Demographic Dividends: The Past, the Present, and the Future

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## Introduction

Every country in the world has experienced and will continue to experience substantial changes in their age structures. These can be traced, first, to fertility decline that reduced the numbers of children in populations and later the number of workers, and, second, to improvements in life expectancy that will eventually produce populations with many more people concentrated at the older ages. The macro economic implications of these changes have been the subject of considerable interest in the last few years.

Analysis of the effects of age structure comes in three forms. First, a series of empirical studies based on aggregate level panel data conclude that demographic factors have a strong, statistically significant effect on aggregate saving rates (Bloom *et al.*, 2003; Deaton and Paxson, 2000; 1996; Kinugasa, 2004; Williamson and Higgins, 2001) and on economic growth (Bloom and Canning, 2001; Bloom and Williamson, 1998; Kelley and Schmidt, 1995). In contrast, earlier studies based on shorter time series found little statistical support for strong demographic effects (Kelley, 1988). Second, detailed case studies of the East Asian miracle provide compelling and consistent evidence that the demographic dividend was an important contributor to that region's economic success (Bloom and Williamson, 1998; Mason, 2001b; Mason *et al.*, 1999). Bloom and Williamson (1998) use econometric analysis to conclude that about one-third of East Asia's increase in per capita income was due to the demographic dividend. Mason (2001a) uses growth accounting methods to estimate that the dividend accounted for about one-fourth of the region's economic growth.

The third approach – the one employed here – relies on macroeconomic simulations to explore the effects of changing age structure (Cutler *et al.*, 1990; Lee *et al.*, 2003; Lee *et al.*, 2001; Mason, 2005). This paper extends two earlier papers. The first formally establishes the potential for two demographic dividends (Mason and Lee, forthcoming). The first dividend arises because over the demographic transition countries experience an increase in the share of their populations concentrated in the working ages. On its face, this has a direct, favorable effect on per capita income. Whether or not the first dividend is realized, however, will depend on how wages, labor force participation rates, and unemployment are affected by the rapid growth in the working age population that typically leads to the first dividend.

The second dividend arises as a response to the prospect of population aging. A key economic challenge for aging populations is to provide for old-age consumption in the face of substantially reduced labor income. Some societies are trying to meet this challenge by relying on transfer systems – either public programs or familial support systems. Other societies are responding by increasing their saving rates and accumulating greater physical wealth or capital. It is in this latter response that prospects for capital accumulation and more rapid economic growth are enhanced.[1]

The second paper employs the two dividend framework to construct measures of the demographic dividends for the countries of the world for the period 1950 to 2000 (Mason, 2005). The analysis supports several conclusions. First, the demographic

[1] Changes in age structure may have additional important effects (Bloom *et al*., 2002). Recent studies suggest that demographic change may have favorable human capital effects (Jensen and Ahlburg, 2001; Montgomery and Lloyd, 1996) although the effects on education are uncertain (Ahlburg and Jensen, 2001; Kelley, 1996)

dividends are potentially quite important – contributing as much as one to two percentage points of growth of per capita income between 1970 and 2000 in the Industrial countries, East and Southeast Asia, Latin America, the Middle East and North Africa, and the Pacific Islands. Second, the greatest gains were in the developing world, although this reflects their relatively unfavorable demographic situation in 1970. Third, in some parts of the world favorable changes in demographic conditions have not yet begun – Sub-Saharan Africa is the notable example. Fourth, the record of translating favorable demographic conditions into more rapid economic growth is very mixed. It appears that East and Southeast Asia were very successful in this effort, while Latin America was not.

The purpose of the analysis presented in this paper is to examine the effects of demographic change over a longer time horizon. We focus on the experience of three countries – India, Japan, and the United States. They have been selected, in part, because of their distinctive demographic experiences. The demographic transition began earliest in the US, later in Japan, and later still in India. The US experienced a very substantial baby boom from 1946 to 1964. Japan experienced high fertility for a short period following the end of World War II, but nothing on the order of the US baby boom.

Second, the countries have been selected because data availability allows us to explore the economic affects of changes in age structure over an extended period of time – beginning in 1850 in the US, 1880 in India, and 1900 in Japan.

Third, the future of these countries is of considerable interest both because of their size in the world economy but also because of their demographics. India will soon be the largest country in the world. Japan is now the oldest country in the world, while the US is relatively young for an industrial country. Using long-term population projections we are able to explore the potential effects of demographic change well into the future.

Fourth and most importantly we can use the diverse experiences of these countries to judge whether or not changes in age structure have played an important role in their development experiences.

### *Two Demographic Dividends*

The first demographic dividend arises and dissipates as changes in age structure interact with the lifecycle of production and consumption. Children and the elderly produce much less than they consume, whereas working-age age adults, on average, produce much more than they consume. Populations with heavy concentrations at the working ages are advantaged at producing high levels of per capita income. Child and old-age dependency ratios are often used to capture the key features of the economic lifecycle, but more detailed and precise estimates are becoming available. Estimated age profiles of production and consumption for the US in 2000 are shown in the upper panel of Figure 1. The values are broadly consistent with general characterizations of the economic lifecycle, but certain features of the US profiles are striking. First, the ages of dependency are not very close to those often used to delineate the dependent ages (under 15 and 65 and older). In 2000, US residents under the age of 26 and over the age of 57 were dependents in the sense that they consumed more than they produced through their labor. Estimates for Taiwan are similar – residents under the age of 25 and over the age of 56 consumed more than they produced in 1998. In Indonesia, the crossing points for consumption and production are 20 and 60 (Lee *et al.*, 2005). Second, the estimates in

Figure 1 imply a gradation of dependency. Those who are 25 and those who are 60 are dependents, but to a much smaller degree than those who are 18 and those who are 75.

The manner in which the economic lifecycle interacts with the age distribution is apparent from the three extreme age distributions in the lower panel of Figure 1. The youngest age distribution is for the United States in 1850. Over half of its population was under the age of 20 and only 43% were of "working age" – 20-59. In contrast, the India distribution projected for 2040 has an unusually high concentration of the population in the working ages – 56% are between the ages of 20 and 60. The projection for Japan in 2070 represents a third extreme. In this population only 40% are in the 20 to 59 age group, while over 40% are 60 and older. The Japanese age structure is even more unfavorable for current production than the US age distribution, but because Japan's 2070 population is old while the US 1850 population is so young.

Figure 1a Consumption and Labor Income by Age, US 2000
Figure 1b. Age Distributions, Three Extremes

Taking these three cases together illustrates the changes in age structure over the demographic transition, perhaps in extreme form, and the implication for the first demographic dividend. The transition from the US to the Indian distribution is marked by a substantial relative increase in the working-age population and, assuming that workers can be fully employed, an increase in per capita income. The transition from the Indian to the Japanese age distribution would undo the gains from the first part of the age transition. During this part of the age transition, changes in age structure represent a drag on growth in per capita income.

The second dividend arises to the extent that consumers and policymakers are forward-looking and respond effectively to the demographic changes that are coming. With a rise of the elderly dependent population on the horizon, consumption in the future can be maintained only through the accumulation of wealth in some form. One possibility is that individuals and/or firms and governments acting on the behalf of consumers accumulate capital. If invested in the domestic economy, the result will be capital deepening and more rapid growth in output per worker. If invested abroad, the result will be an increase in the current account and national income. In either case, per capita income will grow more rapidly.

The first and second dividend are formalized in Mason and Lee (forthcoming) drawing on earlier work by Cutler et al. (1990). Define the effective number of consumer (N) and the effective number of producers (L) as:

$$\begin{aligned} N(t) &= \sum_a a(a)P(a,t) \\ L(t) &= \sum_a g(a)P(a,t) \end{aligned} \tag{1}$$

where $P(a,t)$ is the population. Output per effective consumer ($Y/N$), is given by:

$$\frac{Y(t)}{N(t)} = \frac{L(t)}{N(t)} \times \frac{Y(t)}{L(t)}, \tag{2}$$

Equation (2) is readily converted from levels to rates of growth by taking the natural log of both sides and the derivate with respect to time:

$$\dot{y}(t) = \dot{L}(t) - \dot{N}(t) + \dot{y}^l(t). \tag{3}$$

The rate of growth in output per effective consumer ( $\dot{y}$ ) is the sum of the rate of growth of the support ratio ( $\dot{L}(t)-\dot{N}(t)$ ) and the rate of growth of productivity ( $\dot{y}^l$ ). The first dividend is defined as the rate of growth of the support ratio. The second dividend operates through productivity growth by inducing the accumulation of wealth and capital-deepening as discussed more extensively below.

### *Methods and Sources*

Estimates of the first demographic dividend require an age profile of consumption and labor income and population age distributions. The results are based on estimates of consumption and labor income by age for the United States in 2000. Consumption includes both private and public consumption. Private consumption is estimated primarily using consumer expenditure surveys. Public consumption estimates are based on administrative records, estimates of utilization, and other information that can be used to allocate public spending on education, health, and other public programs to the intended beneficiaries of those programs. Labor income estimates are based on wage and income surveys and include earnings of employees, estimates of the return to labor in family businesses, and other forms of labor income. Detailed estimation procedures are described in Mason et al. (2005).

Historical population data are taken from a variety of sources available from the author. Data from 1950 to 2050 are based on the most recent UN population projections (United Nations Population Division, 2005). Data for 2050 to 2150 are based on UN long-range population projections (United Nations Population Division, 2004). Results for individual countries are not published, but were provided to the author by the UN Population Division.

### *The First Dividend: Long-term Effects*

The support ratios are very different for Japan, the US, and India (Figure 2). The US had a very young age structure and an unfavorable support ratio in 1850. Over the next ninety years, however, the US experienced a steady and pronounced rise in the support ratio – a gain exceeding twenty percent. The effects of the post-World War II baby boom are pronounced and quite apparent. Between 1950 and 1970, the support ratio decline sharply only to return to pre-baby boom levels in 2000. During the first half of the 21st Century the support ratio is projected to decline steadily in the US dropping back to very nearly the 1850 value.

The Japanese experience is tracked from 1900. Japan's population was quite young at that time with 44% under the age of twenty. In this respect Japan's population was very similar to the US population and its support ratio was nearly identical to the US support ratio. The percentage under the age of 20 was rising gradually and the support ratio was declining. Fertility decline began in the 1930s, but it was also accompanied by a decline in infant and child mortality. Japan experienced a mini-baby boom in the early 1950s and a dramatic fall, thereafter, with replacement fertility reached in 1959. The effect of fertility decline on the support ratio was felt beginning in the early 1950s as the ratio rose very rapidly, reaching a peak in 1980. During the last two decades of the 20th Century, the support ratio declined gradually and Japan. A much more precipitous decline has begun that is expected to push the support ratio strongly lower to a value of only 0.8 in 2050. The long-range projections prepared by the UN Population Division imply a relatively stable support ratio after 2050, but this will be so only if fertility recovers and life expectancy improves more slowly than it has in recent decades.

The trend in the Indian support ratio bears some similarity to Japan's. They are both single-peaked and their amplitudes are similar. Fertility decline began later in India and has proceeded more slowly than in Japan. As a consequence, the rise in the support ratio began later in India by several decades and the rate at which it increased has been slower. Based on the most recent UN population projections, India's support ratio will not peak until 2040. Another feature that India and Japan share is that both countries apparently experienced a pre-transition period of relative stability during the first half of the 20th Century.

Figure 2. Support Ratios for India, Japan, and the United States

The first demographic dividend, i.e., the rate of growth of the support ratio, for the US, Japan, and India are shown in Figure 3. The US had two distinct dividend periods – first lasting from 1850 to 1940 and the second lasting from 1970 to 2000. The dividend was strongly negative between 1950 and 1970 and has turned negative again and will continue to be a drag on economic growth for the foreseeable future.

Japan's first dividend was concentrated primarily in a thirty year period – from 1950 to 1980.[2] Before that age-structure played was moderately negative. The first dividend turned negative again in 1980 and will be an even greater drag on economic growth during the coming decades.

The support ratio deteriorated in India between 1955 and 1975 as declining rates of infant and child mortality produced an age structure with a large share of children. From 1975-2005 India experienced a demographic dividend which is anticipated to continue until 2040.

Figure 3. The First Dividend, India, Japan, and the United States.

These key demographic phases are summarized in Table 1 which reports the average annual rate of growth of the support ratio. Japan experienced the strongest boost of any of the countries during its dividend period. As reported in the column labeled support ratio, changes in the support ratio led to an increase in GDP per effective consumer of 0.6 per cent per year for a period of 30 years. The US baby-boom induced dividend was 0.4 per cent per year and its pre-war dividend contributed a little less than 0.3 per cent per year to economic growth. India's dividend contributed about one-third of one percent of economic growth per year between 1975 and 2005. To this point the largest negative dividend occurred in the US. As a result of the baby boom, income growth slowed by 0.5 percent per year between 1950 and 1970. Japan is expected to experience an even larger negative effect (-0.65 percent per year) in the coming decades and it is important to note that this will be experienced for a period of forty-five years as compared with two decades for the US downturn.

Table 1. Growth rates of the support ratio and GDP per effective consumer.

[2] See Ogawa and Matsukura (2005) for alternative estimates of the first dividend.

To assess the size of these effects it is useful to compare the first dividend to the rates of economic growth achieved during the same periods. The first step in carrying out this comparison is to construct an estimate of the rate of growth of output per effective consumer – our measure of economic growth. This is done by subtracting the rate of growth of effective consumers per capita from the rate of growth of GDP per capita. With the exception of pre-1955 India and pre-1950 Japan, the effective number of consumers grew more rapidly than the population because the share of high-consuming adults was increasing in the population. Thus, the rate of economic growth, incorporating changes in age-related "needs", is somewhat less than the rate of per capita GDP growth. The adjustments are relatively modest – typically resulting in a reduction of 5 to 10 percent or less. The only exception is in Japan 1980-2005 where the adjustment reduced per capita GDP growth by 15%.

The first dividend has contributed the most to economic growth, in percentage terms, in the US. Almost 20 percent of US growth in output per effective consumer between 1970 and 2000 and 17 percent between 1850 and 1940 was accounted for by the first dividend. In India and Japan, the first dividend contributed a little more than 10 percent of economic growth during the positive dividend periods. The largest negative effect was also felt in the US where the adverse effect of the baby boom was nearly equal to one-quarter of the growth achieved during this period. Also of note is the 13 percent reduction in economic growth in Japan between 1980 and 2005 attributable to the first dividend.

**The Second Demographic Dividend**

The accumulation of wealth is implicit in the age profiles of consumption and production that lead to the first demographic dividend and its demise. Individuals in their late 50s and older will at every age over the remainder of their lives consume more than they produce – at many ages substantially more – if the current profiles persist. This is only possible if those individuals hold substantial wealth.

This wealth can take different forms, however (Lee, 1994a, 1994b). One possibility is that the old will rely on transfers from public pension and welfare programs or from adult children and other family members. In this case, individuals are accumulating transfer wealth as a means of financing consumption during their retirement years. A second possibility is that individuals accumulate capital during their working years and that this serves as the source of support during retirement years. Both of these forms of wealth can be used to deal with the lifecycle deficit at older ages, but capital also influences economic growth, i.e., the productivity term in the economic growth model presented above (equation (3)). The pro-growth effect of capital accumulation is the source of the second demographic dividend.

Demographic factors lead to an increase in the demand for lifecycle wealth and a second demographic dividend in two ways. First, there is a compositional effect. A growing share of the population consists of individuals who are nearing or who have completed their productive years. Second, there is a behavioral effect. The rise in life expectancy and the accompanying increase in the duration of retirement lead to an upward shift in the age-profile of wealth.

The second dividend is more complex to estimate than the first dividend, in part because the accumulation of wealth is intrinsically forward looking. Individuals accumulate wealth in anticipation of future needs to support consumption, to finance bequests, and to respond to other uncertain events. The analysis presented here emphasizes the lifecycle motive, i.e., the accumulation of wealth over the lifetime necessary to finance future consumption in excess of future labor income. The relevant demography is captured by the projections of the equivalent numbers of consumer and producers for each cohort. Each cohort's lifecycle wealth increases as the future person-years of consumption rises relative to the future person-years of production, both appropriately discounted.

Wealth is accumulated during the working years out of the surplus – the excess of labor income over consumption – shown in Figure 1. The accumulation of wealth for retirement competes, however, with the support of children. Thus, some portion of the surplus is saved and some portion is transferred to children. To simplify calculations, we assume that surpluses at younger ages are transferred to children while surpluses at older ages are accumulated as wealth. Total lifecycle wealth, then, is the wealth held by all those older than the age at which the accumulation process begins. To be specific, we use the wealth held by those who are 50 and older to measure the effect of demography on lifecycle wealth and the second demographic dividend. Our interest is more in the rate at which wealth grows rather than in its absolute level. As long as our approximation is proportional to a more a precise measure, this simplifying assumption will have no effect on the results.

Following the method introduced in Mason (2005), let $N(\leq b, t+x)$ be the number of effective consumers born in year $b$ or less who are alive in year $t+x$. Letting $b=t-a$, then $N(\leq b, t+x)$ is the effective number of consumers $a$ years or older in year $t$ who are still alive in year $t+x$. If the relative per capita cross-sectional age profile of consumption is fixed and shifting upward at rate $g_c$, then the total consumption of the cohort born before age $b$ in year $t+x$ is equal to $\bar{c}(t)e^{g_c x}N(\leq b, t+x)$, where $\bar{c}(t)$ is consumption per effective consumer in year $t$.[3] The present value of the future lifetime consumption of the cohort born in year $b=t-a$ or earlier is:

$$\bar{c}(t)\mathrm{PV}[\mathrm{N}(<b,t)] = \bar{c}(t)\sum_{x=0}^{w-a} e^{(g_c - r)x} N(\leq b, t+x). \tag{4}$$

where PV[] is the present value operator. In similar fashion, if the shape of the per capita cross-sectional age profile of production is fixed and shifting upward at rate $g_y$, then the total production of the cohort born before age $b$ in year $t+x$ is equal to $\bar{y}^l(t)e^{g_y x}L(\leq b, t+x)$ where $\bar{y}^l(t)$ is production or labor income per effective producer. The present value of the future lifetime production of the cohort born in year $b=t-a$ or earlier is:

$$\bar{y}^l(t)\mathrm{PV}[\mathrm{L}(<b,t)] = \bar{y}(t)^l\sum_{x=0}^{w-a} e^{(g_y - r)x} L(\leq b, t+x). \tag{5}$$

[3] For the sake of simplicity, I assume that the rate of growth of per capita consumption and the interest rate are constant. Although this is a standard steady-state assumption, there is no reason to expect this to be the case during periods of transition. To treat $g$ and $r$ as endogenous is not a tractable alternative without employing a detailed, country-specific simulation model (Lee *et al*., 2000; Lee *et al*., 2003). A more general formulation that allows for changing growth rates is provided by Mason and Lee (forthcoming)

In the absence of bequests, the lifetime budget constraint insures that the wealth in year *t* of those born in year *b* or earlier equals the difference between the present value of future lifetime consumption and future lifetime production, i.e.,

$$W(\leq b,t) = \bar{c}(t)\mathrm{PV}[\mathrm{C}(\leq b,t)] - \bar{y}^{l}(t)\mathrm{PV}[\mathrm{L}(\leq b,t)]. \tag{6}$$

Algebraic manipulation yields an expression for the ratio of wealth to total labor income, $w(<b,t) = W(<b,t)/Y^{l}(t)$:

$$w(\leq b,t) = [C(t)/Y^{l}(t)]\mathrm{PV}[\mathrm{C}(\leq b,t)]/N(t) - \mathrm{PV}[\mathrm{L}(\leq b,t)]/L(t), \tag{7}$$

or, alternatively:

$$w(\leq b,t) = [\bar{c}(t)/\bar{y}^{l}(t)]\mathrm{PV}[\mathrm{C}(\leq b,t)]/L(t) - \mathrm{PV}[\mathrm{L}(\leq b,t)]/L(t). \tag{8}$$

$\mathrm{PV}[\mathrm{C}(\leq b,t)]/L(t)$ is the present value of future lifetime consumption of all persons born in year *b* of earlier per effective producer in year *t*. $\mathrm{PV}[\mathrm{L}(\leq b,t)]/L(t)$ is the present value of future lifetime production of all persons born in year *b* or earlier per effective producer in year *t*.

Under golden-rule, steady-state growth, equation (7) can be readily evaluated: the ratio of consumption to labor income is equal to 1 and drops out; the rate of productivity growth and the rate of growth of equivalent consumption, $g_y$ and $g_c$, are constant and equal to each other.

The situation is more complex under the dynamic conditions that characterize the current world. If the ratio of wealth to income is rising over time, because for example it is below its steady-state level, the ratio of consumption to labor income will be less than one and $g_c$ will exceed $g_y$. In addition, the rate of growth of labor income will be varying in response to changes in the capital intensity of the economy. Interest rates may be declining as the ratio of wealth to labor income rises. And whether and the extent to which these variables change will depend on whether or not the economy is open or closed to capital flows and whether or not it is large enough to influence world capital markets. To fully incorporate all of these complexities would require a detailed, country-specific simulation model. The calculations here abstract from these many complexities and emphasize only the demographics.

To calculate the second dividend, $g_y$ and $g_c$ are assumed to equal 0.015, the rate of interest to equal 0.03, and the ratio of consumption to labor income to equal 1.0. The ratio of wealth of those 50 and older to total labor income is used to approximate the ratio of total wealth to total labor income. Analysis of the effects on productivity and economic growth are based on the assumption that the ratio of capital to lifecycle wealth is constant. In other words, the relative importance of capital and transfers in supporting consumption at older ages does not change.

### ***Simulations of Lifecycle Wealth and the Second Dividend***

The simulations of lifecycle wealth and the second demographic dividend are summarized in Figure 4, which charts the simulated ratio of wealth to income, and Figure 5, which charts the simulated ratio of output per worker assuming that (1) the ratio of capital to income grows at the same rate as the ratio of lifecycle wealth to income; and (2) the elasticity of output with respect to capital is one-third.[4]

Figure 4. Wealth/Income Simulations, India, Japan, and the US.

Lifecycle wealth in the US began to increase beginning in 11850. By 1900 lifecycle wealth in the US was twice that of India and about 10% greater than in Japan. During the next forty years lifecycle wealth grew rapidly in the US, but not in Japan nor in India. By 1950, US lifecycle wealth relative to income was 4 times lifecycle wealth in India and about twice Japan's lifecycle wealth. The year 1950 marked an important turning point for Japan as lifecycle wealth began to grow very rapidly. By 1975 Japan had passed the US – a lead that was extended until 2000 when the ratio of lifecycle wealth to output was 6.0 in Japan and 3.6 in the US.

In contrast, lifecycle wealth in India has increased quite slowly until recently. The ratio of lifecycle wealth to income did not reach 1.0 until 1985. Japan reached this milestone in 1940 and the US in 1905. More rapid growth has begun, however, as India's age structure has begun to change and as its life expectancy has continued to improve.

Over the next fifty years, if UN population projections prove to be accurate, lifecycle wealth will continue to grow more rapidly than income in all three countries. Japan will maintain its lead, although the US will gain relative to Japan and India will gain substantially relative to both of the advanced industrial economies. Projected wealth in Japan reaches a plateau around 2030 and declines slightly, thereafter. Long-range projections to 2150 show this to be a temporary phenomenon, however. For all three countries wealth is projected to grow more rapidly than income. The projected growth is slowest in Japan and most rapid in India from 2050 to 2150, but the wealth to income ratio remains highest in Japan, followed by the US, and then by India.

The implications for productivity growth are important if the increase in lifecycle wealth translates into an increase in capital. There are interesting details in Figure 5, but here we will limit ourselves to the broad trends. Before 1940, capital deepening induced by demographic change would have increased output per worker by 0.6% per year in the US, 0.2% per year in Japan, and by about 0.1% per year in India. Between 1950 and 2000, the effect of lifecycle wealth on productivity would have declined in the US to 0.4% per year and increased substantially in India to 0.8% per year and in Japan to 1.6% per year. The effects in India and Japan are quite substantial. For the next 50 years (2000-2050), the productivity effect for the US does not change, remaining at 0.4%. For India the effect on productivity is 1.1% per year, while for Japan the productivity effect drops to only 0.2% per year.

Figure 5. The Second Dividend: Rates of Growth of Output per Worker

[4] This is the case with, for example, a Cobb-Douglas production function with labor augmenting technological change and an elasticity of one-third for capital and two-thirds for effective labor.

### *Combining the First and Second Dividends*

The combined effects of the first and second dividend on economic growth are readily calculated. Equation 3 can be used in conjunction with the results presented above to calculate either the rate of growth of per capita income or the rate of growth of total income attributable to the first and second dividends. First, we compare the actual to the "predicted" trend in GDP using the calculated growth rates. The predicted values are set equal to the actual GDP for 1950.

Growth in the effective labor force and growth in lifecycle wealth explain a remarkably high portion of economic growth in all three countries prior to 1950. The graphs are drawn using a log scale to facilitate comparisons and, of course, the slopes are equal to the rates of growth. In India, the "predicted" and the actual GDP are essentially indistinguishable (Figure 5). In Japan, the rate of growth between 1900 and 1940 is significantly higher than that due solely to the first and second dividends (Figure 7). In the US, the predicted growth in GDP induced by demographics was only slightly lower than the actual growth.

Figure 6. GDP Growth in India, 1890-1995.

Figure 7. GDP Growth in Japan, 1900-1995.

Figure 8. GDP Growth in the US, 1850-1990.

After 1950 rates of economic growth are consistently higher than predicted by demography. In each country the gap between the predicted and the actual GDP grows steadily over time. The gap is relatively modest for India, largest for Japan, and intermediate for the US.

The differences between actual and the predicted growth are summarized in Table 2. In India, actual real GDP growth was 0.7 percent per annum as compared with a predicted growth of 0.8 percent. After 1950, actual growth average 4.0 percent per year while the predicted was 3.4 percent per year. The post-1950 demographic regime would have induced an increase in GDP growth of 2.6 percent per year under the assumptions imposed. GDP growth actually increased by 3.3 percent per year. The percent of economic growth "explained" by demographic factors was 115% before 1950 and 85% after 1950.

Table 2. A Comparison of GDP Growth with Predicted Growth, India, Japan, and the US.

In Japan, actual GDP growth was 3.5 percent per year between 1900 and 1940 as compared with a predicted rate of increase of 2.0 percent. After 1950, the actual increased to 6.1 percent and the predicted to 4.1 percent. Demographics accounted for almost 60 percent of the increase before 1940 and for two-thirds of the increase after 1950. It is striking that in both Japan and India that the acceleration in economic growth after 1950 is closely tied to substantial changes in the demographic regime.

The situation was quite different in the US. Demographic factors before 1950 were predicted to produce GDP growth of 3.1 percent per year. Actual growth was 3.5 percent per annum. Demography was less pro-growth after 1950 when the combined effect of the demographic factors was to produce GDP growth of 2.2 percent per year. Actual US GDP growth declined very marginally, however, from 3.5 percent per annum to 3.3 percent per annum. The percentage of GDP growth explained by demographic factors dropped from 87 percent to 67 percent. The demography changed much less in the US than in Japan or India, as did the actual rates of economic growth.

Table 2 also reports the importance of growth in the effective labor force and growth in wealth to GDP growth. In India, predicted GDP growth increased after 1950 both because of an increase in the rate of growth of the effective labor force and because of an increase in the predicted rate of growth of wealth. In Japan, the post-1950 effects of wealth are very large and substantially greater than before 1950. In the US, the rates of the growth of the effective labor and the rates of growth of wealth both dropped, although the change was much greater in the rate of growth of the labor force than the rate of growth of wealth.

As a final exercise we consider the contributions of the first and second dividend to growth in GDP per effective consumer. Recall from equation 3 that growth in output per effective consumer is equal to two additive factors: the rate of growth of the support ratio and the rate of growth of output per worker. Estimates of these two "dividends" are presented above and summarized and combined in Table 3 using the time periods distinguished in the analysis of the first dividend.

Table 3. The First and Second Dividend as Compared with Actual GDP Growth per Effective Consumer, India, Japan, and the United States.

The second dividend is in all cases greater than the first dividend and in most instances the differences are large. Of particular note are three periods during which the second dividend contributed at least one percentage point to growth in output per effective consumer: 1975-2005 India, 1950-1980 Japan, and 1980-2025 Japan. The first dividend has varied in its effect in each country. It was negative in India before 1975, in Japan after 1980, and in the United States during the baby boom. With the exception of the US baby boom, the combined effects of the first and second dividend have been to increase the rate of growth of output per effective consumer. During these periods the share of growth attributable to these two factors has been very substantial. If we exclude India's slow growth period, the first and second dividend explained between 30 and 57 percent of the total growth in output per effective consumer. During the US baby boom, the second dividend dropped in magnitude and it was not sufficient to offset the strong negative effect of the first dividend.

Demographic change appears to be favorable in India for some time to come. For 2005 to 2050, the combined effects of the first and second dividend are to raise per capita GDP growth by 1.24 percent per year. The picture is very different in the US and particularly in Japan. In the US, the projected growth in for a rise of 0.23 percent per year, while in Japan the project growth effect of demographics is -0.45 percent per year.

### *Final Remarks and Qualifications*

The analysis presented here supports the view that changes in age structure have been an important part of the development process for some time and may well be important for years to come. The US case is striking in this regard. Except for the interruption of the baby boom period, changes in age structure have had an important effect on growth in GDP and growth in income per effective consumer for 150 years. Japan offers an interesting contrast with demography playing a much less important role prior to 1950, but a much more important role after 1950. India provides still another scenario. The positive growth effects were delayed in India, but during the last fifty years they have been important and potentially will continue to be important for decades to come.

For the US it appears that changes in age structure will play a somewhat diminished role in the future, at least in its effect on economic growth. Although the share of the working age population will decline over the next 50 years, the demand for lifecycle wealth may raise productivity more than enough to offset the negative first dividend. This is not the case in Japan, however, where the first dividend is negative, large, and swamps the second dividend.

No formal statistical analysis has been undertaken to formally test the validity of the theoretical model on which simulations are based. It is not entirely clear that formal analysis is warranted. Comparison of the simulations with the actual experience in these three countries is intriguing, however. In particular, rapid economic growth in both India and Japan occurred as demographic conditions shifted in a highly favorable way. Clearly changes in age structure are only part of the story, but they are plausibly an important part. This contrasts with the US where demographic shifts have been relatively modest and generally consistent with the long-run trends in economic growth.

The results presented here are suggestive, then, but they are far from conclusive. Many issues need to be explored further. First, all of the calculations have been based on age profiles of consumption and labor income for the US. These profiles vary over time and across countries. Over the long time span considered here perhaps they have changed considerably.[5] Second, all calculations of the second dividend are based on the assumption that capital is growing at the same rate as lifecycle wealth. Although this is a plausible starting point, it may be entirely wrong. Both Japan and the United States began and expanded major public pension programs during the periods under consideration. Thus, part of the increase in lifecycle wealth would have been met by transfers rather than by capital accumulation. But in Japan and the US, familial support for the elderly has declined substantially – in the late 18th and early 19th Centuries in the US and more recently in Japan. Hence, this would serve to increase capital as a share of life cycle wealth.[6] Third, the implications of international capital flows have been neglected entirely. In recent years, the US has experienced substantial net capital inflows and Japan has invested heavily abroad – in other Asian countries and in the US. A more complete analysis would surely take this into consideration.

[5] See (Lee *et al*., 2005)

[6] A more detailed discussion and analysis of the implications for capital accumulation of changing transfer system can be found in (Lee *et al*., 2003)

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Table 1. Growth rates of the support ratio and GDP per effective consumer, India, Japan, and the United States during key demographic phases.

| | Support ratio | GDP per capita | Effective consumers per capita | GDP per effective consumer | Growth rate of support ratio/Growth rate of GDP per effect consumer (%) |
|---|---|---|---|---|---|
| | **India** | | | | |
| 1880-1955 | -0.01 | 0.18 | -0.01 | 0.18 | -6.2 |
| 1955-1975 | -0.14 | 1.51 | 0.02 | 1.49 | -9.1 |
| 1975-2005 | 0.34 | 3.12 | 0.13 | 2.98 | 11.5 |
| 2005-2050 | 0.20 | | | | |
| | **Japan** | | | | |
| 1900-1940 | -0.06 | 2.23 | -0.02 | 2.24 | -2.5 |
| 1950-1980 | 0.61 | 5.19 | 0.26 | 4.93 | 12.3 |
| 1980-2005 | -0.23 | 2.04 | 0.32 | 1.72 | -13.2 |
| 2005-2050 | -0.65 | | | | |
| | **United States** | | | | |
| 1850-1940 | 0.27 | 1.66 | 0.11 | 1.55 | 17.3 |
| 1950-1970 | -0.51 | 2.20 | 0.05 | 2.15 | -23.7 |
| 1970-2000 | 0.40 | 2.15 | 0.11 | 2.04 | 19.5 |
| 2000-2050 | -0.20 | | | | |

Notes and sources. Growth rate of per capita GDP for 1970 and later based on World Development Indictors 2005. Most recent growth rates for India and Japan are based on GDP per capita for 2003. Rates are calculated using real values in local currency. Growth rates of per capita GDP prior to 1970 calculated from Maddison 1995 Table D. GDP per capita for India in 1880 is a simple average of values reported for 1870 and 1890.

Table 2. A Comparison of Actual and Predicted GDP Growth, India, Japan, and the US.

| | GDP Growth | | | Predicted growth rates | | Contribution to Growth | | |
|---|---|---|---|---|---|---|---|---|
| | Actual | Predicted | Residual | Effective Labor Force | Wealth | Effective Labor Force | Wealth | Percent Explained |
| **India** | | | | | | | | |
| < 1950 | 0.7 | 0.8 | -0.1 | 0.6 | 1.1 | 0.4 | 0.4 | 115.4 |
| 1950 + | 4.0 | 3.4 | 0.6 | 2.3 | 5.6 | 1.5 | 1.9 | 85.2 |
| Change | 3.3 | 2.6 | 0.7 | 1.7 | 4.4 | 1.1 | 1.5 | |
| **Japan** | | | | | | | | |
| < 1940 | 3.5 | 2.0 | 1.4 | 1.1 | 3.9 | 0.7 | 1.3 | 58.7 |
| 1950 + | 6.1 | 4.1 | 2.0 | 1.6 | 9.3 | 1.0 | 3.1 | 67.9 |
| Change | 2.6 | 2.1 | 0.5 | 0.4 | 5.4 | 0.3 | 1.8 | |
| **US** | | | | | | | | |
| < 1950 | 3.5 | 3.1 | 0.4 | 2.2 | 4.8 | 1.5 | 1.6 | 87.4 |
| 1950 + | 3.3 | 2.2 | 1.1 | 1.3 | 4.1 | 0.9 | 1.4 | 67.0 |
| Change | -0.2 | -0.9 | 0.6 | -1.0 | -0.7 | -0.6 | -0.2 | |

Table 3. The First and Second Dividend as Compared with Actual GDP Growth per Effective Consumer, India, Japan, and the United States.

| | Actual GDP growth per effective consumer | First dividend: growth of the support ratio | Second dividend: Effect of growth of lifecycle wealth | First + Second Divident | First and second dividend as a percent of actual |
|---|---|---|---|---|---|
| | **India** | | | | |
| 1880-1955 | 0.18 | -0.01 | 0.13 | 0.12 | 63.7 |
| 1955-1975 | 1.49 | -0.14 | 0.60 | 0.47 | 31.2 |
| 1975-2005 | 2.98 | 0.34 | 1.02 | 1.37 | 45.8 |
| 2005-2050 | | 0.20 | 1.04 | 1.24 | |
| | **Japan** | | | | |
| 1900-1940 | 2.23 | -0.06 | 0.20 | 0.15 | 6.6 |
| 1950-1980 | 6.23 | 0.61 | 1.72 | 2.32 | 37.3 |
| 1980-2005 | 1.72 | -0.23 | 1.21 | 0.98 | 57.1 |
| 2005-2050 | | -0.65 | 0.19 | -0.45 | |
| | **United States** | | | | |
| 1850-1940 | 1.55 | 0.27 | 0.62 | 0.89 | 57.6 |
| 1950-1970 | 2.15 | -0.51 | 0.24 | -0.27 | -12.6 |
| 1970-2000 | 2.04 | 0.40 | 0.50 | 0.90 | 44.0 |
| 2000-2050 | | -0.20 | 0.43 | 0.23 | |

Notes and sources. See text and Table 1.

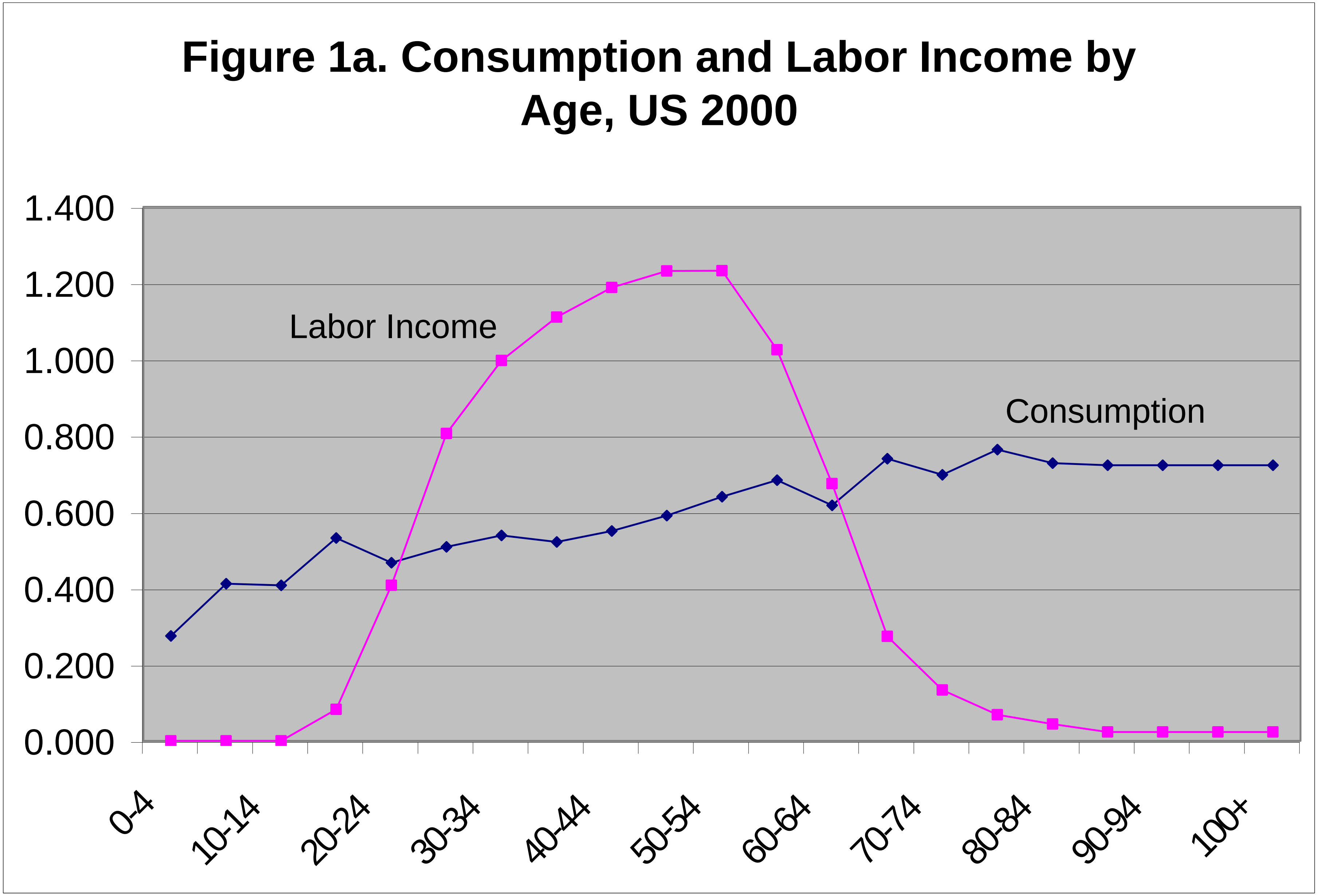


Figure 1a. Consumption and Labor Income by Age, US 2000
Labor Income
Consumption
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
0-4
10-14
20-24
30-34
40-44
50-54
60-64
70-74
80-84
90-94
100+

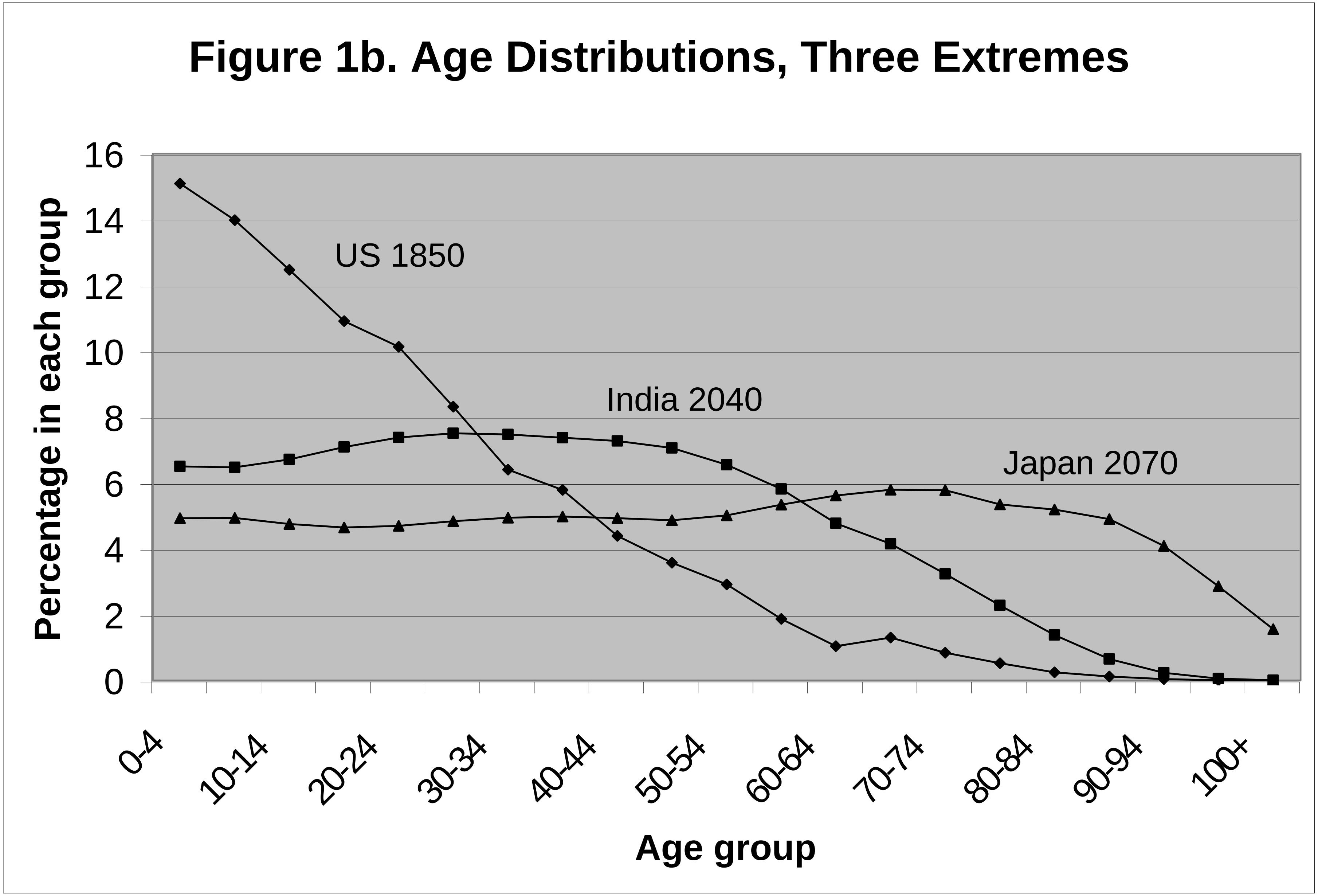


Figure 1b. Age Distributions, Three Extremes
Percentage in each group
16
14
12
10
8
6
4
2
0
US 1850
India 2040
Japan 2070
0-4
10-14
20-24
30-34
40-44
50-54
60-64
70-74
80-84
90-94
100+
Age group

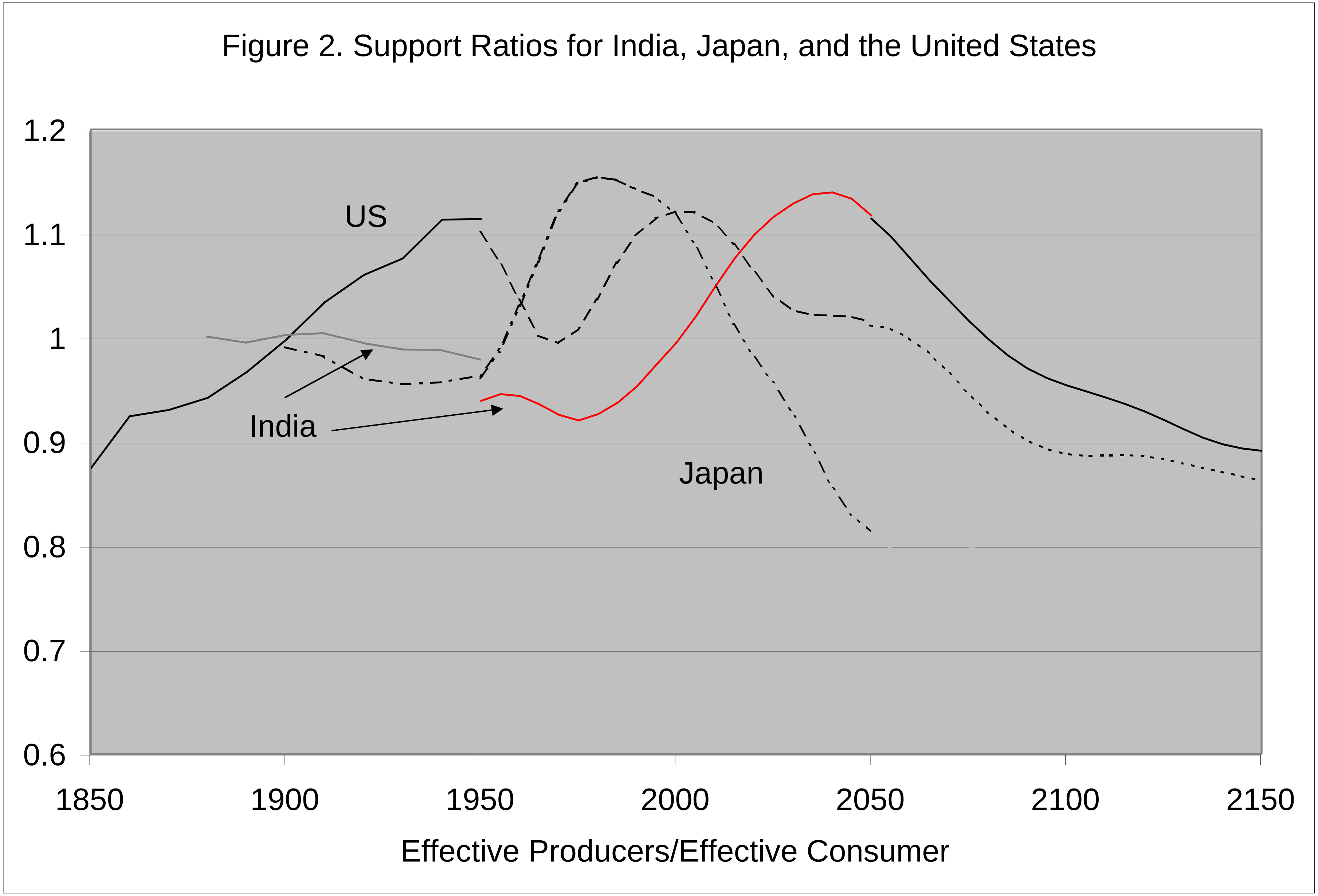


Figure 2. Support Ratios for India, Japan, and the United States
1.2
1.1
1
0.9
0.8
0.7
0.6
US
India
Japan
1850
1900
1950
2000
2050
2100
2150
Effective Producers/Effective Consumer

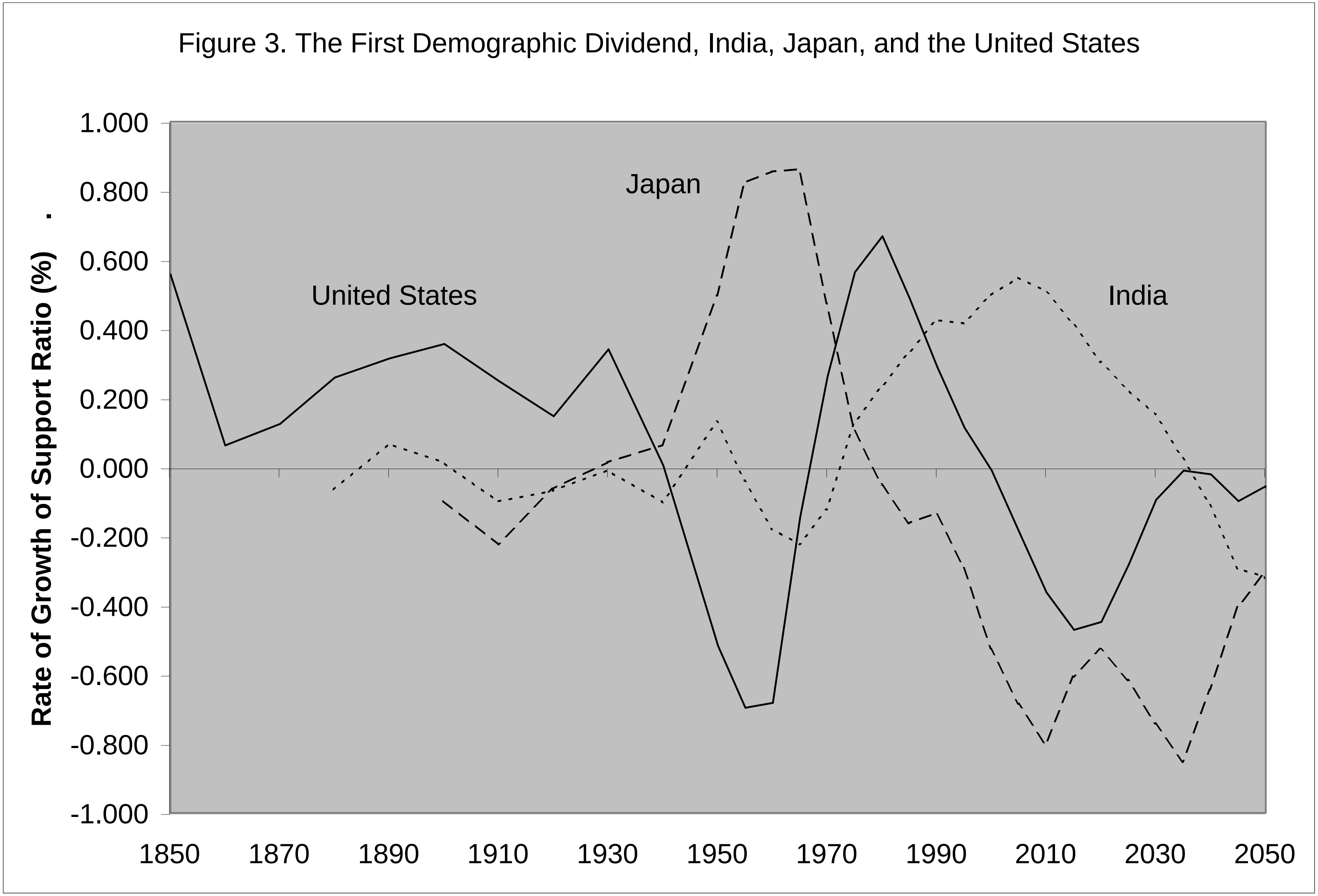
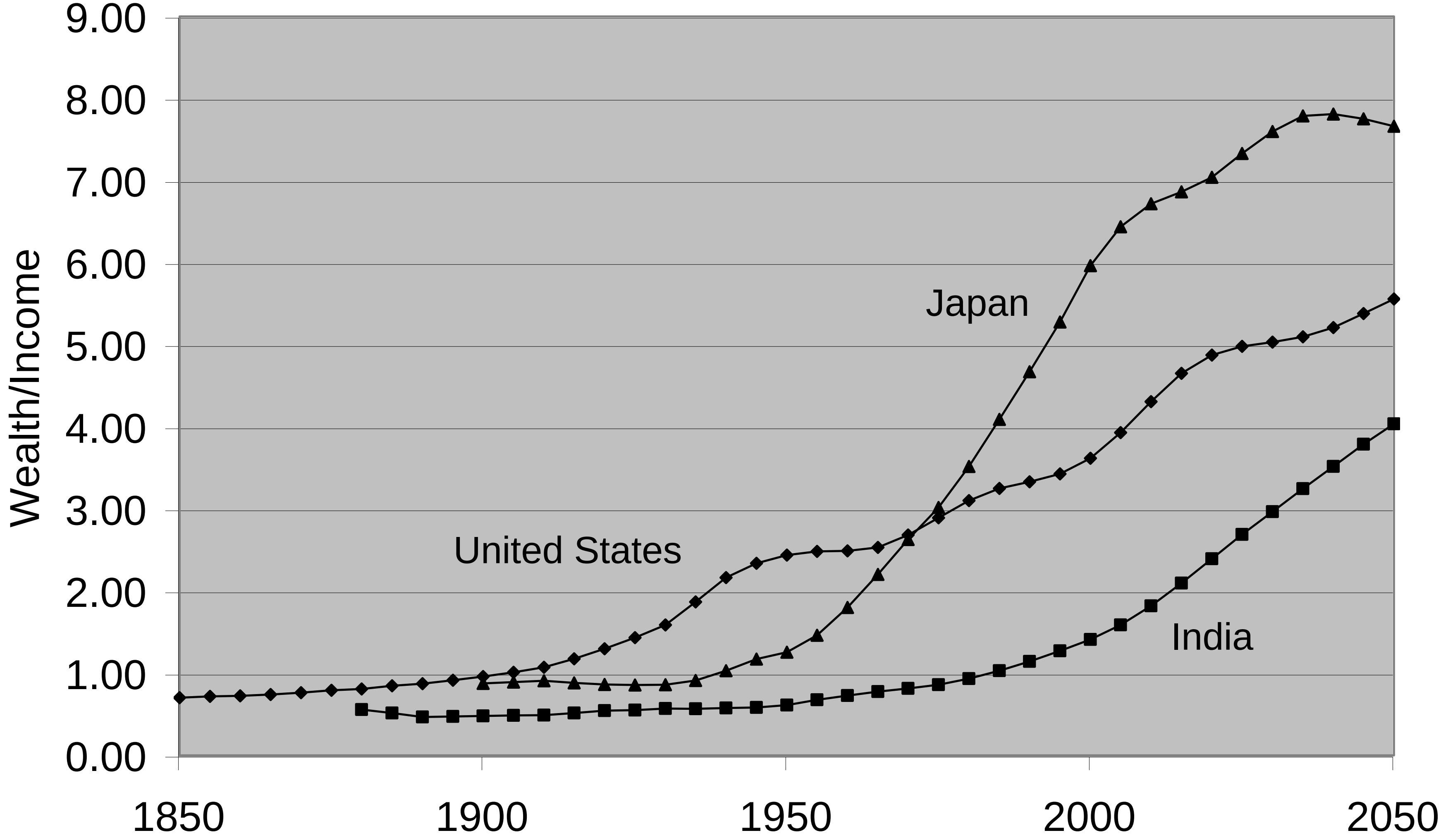


Figure 3. The First Demographic Dividend, India, Japan, and the United States
Rate of Growth of Support Ratio (%)
1.000
0.800
0.600
0.400
0.200
0.000
-0.200
-0.400
-0.600
-0.800
-1.000
1850
1870
1890
1910
1930
1950
1970
1990
2010
2030
2050
Japan
United States
India

Figure 4. Wealth/Income Simulations, India, Japan, and the US



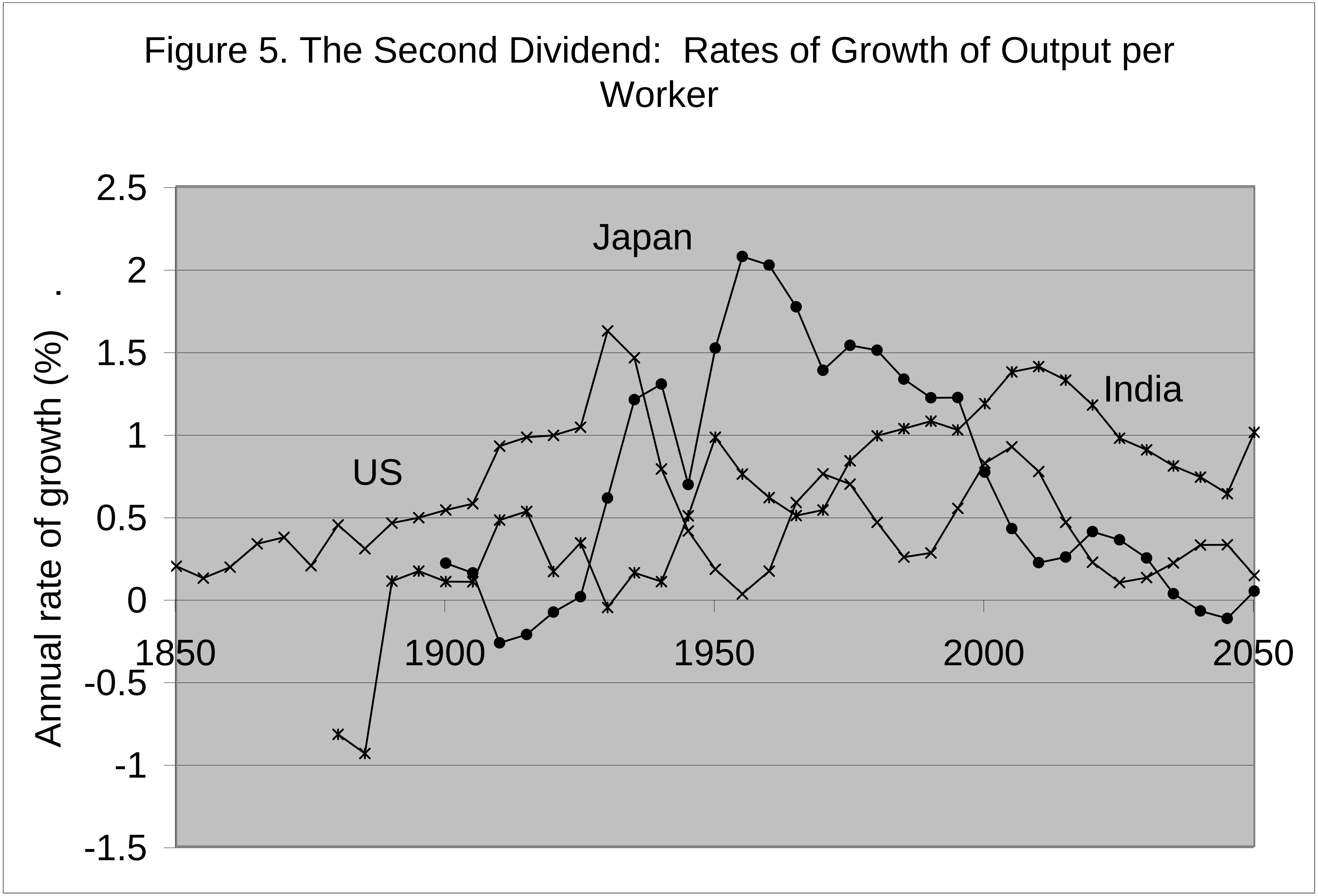


Figure 5. The Second Dividend: Rates of Growth of Output per Worker
Annual rate of growth (%)
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
1850
1900
1950
2000
2050
Japan
US
India

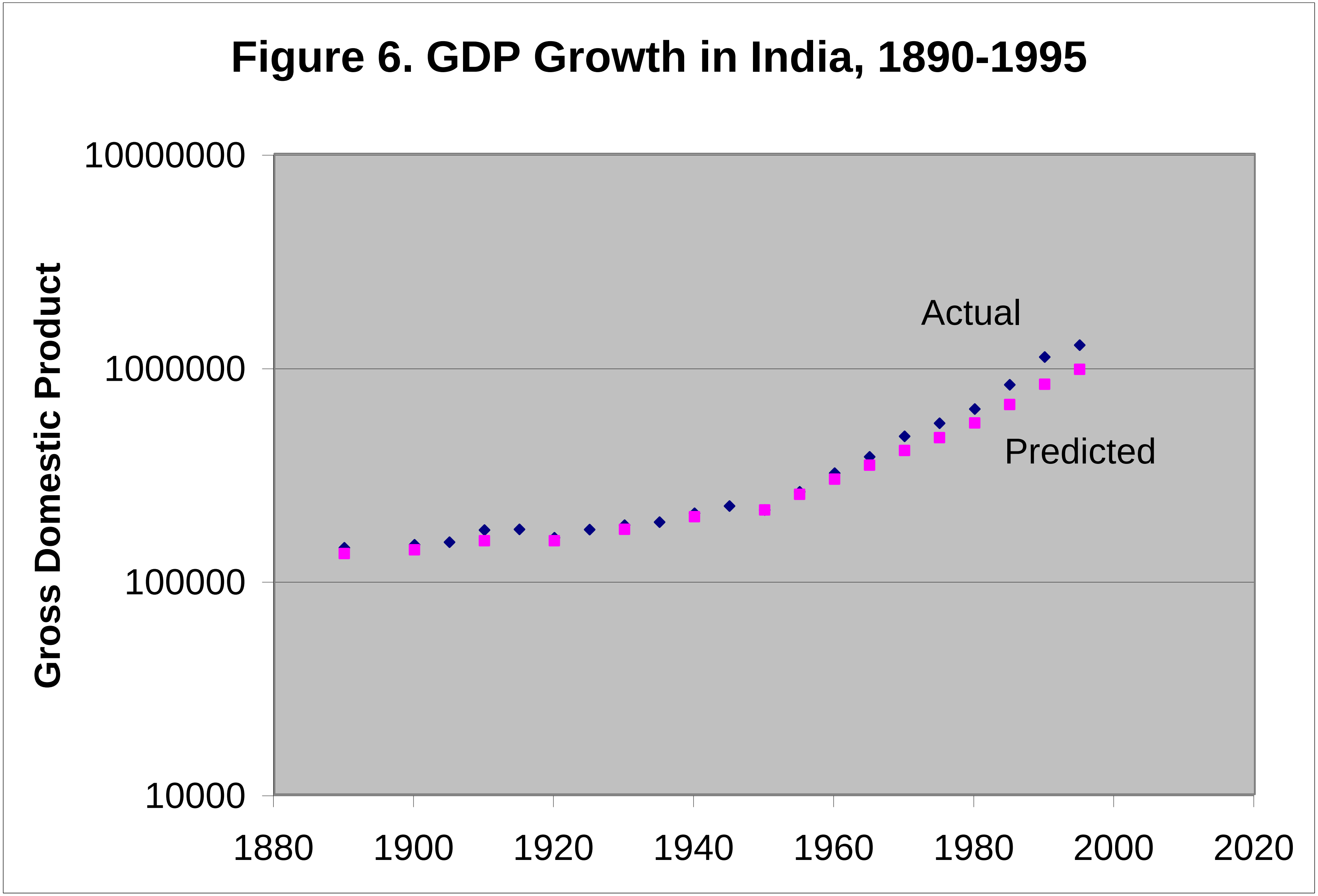
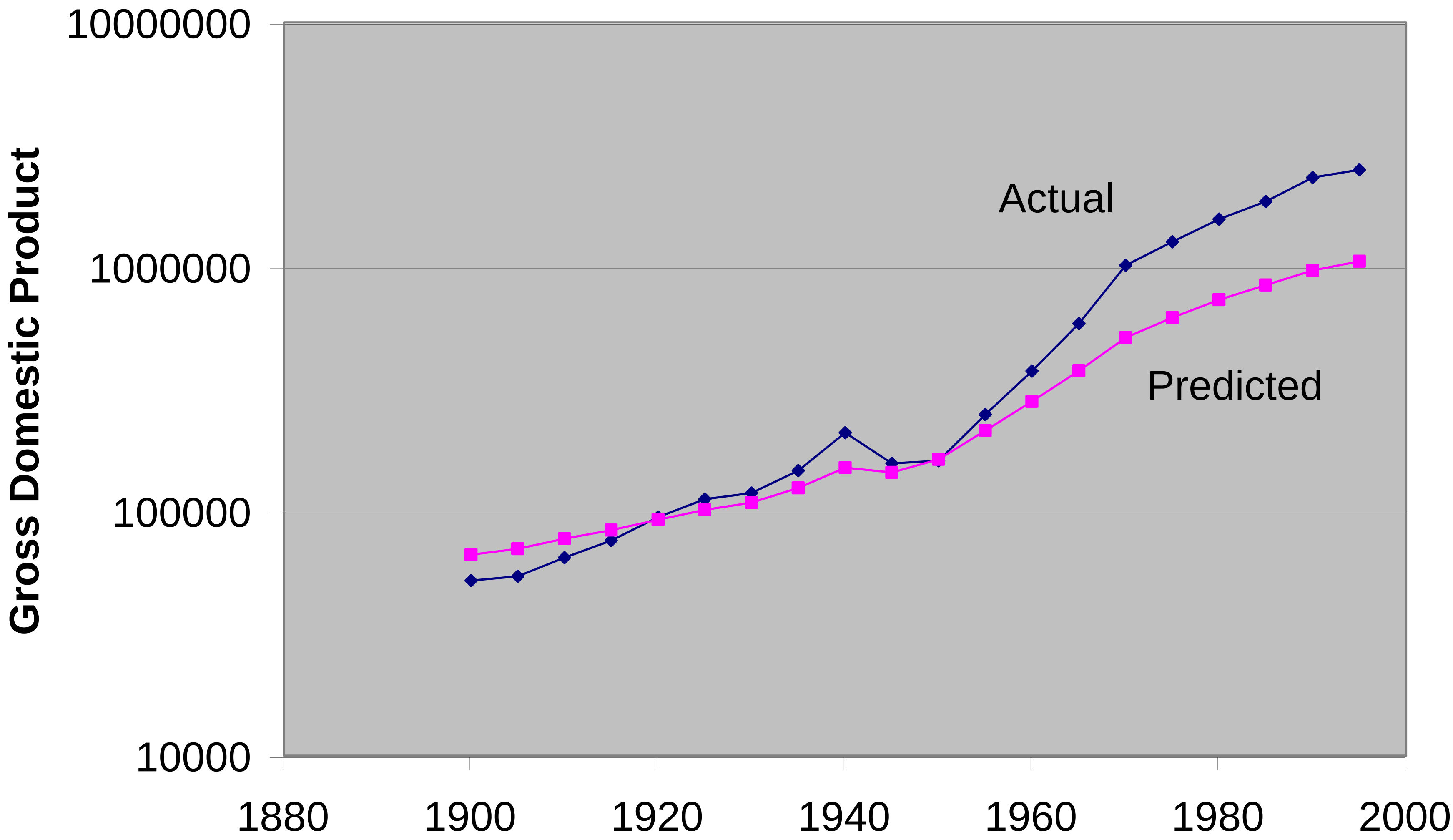


Figure 6. GDP Growth in India, 1890-1995
Gross Domestic Product
10000000
1000000
100000
10000
1880
1900
1920
1940
1960
1980
2000
2020
Actual
Predicted

# Figure 7. GDP Growth in Japan, 1920-1995



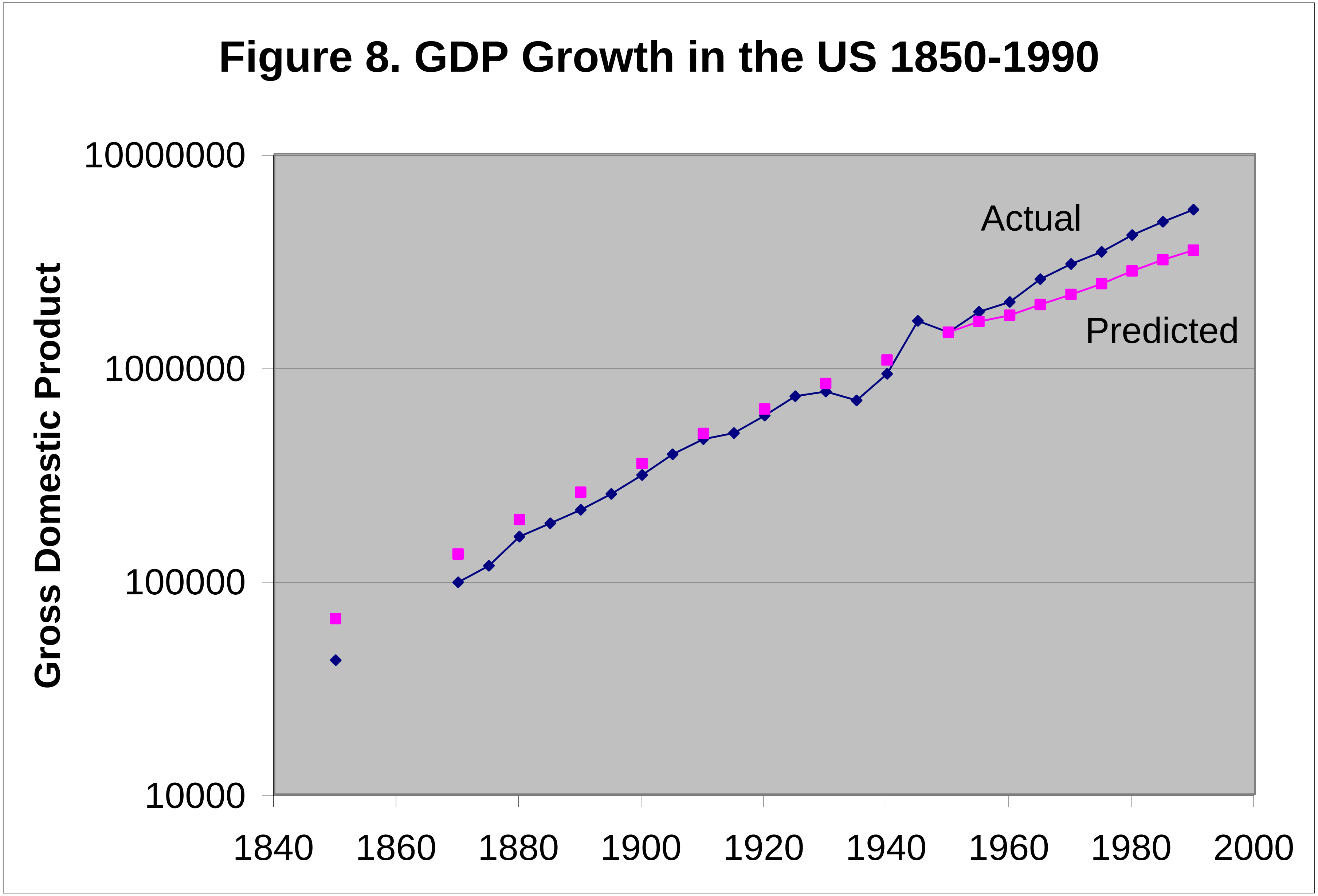


Figure 8. GDP Growth in the US 1850-1990
Gross Domestic Product
10000000
1000000
100000
10000
1840
1860
1880
1900
1920
1940
1960
1980
2000
Actual
Predicted