robust consumption, stimulated by rising stock and land prices. In contrast, the mid- to late-1990s rise in private saving is related to the recessionary economy, increase in unemployment, uncertainty and pessimism, all raising the perceived need for precautionary saving. Horioka (1991, 1992) finds that the level and growth of Japanese GDP explains about 65 percent of the variation in the private saving rate.<sup>4</sup>

The literature suggests that the second most important reason for Japan's high private saving rate is the favorable age structure of the population. Until the early 1970s, the proportion of the aged (over 65) to the working age population (20-64)—the so-called “dependency ratio”—was low in Japan. According to the life-cycle hypothesis, an increase in the dependency ratio has a significant negative effect on the private saving rate. Horioka (1991, 1992) finds that adding the dependency ratio to the equation already including the level and growth of GDP raises the proportion of private saving explained from 65 percent to 75 percent. Moreover, Horioka estimates that a one percentage point increase in the dependency rate will cause the private saving rate to decline by 1.0 percentage points. These and similar estimates suggest that the 12 percentage point increase in the dependency rate between 1975 and 1998 has depressed private saving by about 12 percentage points annually.

The *government saving rate* rose until the mid-1960s, then gradually fell to its historical low in 1978. Subsequently, the rate rose (again) until the early 1990s, when it started to decline to (almost) its new low in 1998. The trend in Japanese government saving is also closely related

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<sup>4</sup>Horioka's results, however, must be interpreted with caution, since he includes variables with different orders of integration,  $I(\cdot)$ , in the same estimating equation. His demographic variables are  $I(2)$ , but the level and growth of GDP are  $I(0)$ , and  $I(1)$ , respectively.

to economic growth. Government saving surged until the mid-1960s as growth rates were consistently above government projections, leading to rising tax revenues. From the mid-1960s, however, the demand for government services increased, dampening the budget surpluses. The recessionary 1970s led to counter-cyclical measures and a further drop in government saving. To halt the decline in government saving, the Japanese government in the early 1980s introduced budget freezes and reformed the tax system. These measures and strong economic growth in the mid- to late-1980s led to rising budget surpluses. However, as the economy tanked in the early 1990s, falling tax revenues and the need for expansionary fiscal policy again depressed government saving rates.

The *investment rate* also rose steadily, peaking in 1973. Since then, it has fallen slightly. Compared to household and government saving rates, the investment rate has remained comparatively stable. The main determinant of the Japanese investment rate has again been economic growth.<sup>5</sup> As GDP growth surged in the 1950s and 1960s, Japanese investment was able to grow to take advantage of newly available technologies. Since the early 1970s, the investment rate has dipped somewhat, but has remained at a high level. The surge in investment rates in the late 1980s is related to the cheap financing available to firms, due to rising stock and land prices. Although private investment has dipped in the 1990s, rising government investment owing to expansionary public works projects in the mid- to late 1990s has kept overall investment rates high.

Japanese *net exports* were in persistent deficit until the early 1970s, reflecting strong

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<sup>5</sup>Kiyotaki and West (1996) find that Japanese private plant and equipment investment between 1961 and 1994 can be well explained by the “flexible accelerator” model, with lagged output as the sole explanatory variable.

investment demand, but inadequate saving. However, by the mid-1980s, the surge in saving and decline in investment pushed Japanese net export surpluses (as a percentage of GDP) into record territory. Subsequently, as a result of strong domestic consumption in the late-1980s and strong government investment in the 1990s, the net export surpluses (as a percentage of GDP) declined.

### **III. Aging: The Impact on Consumption Per Capita, and Total Saving and Investment.**

The economic consequences of population aging depend on the nature of underlying demographic change as well as the relationship between the resource needs of individuals of different ages. This section presents our estimates of the economic burden of increased dependency, as well as the impact of population aging on total saving (investment) rates, assuming for now, that Japanese saving equals investment (closed economy).

#### *Changing Demographic Structure*

Figure 2 plots the Japanese government's projections of the Japanese total population and the percentage of the total population that is elderly.<sup>6</sup> The total Japanese population is expected to peak at close to 130 million in 2005, then gradually decline to about 100 million by about 2050. The percentage of the population over age 65 has grown rapidly, especially since 1980, and now stands at about 15 percent. By 2020, the percentage should approach 25 percent, and by 2050, 33 percent. By 2030, the percentage of the very old (age over 80) should exceed 10

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<sup>6</sup>The figures for 1955 to 1998 were calculated from data presented in the Prime Minister's Office (various years). The figures from 1999 to 2050 were calculated from the medium projections of the population by age group presented in Ministry of Health and Welfare (various years).

percent. These Japanese rates of population aging are much higher than in other countries. For example, in the U.S., only about 15 percent of the population will be above age 65 by 2025.

Declining fertility is the principal source of the changing demographic patterns.<sup>7</sup> In the years following World War II, the total fertility rate in Japan rose to about 4 by 1950. Fertility sharply declined during the 1970s and 1980s, from 2.1 per household in 1974 to 1.4 per household in 1997. The total fertility rate is projected to decline to about 1.2 over the next several decades. Moreover, Japan has allowed almost no immigrants, who, especially in English speaking countries, have helped keep the population young. These trends have important implications for the demographic structure of the population over the next half-century.

### *The Support Ratio*

Demographic shifts affect the economy's consumption opportunities because they change the relative sizes of the self-supporting and dependent populations. Following Cutler, Poterba, Sheiner, and Summers (1990), we summarize these changes by the *support ratio*, denoted by  $\alpha$ , which we define as the effective labor force, LF, divided by the effective number of consumers, CON,

$$\alpha = LF / CON.$$

The first issue in measuring the support ratio concerns the relative consumption needs of people at different ages. We assume that all people have identical resource needs so that:

$$CON = \sum_{i=1}^{99} N_i ,$$

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<sup>7</sup>The causes of this declining fertility is analyzed in Takayama (1998).

where  $N_i$  is the number of people of age  $i$ .

The second issue concerns the effective labor force. The first measure, LF1, assumes that all people aged 20-64 are in the labor force, while individuals 19 and under or 65 and over are not:

$$LF1 = \sum_{i=20}^{64} N_i .$$

This measure is used by the Japanese government in projecting the future labor force.

The second measure, LF2, recognizes that both human capital and labor force participation rates vary by age. We use data on the average 1990 earnings of people of each age (measured in five-year intervals) and sex ( $W_{ij}$ , where  $i$  is age, and  $j = M$ , male or  $F$ , female), along with data on age and sex specific labor force participation rates ( $PR_{ij}$ ):<sup>8</sup>

$$LF2 = \sum_{i=15}^{80} (W_{iM} * PR_{iM} * N_{iM} + W_{iW} * PR_{iW} * N_{iW}) .$$

This measure assumes that earnings accurately reflect a worker's human capital. If age-earnings profiles are hump-shaped, then labor productivity peaks in middle-age. Thus, this measure recognizes that the human capital of a society with a high fraction of people in middle age is higher than that of a society with many older workers, whose earnings and labor force participation rates decline.

The two support ratios using the two measures of the labor force are reported in Figure 3. The two support ratios have very similar patterns, especially after 1995. Using LF1, the support ratio declines from 1 in 1990 to 0.80 in 2050. Using LF2, the support ratio declines from 1 in

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<sup>8</sup>The data on earnings and labor force participation rates are from Ministry of Labor (various years).

1990 to 0.78 in 2050. Between 2005 and 2030, the second support ratio declines more than the first, owing to the fall in high earning, prime age males. Given the similarity in the two support ratios, for the remainder of this paper, we focus on the first support ratio (LF1).

### *Shifting Dependency Burdens and Consumption per Capita.*

This section explores how the demographic shifts described above affect the economy's level of capital accumulation and sustainable level of consumption. Here for simplicity, we assume that the Japanese economy is closed so that total saving equals investment, and that the economy is continuously in the steady-state. Alternatively, households are "naive" and simply consume a fraction of their current income. In Section IV, we relax these assumptions, and allow for international lending, and time for transitioning between one steady state and another.

Demographic change has two offsetting effects on consumption opportunities. An increase in dependency, or fall in  $\alpha$  lowers output per person. When dependency increases, the number of workers falls more rapidly than the total population. Thus, each person is left with less output. Offsetting this effect, however, is that investment requirements are reduced by the slower labor force growth, thus allowing more output for consumption. As the number of workers fall, the need to equip workers with capital equipment declines, reducing investment requirements. With this reduction in investment requirements, more output can be diverted to consumption.

We assume that the economy is always in the steady-state, closed, and that there is no technical change. That is, we assume that when the support ratios and the labor force growth rates change, the economy transitions immediately from one steady-state to another. The familiar equation of consumption equals output minus investment (see Barro and Sali-i-Martin, 1995) for

consumption per capita is then:

$$c = \alpha[f(k) - nk - \delta k],$$

where  $\delta$  is the constant depreciation rate, assumed to be 0.13.<sup>9</sup>

Re-writing the expression to find the change in steady-state consumption for changes in  $\alpha$  and  $n$ :

$$\Delta c / c = \Delta \alpha / \alpha - \alpha(k / c) \Delta n$$

with  $c$ ,  $k$ , and  $\alpha$  evaluated at the initial steady-state (actual values in 1998). This equation captures the two offsetting effects of demographic change. A decline the support ratio reduces the level of per capita consumption that is feasible given the economy's output. More specifically, in the steady-state, capital per labor and output per labor are constant. When the support ratio declines, the labor-population ratio declines, lowering the output per population ratio, which determines what consumption per capita level is feasible.

At the same time, however, a decline in the *growth rate* of the labor force ( $\Delta n < 0$ ) permits more consumption for a given capital-output ratio. Maintaining constant capital intensity requires investment of  $k(n + \delta)$ . When  $n$  falls, less investment is necessary to equip workers with capital, allowing more output to be diverted to consumption. To quote Cutler, et. al. (1990), "society receives a 'consumption dividend' when it is able to invest less and still maintain a given level of per capita output."

The size of these two offsetting effects are reported in Table 2, using the government's definition of the effective labor force, LF1. For every five year period 2000 to 2040, we show the

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<sup>9</sup>Hayashi (1986) has shown that depreciation in Japan is much higher than in other countries, and that the depreciation rate could be as high as 13 percent.

steady-state consumption per capita change associated with changes in  $n$  (column a), changes in  $\alpha$  (column b), and the combined effect (column b-a). The results are presented in annualized terms; a 1 percent decline is a decline of 1 percent per year.

The combined effect, or the total change in per capita consumption, fluctuates widely. Per capita consumption is estimated to grow from 2000 to 2010, decline sharply from 2010 to 2020, modestly increase from 2020 to 2035, then decline sharply again. From 2035, per capita consumption will be declining at about 1 ½ percent per year. The first effect, that of dependency, always exerts a negative influence, especially strongly between 2010 and 2020, and after 2035. A rise in dependency lowers output, leaving less output to be consumed by each person.

The second effect, that of the consumption dividend, is both negative and positive, depending on the year. The consumption dividend effect is determined by the *deceleration* of the labor force. Although the labor force is continuously declining between 2000 and 2040, the rate of decline alternates between positive and negative. It is the rate of decline that influences the sign and magnitude of the consumption dividend. Between 2000 and 2010, the decline in the labor force growth rate is especially large, lowering investment requirements, and allowing more output for consumption. Between 2010 and 2020, however, the labor force growth rate increases ( $\Delta n > 0$ ), raising investment requirements and contributing to the sharp decline in per capita consumption. Between 2020 and 2035, the labor force growth rate declines again, helping to raise per capita consumption. Finally, from 2035, both the consumption dividend and dependency effects contribute to the decline in per capita consumption.

*Shifting Support Ratios and the Investment (Saving) Rate.*

Given our steady-state and closed-economy assumptions, it can be shown that the gross investment (saving) rate is:

$$I/Y = (n + \delta)K/Y .$$

The equation says that the investment rate must be sufficient to keep the capital-output ratio constant. Output grows at the rate,  $n + \delta$ ; thus the capital stock must also increase by  $n + \delta$ . This increase can be ensured by an investment rate of  $(n + \delta)K/Y$ .

Under the government's demographic projections (LF1), changes in  $n$  are not expected to substantially alter the annual investment rates (Table 2, last column). This is because changes in  $n$  (at 1 percent to 2 percent) are small relative to  $I/Y$  (at around 30 percent). Over the next 10 years, investment rates will fall by about 2 percentage points, as the growth in the labor force declines ( $\Delta n < 0$ ). With lower labor force growth, less investment is required to maintain a given capital-output ratio.

In this Section, we showed that the demographic shifts underway in Japan will lead to significant shifts in per capita consumption growth rates. Per capita consumption will rise moderately until 2010, then fall sharply between 2010 and 2020. From 2035, per capita consumption will again fall sharply.

#### **IV. Demographic Change and the Optimal Saving-Investment Balance.**

The results presented so far suggest that projected changes in demographics--changes in the labor force and in dependency--will in the long-run (post-2035) lower per capita consumption levels. However, we made several unrealistic assumptions in achieving these results-- that the economy is always in steady-state, and that total saving always equals total investment (closed

economy). Here, we allow the economy time to transition between steady-states when demographic conditions change, and allow the economy to lend to and borrow from the rest of the world. We adopt the neoclassical framework and assume that consumers maximize (lifetime) utility, and firms maximize firm value. Unlike in the model of the previous section, in this model, households base their consumption on both current and future income. Thus, consumption can be detached from current income; households adjust their saving to keep consumption growth constant into the future.

Specifically, in our simulations, we adopt the standard small country, open capital markets Ramsey optimal growth model (Barro and Sali-i-Martin, 1995, chapter 3). With the model, we can examine how a society should adjust its optimal saving and investment rate policies in response to changes in demographic variables. We simulate the model using plausible parameter values and the projected future paths of the support ratio and the growth in the labor force. Given our perfect international capital mobility and small country assumptions, the determination of optimal saving and investment rates can be analyzed separately.

### *Optimal Investment Rates.*

We assume that firms maximize the present discounted value of profits:

$$V = \int_0^{\infty} e^{-r\tau} [Y_t - w_t \hat{L}_t - \text{adc}_t] d\tau, \quad (1)$$

where  $Y_t$  is gross output,  $r$  is the world real rate of interest,  $w_t$  is wages,  $\hat{L}_t$  is the effective labor force, and  $\text{adc}_t$  are adjustment costs to changing the capital stock, such as retooling and

downtime.

Effective labor and capital grow according to:

$$\hat{L}_t = L_0 e^{(n_t + g)t} \quad (2)$$

$$\frac{dK_t}{dt} = I_t - \delta K_t \quad (3)$$

where  $n_t$  is the rate of labor supply growth,  $g$  is the constant rate of labor augmenting technical progress,  $I_t$  is the gross investment rate, and  $\delta$  is the constant depreciation rate.

We maximize (1), given the constraints (2) and (3), and simulate the model, using plausible parameter values. For  $g$  and  $r$ , we take 0.012 and 0.06 (from Jorgenson and Nishimizu, 1979), and for  $\delta$ , 0.13. Labor augmenting technical progress of 1.2 percent implies a growth rate of total factor productivity of 2 percent. For the path of  $n_t$ , we use values from the government's labor force projections (LF1). Details of the simulation are given in Appendix 1.

Table 3 depicts the projected investment rates from 2000 to 2040; the values for the investment rates are normalized so that the investment rate for 2000 is equal to the actual value of 29 percent (in 1998). From the Table, we can see that the total investment rate remains close to its current level. The investment rate rises slightly from 2000 until 2025, but always remains close to the 2000 rate of 29 percent. The investment rate is not sensitive to changes in  $n$ , although it is quite sensitive to changes in  $r$  (which is assumed constant). A fall in  $n$  lowers both output and the capital needed to equip workers, leaving the capital-labor ratio steady. With a steady

capital-labor ratio, the investment rate is also steady (see Section III).

### *Optimal Saving Rates.*

The saving rate is determined from “forward-looking” household behavior. Assume that households wish to maximize their lifetime utility,  $U$ , given by:

$$U = \int_0^{\infty} \frac{c^{1-\theta}}{(1-\theta)} e^{zt} e^{-\rho t} dt, \quad (4)$$

where  $c$  is consumption per capita,  $z$  is the rate of growth in population,  $1/\theta$ , is the intertemporal elasticity of substitution, and  $\rho$  is the pure rate of time preference. This formulation of household preferences assumes that households are dynastic—they care about their children’s, and grandchildren’s welfare (utility) as much as their own.<sup>10</sup>

The budget constraint for households (in per capita terms) is:

$$\dot{a}_t = \alpha_t w_t + r a_t - c_t - z_t a_t, \quad (5)$$

where  $a_t$  is total assets per person or capita. This budget constraint says that growth in assets (per person) is higher, the higher the wages,  $w_t$ , the support ratio,  $\alpha_t$ , and the interest rate,  $r$ . The growth in assets per person is lower, the higher the consumption, and the population growth rate,

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<sup>10</sup>There is a large literature testing whether the dynastic model is applicable for Japan (for a review, see Horioka, 1993). The dynastic model can be contrasted with the life-cycle model, in which households do not care about their children. Thus, in the life-cycle model households bring down their wealth (dissave) in old age. On the whole, the empirical tests support the dynastic model, and reject the life cycle model. The Japanese elderly, on average, leave large bequests to their children, and this bequest giving appears to be motivated by altruism towards the next generation.

$z_t$ . Note that  $\frac{\dot{\alpha}_t}{\alpha_t} = n_t - z_t$ ; that is, the change in the support ratio is equal to the labor force growth

rate minus the population growth rate.

From (4) and (5), we explicitly simulate the growth and level of per capita consumption and the saving rate, using plausible values for the parameters  $\theta$  and  $\rho$  and the government's demographic projections (LF1) for  $n_t$  and  $z_t$  (and thus,  $\alpha_t$ ). Details are given in Appendix 2.

Table 3 depicts the projected optimal saving rates from 2000 to 2040. The optimal saving rate declines a few percent to 24 percent until 2025. The saving rate stabilizes at about that level until 2035, when it resumes its decline. This pattern is a result of shifts in the support ratio. As shown in Appendix 2, optimal consumption per capita always grows at a constant rate of  $g$  (=1.2 percent), but output per capita growth is affected by shifts in the support ratio (as in Section III). As the support ratio *declines* between 2000 and 2025, output per capita falls, the consumption-output ratio rises, and the saving rate falls.

In this section, we showed that consumption per capita will grow steadily at 1.2 percent every year. In the previous section, we showed that consumption per capita growth will fluctuate. Households consume a fraction of their current income, and when their current income fluctuates, their consumption fluctuates. Here, given "forward-looking" households, consumption can be detached from current income. Thus, households prefer to smooth their consumption, and therefore adjust their saving rates to keep the consumption growth rate constant. Thus, when output per capita rises, the saving rate will rise, as households save some of the output for consumption in future periods. In the model of the previous section, households are, in effect,

prevented from adjusting their saving rates to smooth their consumption. Thus, consumption per capita tends to move in the same direction as output per capita.

The results of this section suggest that future demographic trends will affect the optimal saving rate much more than the optimal investment rate. In an open-economy, investment rates are primarily determined by international real interest rates, which are set mainly outside of Japan, and not by domestic demographic variables. Thus, future Japanese net exports will be determined largely by movements in Japanese saving. The optimal saving response using the government's demographic projection is a gradual and continuous decline in the saving rate until 2040.

#### *Net Export Surpluses and Net Foreign Debt.*

From our simulated path of saving and investment rates, we can simulate the future path of the net export surplus, and net foreign debt.

The net export surplus-GDP ratio is equal to:

$$\frac{NX_t}{Y_t} = \frac{S_t}{Y_t} - \frac{I_t}{Y_t},$$

and the current account surplus (change in net foreign debt)-GDP ratio is equal to:

$$\frac{-\dot{D}_t}{Y_t} = \frac{NX_t}{Y_t} - \frac{r * D_t}{Y_t},$$

where  $D_t$  is net foreign debt, and  $-rD_t$  is net factor income received from abroad.

Table 3 depicts the trends in the net export surplus-GDP ratio. Corresponding to the decline in the saving rate, Japan's net export surpluses will continue to decline, and will turn

negative in 2015. By 2040, Japan's net export *deficits* will almost be 10 percent of GDP.

Table 3 also depicts the trends in the net foreign debt-GDP ratio, and the current account-GDP ratio. Japan's net foreign assets (= -net foreign debt) to GDP ratio will peak at 95 percent in 2025. That is, Japan should continue to be a large foreign asset holder for the foreseeable future. Although net exports become negative by 2015, the current account is positive until 2025, owing to interest income receipts on net foreign assets. However, as net export *deficits* continue to mount, the current account turns negative. Correspondingly, net foreign assets start to decline in 2025.

#### *Demographic Change and Economic Size.*

In the simulations of this section, we showed that despite the population aging, Japan's per capita consumption will continue to rise. Optimizing households will lower their saving, so that per capita consumption will grow at a constant 1.6 percent per year.

In addition to the level and growth in per capita consumption, countries may care about the *absolute size in GDP*. A large country like the United States and Germany enjoys greater international power and prestige than a small country, rich in per capita terms like Sweden or Singapore. Because of Japan's slowing labor force growth, Japan's GDP level and economic size will in the future grow more slowly.

Table 3 shows Japan's economic size, assuming the government's labor force projections and annual total factor productivity growth of 2 percent (corresponding to labor-augmenting technical progress,  $g=1.2$  percent). Between 2000 and 2020, Japan's total GDP will grow at an average rate of 1.2 percent per year. All of this growth is propelled by the growth in total factor

productivity of 2 percent. The decline in the labor force subtracts 0.8 percent a year from total GDP growth.

#### *Demographic Change and Fiscal Policy.*

Earlier in this section, we showed that “forward-looking” households will gradually lower their saving rates. So far, we have been silent about the split between government and private saving. The model above assumes ‘Ricardian Equivalence,’ that households pierce the ‘government veil.’ That is, when government deficits rise, private saving will increase to offset the deficits, to keep total saving rates along the optimal path.

Slower GDP growth and population aging are expected to significantly worsen Japanese government fiscal positions over the next 25 years. Tax revenues will fall and public pension benefits will rise (Takayama, 1998). Masson and Tryon (1990) find that between 2000 and 2025, the budget deficit will deteriorate by -2.5 percentage points, owing to increasing pension burdens. Takayama (1998) projects similarly large budget deficits. The Japan Center for Economic Research (2000) estimates that the government saving-GDP ratio will decline from 2 percent in 1998 to -2.4 percent of GDP by 2025. These high rates of government *dissaving* over the next few decades imply that if households want to smooth their consumption into the indefinite future, they will have to keep private saving rates high, perhaps close to today’s level of 29 percent.

#### *Comparison with Earlier Projections of the Japanese Saving-Investment Balance.*

Unlike this paper, most earlier projections of the Japanese saving-investment balance are not based explicitly on “forward-looking” behavior by firms and households. Horioka (1991,

1992) using reduced-form time-series econometrics, estimates that Japanese private saving will become -15 percent by 2020. Noguchi (1989) finds that the aging will cause the ratio of investment to GDP to decline until 2015, and increase thereafter. The primary reason for the decline is the fall in the working-age population and the resultant decline in the labor force. Noguchi's results further indicate that between 2000 and 2015, the decline in the saving rate will exceed that in the investment rate. Thus, his results imply that Japan's net export surplus will widen between 2000 and 2015, but it will narrow after 2015, despite the fact that the saving rate will continue its decline.

Auerbach et. al.'s (1989) model is noteworthy in that it is based on an explicit utility maximization framework, although details of their model differ from those of the model adopted here. They find that Japan's net exports will narrow until 2030, becoming negative in 2030, and widen anew after 2030, eventually reaching its long-run level of 2.3 percent of GDP.

With regards to more recent projections, the International Monetary Fund (IMF) (2000) estimates that in 2005, the Japanese total saving rate will be 29.5 percent, with the private and public saving rates at 24.2 percent and 5.4 percent, respectively. The IMF estimates that in 2005, private investment will be 26.3 percent. The Japan Center for Economic Research (JCER) (2000) estimates that in 2005, private and public saving will be 8.3 percent and -2.0 percent, respectively. The JCER estimates that in 2025, private and public saving will be 3.7 percent and -2.4 percent. Finally, the JCER estimates that between 2015 and 2025, there will be *no* growth in real per capita consumption. Both the IMF and JCER projections are based on traditional large scale macro econometric models.

Thus, although the details of the earlier projections differ, they all appear to project

declining future saving rates, stable investment rates, and growing current account deficits. The earlier research also projects no growth in per capita consumption, especially after 2015.

## V. Conclusion.

The rapid aging of the population currently underway in Japan—Japan’s demographic destiny—should lead to narrowing current account surpluses over the next 25 years. The current account will turn to deficit in 2025, and the deficit will continue to widen between 2025 and 2040. Although investment rates will remain close to current rates of 29 percent, saving rates will decline from today’s 31 percent to 24 percent in 2025, and 20 percent in 2040.

We project that despite the population aging, per capita consumption will grow until 2010. What happens after 2010 depends on the assumptions behind the projections. If we assume that households consume based only on their current income, then after 2010, consumption per capita falls in most years. If we assume that households are “forward looking,” consumption and current income can be detached. Households can keep their consumption growth positive and constant indefinitely into the future by lowering their saving rates.

Admittedly, the assumptions underlying our projections are somewhat stylized and special. For example, in our open economy model, we assumed that real interest rates are determined internationally, and are exogenous to Japan. However, since Japan is a large capital exporter, if Japanese saving, say, increases, international real interest rates may fall, resulting in endogenous real interest rates. Endogenous international real interest rates generally imply that saving and investment rates move closer together, which may imply an upper limit to future Japanese current account deficits.

Appendix 1: Simulation of the Optimal Investment Rate.

The investment rate is determined from firm behavior. Assume that Japanese firms produce using a production function of:

$$Y_t = K_t^\gamma \hat{L}_t^{1-\gamma}$$

where  $\gamma$  is the capital share. Capital and effective labor grow according to:

$$\hat{L}_t = L_0 e^{(n_t+g)t} \quad (A1)$$

$$\frac{dK_t}{dt} = \dot{K}_t = I_t - \delta K_t \quad (A2)$$

where  $n_t$  is the rate of labor supply growth, which in our framework changes over time,  $g$  is the constant rate of labor augmenting technical progress,  $I_t$  is the gross investment rate, and  $\delta$  is the constant depreciation rate.

In addition, it is assumed that firms face adjustments costs to changing their capital stock such as retooling and downtime:

$$\text{adj cost} = I * [1 + b / 2 * I / K].$$

We assume that firms maximize the present discounted value of profits:

$$V = \int_0^{\infty} e^{-rt} [K_t^\gamma \hat{L}_t^{1-\gamma} - w_t \hat{L}_t - I_t * (1 + b / 2 * I_t / K_t)] dt$$

subject to equation (A2), where  $r$  is the international real rate of interest:

The optimal paths of the capital stock per effective labor and the shadow value of capital

(Tobin's  $q$ ) are:

$$\frac{d\hat{k}}{dt} = \hat{i} - (g + n + \delta) * \hat{k} = [(q - 1) / b - (g + n + \delta)] * \hat{k} \quad (A3)$$

$$\frac{dq}{dt} = (r + \delta) * q - [\gamma \hat{k}^{\gamma-1} + \frac{(q-1)^2}{2b}] \quad (A4)$$

Equations (A3) and (A4) imply steady-state values of  $\hat{k}$  and  $q$  of:

$$\gamma \hat{k}^{\gamma-1} = r + \delta + b * (g + n + \delta) * [r + \delta - (1/2) * (g + n + \delta)] \quad (A5)$$

$$q = 1 + b * (g + n + \delta) \quad (A6)$$

We discretize differential equations (A3) and (A4), to find the levels of steady-state capital per effective labor and  $q$  in an earlier year that will lead the economy to the terminal steady-levels of  $\hat{k}$  and  $q$  in 2050 (given by (A5) and (A6)). For the parameters used in the simulations, we take values culled from the literature. For  $\gamma$ ,  $g$ ,  $\sigma$ ,  $r$ ,  $a$ , and  $b$  we use 0.40, 0.012, 0.13, 0.06, 0.35, and 6. The values are fairly standard, except for the high value of the depreciation rate,  $\sigma$  (Hayashi, 1986).

Our simulation strategy is to start from 2050 and simulate backwards using the value of the labor force growth rate,  $n_t$ , for that year all the way back to 2000. The data for  $n_t$  are available only every five years. We assume that  $n_t$  changes discretely only every five years;

within any five year interval, say 2005 to 2010,  $n_t$  is constant. As it turned out, given our parameter values, new steady-states were reached in about 5 years for all  $n_t$ . For example, between 2050 and 2045,  $n_t$  is projected by the government to be -0.013 per year. With this  $n_t$ , and the steady-state values of  $\hat{k}$  and  $q$  from (A5) and (A6), and the equations of motion (A3) and (A4), steady-states of  $\hat{k}_{2045}$  and  $q_{2045}$  were reached in about 5 years. Now with these  $\hat{k}_{2045}$  and  $q_{2045}$  as starting values, with  $n_t$  again projected to be -0.013 between 2045 and 2040, steady-states of  $\hat{k}_{2040}$  and  $q_{2040}$  were achieved in 2040, and so on. This process was repeated every five years until 2000.

Finally, from the paths of  $\hat{k}_t$  and  $q$ , we can calculate investment per effective labor (from (A3)), and output per effective labor (from the production function), and thereby calculate the investment rate (investment/output).

Appendix 2: Simulation of the Optimal Saving Rate.

From (4) and (5) in the text, it can be shown that the growth in per capita consumption is constant and equal to:

$$\frac{\dot{c}}{c} = \frac{1}{\theta} * (r - \rho)$$

and that consumption per capita at time 0 (in our case, the year 2000), depends in a complicated way on the parameters of the consumption problem, and the entire future paths of  $n_t$ ,  $\alpha_t$ , and  $w_t$ :

$$c(0) = f(r, \rho, \theta, n_t, \alpha_t, w_t),$$

for  $t=1 \dots \infty$ .

For convenience, rather than simulating the path of consumption per capita, we actually simulate the path of consumption per effective labor,  $\hat{c}_t$ . In addition, to prevent consumption per effective labor from approaching zero asymptotically, we assume that  $r = \rho + \theta g$ . In this case, it can be shown from (4) and (5) in the text that along the optimal path,  $\frac{d\hat{c}_t}{\hat{c}_t} = \frac{-\dot{\alpha}_t}{\alpha_t}$ . Thus,

consumption per effective labor falls when the support ratio rises.

For parameter values, we assume that  $\theta = 3$ , and  $\rho = 0.024$ , and that the projected demographic values for 2050 persist as the economy's final steady-state. Finally, using our consumption per effective labor and output per effective labor (from Appendix 1) projections, we simulate the future path of the optimal saving rate. We assume that the projection paths of  $n_t$  and

$z_t$  have already been anticipated by households in the year 2000 (1998, in the actual data). Thus, the simulated values for optimal consumption and saving in 2000 are the actual values.

In the Table, the saving rate moves in the same direction as the support ratio. The intuition is the following. With the assumption  $r = \rho + \theta g$ , we can show that from 2000, consumption per capita growth will be constant at  $g$ . Since consumption per capita growth is constant, fluctuations in the optimal saving *rates* must be driven by fluctuations in output per capita. A fall in the support ratio lowers output per capita, raises the consumption-output ratio, and lowers the saving rate. In turn, a rise in the support ratio raises the saving rate by the same mechanism. Thus, the optimal saving rate moves in the same direction as the support ratio.

Figure 1

### Saving, Investment, and Growth Rates

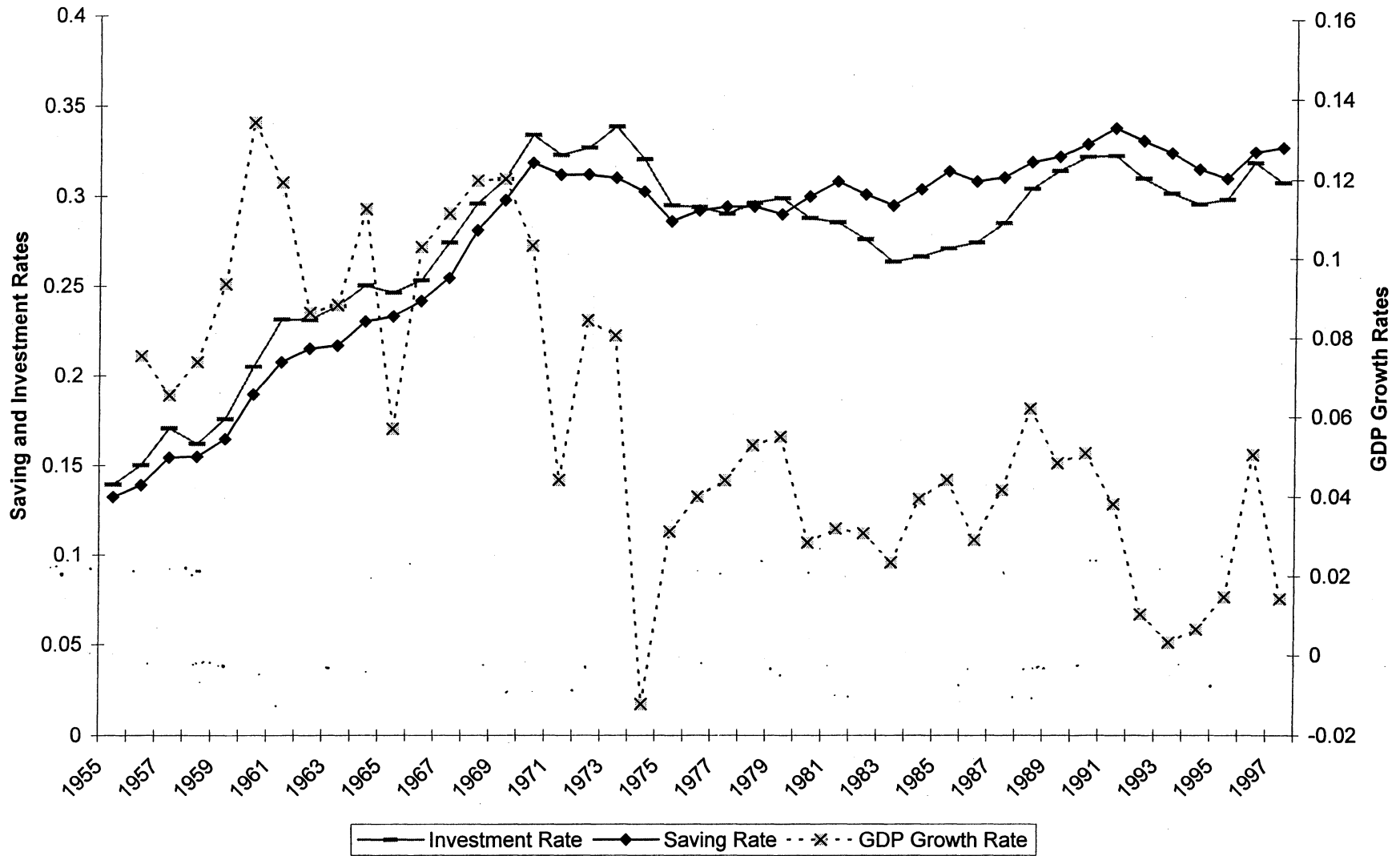


Figure 2

### Population and Elderly Projections

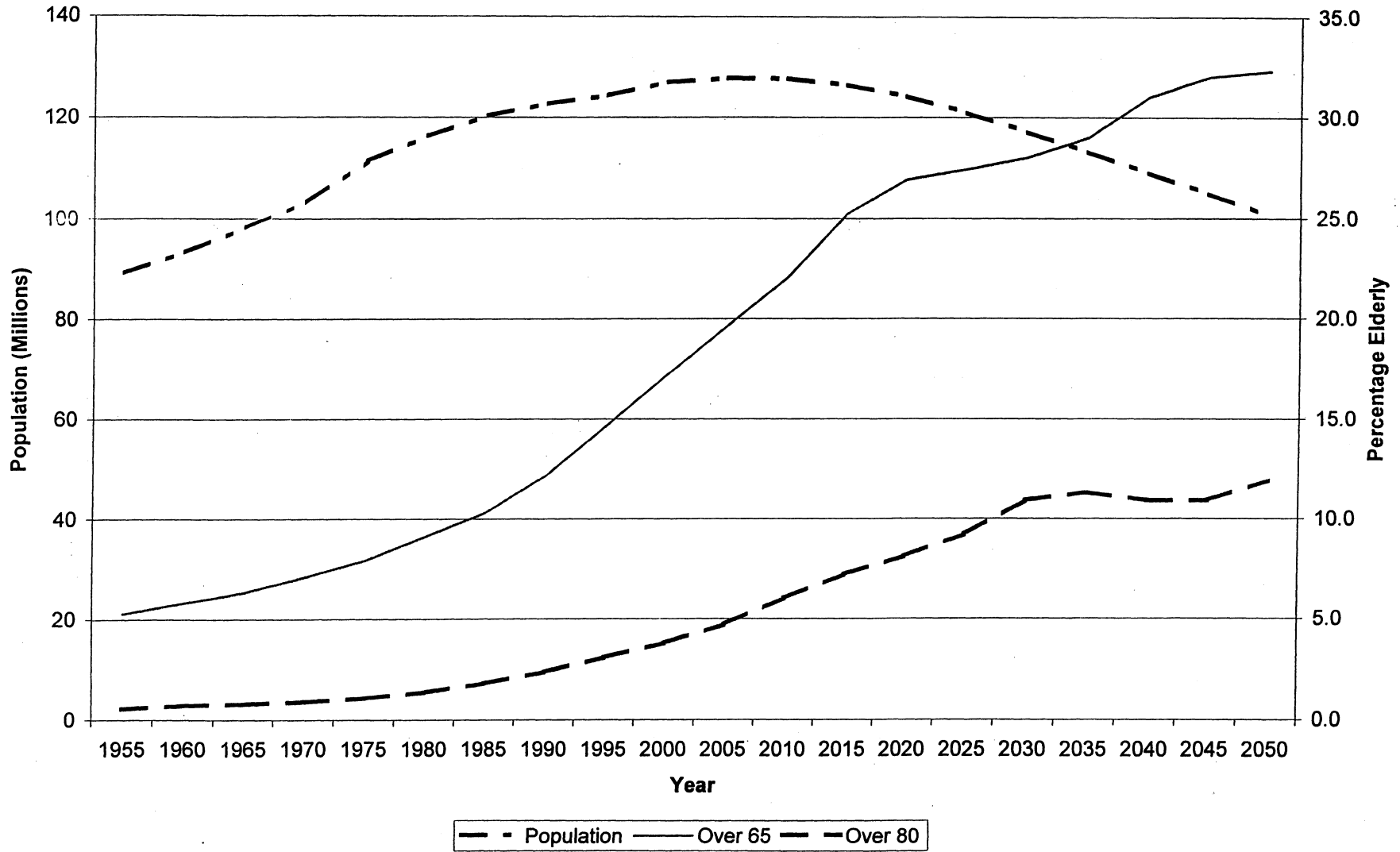


Figure 3

### Support Ratios

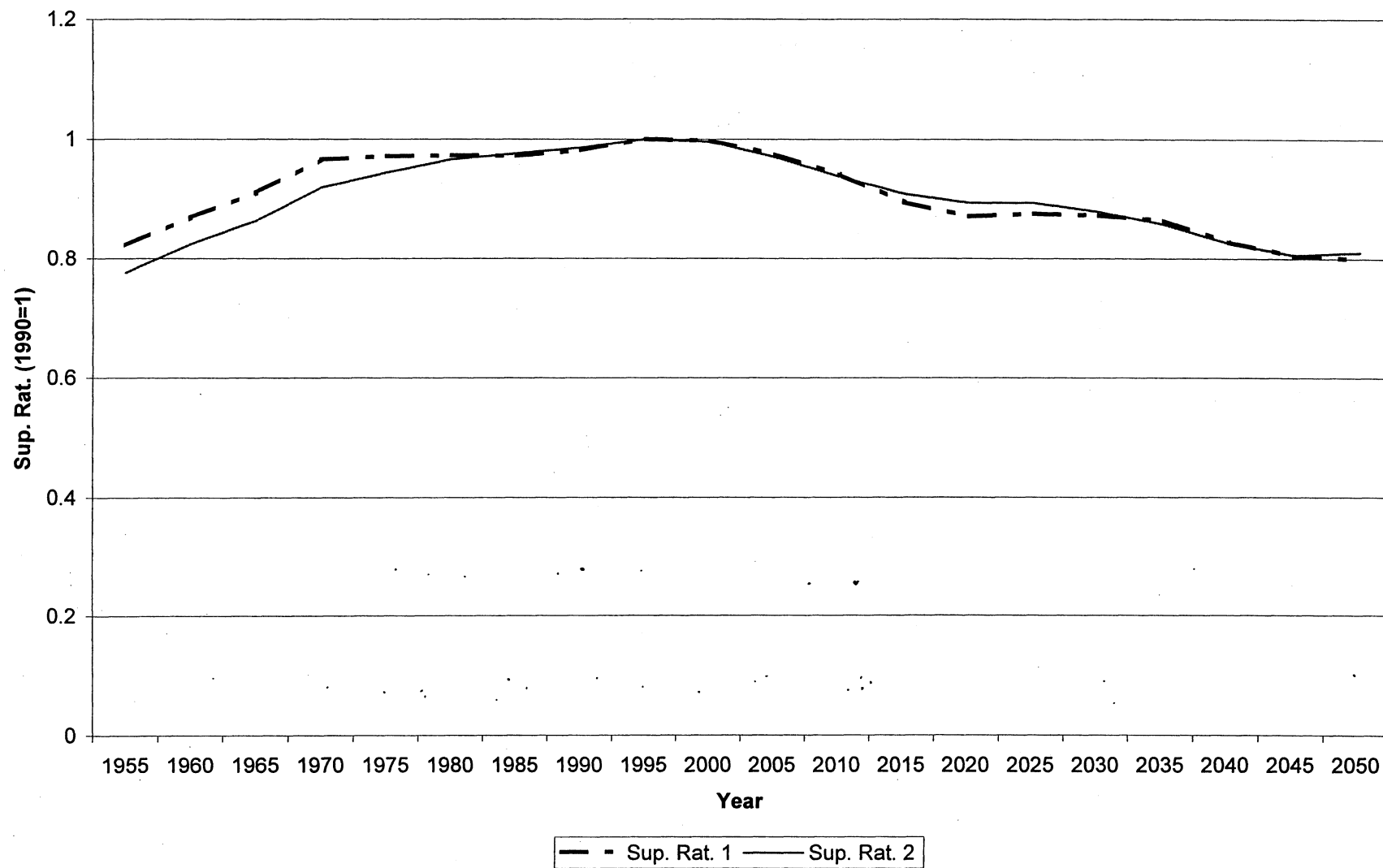


Table 1

## Japanese Private and Government Saving, Investment, and Net Exports

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	Private Saving/ GDP	Government Saving/ GDP	Investment/ GDP	Net Export Surplus/ GDP
<i>Averages</i>				
1955-1973	0.13	0.10	0.25	-0.02
1974-1979	0.26	0.03	0.30	-0.01
1980-1990	0.26	0.05	0.29	0.02
1990-1998	0.28	0.05	0.31	0.02

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1/ Investment includes private plant and equipment, government, and inventory investment.

Source: Economic Planning Agency, Annual Report on the National Accounts, 1999 Edition.

Table 2

**Shift in Per Capita Consumption from  
Demographic Shocks**  
(Annualized Percentage Changes)

Government Demographic Projection (Support Ratio 1)

	<i>Labor Force Growth 1/</i>	<i>Effect of Change in Labor Force Growth 1/ (a)</i>	<i>Effect of Dependency 1/ (b)</i>	<i>Total Change in Per Capita Consumption 1/ (b)-(a)</i>	<i>Implied Investment Rate (Saving Rate) 2/</i>
2000	-0.33%	-1.05%	-0.46%	0.59%	31.2%
2005	-0.73%	-1.24%	-0.71%	0.53%	30.3%
2010	-1.20%	0.81%	-1.01%	-1.82%	29.2%
2015	-0.89%	1.26%	-0.53%	-1.79%	31.0%
2020	-0.42%	-0.76%	0.10%	0.86%	30.3%
2025	-0.71%	-0.49%	-0.07%	0.42%	29.9%
2030	-0.89%	-1.84%	-0.20%	1.64%	28.3%
2035	-1.59%	0.73%	-0.84%	-1.57%	28.9%
2040	-1.31%	0.91%	-0.54%	-1.45%	29.7%

Notes: 1/ Annualized percentage change from the previous five year period.

2/ Level of investment rate.

Table 3

Projections of Investment and Saving Rates, Net Export, and  
Debt/GDP Ratios

	Support Ratio Level 1/ $\alpha$	Investment Rate 2/ I/Y	Saving Rate 2/ S/Y	Net Export/ GDP 2/ NX/Y	Current Account/ GDP 2/ NX/Y-rD/Y	External Debt/ GDP 2/ -D/Y	Real GDP Level 3/
2000	0.62	29%	31%	2%	4%	25%	492
2005	0.61	29%	31%	2%	5%	46%	535
2010	0.59	29%	29%	0%	4%	68%	570
2015	0.56	28%	26%	-2%	2%	84%	593
2020	0.54	30%	25%	-5%	1%	93%	627
2025	0.55	31%	24%	-7%	-1%	94%	679
2030	0.54	31%	25%	-6%	-1%	91%	724
2035	0.54	31%	23%	-8%	-2%	83%	765
2040	0.52	29%	20%	-9%	-5%	67%	785

Notes: 1/ From government labor force projections (LF1). Annualized percentage change from the previous five year period.

2/ Levels of the investment and saving rates, net export, and external debt/GDP ratios.

3/ In trillions of 1990 yen.

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