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The Baby Boom and Economic Growth

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ABSTRACT

This paper presents a model of economic growth based on the life-cycle hypothesis to determine the path of capital accumulation and economic growth as the baby boom passes through the U.S. economy. The model predicts that a baby boom causes a temporary decline of the capital-labor ratio. The temporary drop of the capital-labor ratio requires a decrease in consumption per capita but as the baby boom generation nears retirement, capital intensity increases, which raises output per worker and per capita consumption. Furthermore, and perhaps counter intuitively, the model predicts that the saving rate of the economy falls during the period of increasing consumer welfare. These results suggest that consumer welfare may increase as the baby boom generation begins to retire near the turn of the century. Thus the retirement of the baby boom generation need not necessarily be a cause of concern.

KEYWORDS: baby boom, simulation, growth, life-cycle, demographics, aging

JEL CLASSIFICATION: D91, E17, E21, E22, J11

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I. Introduction

Between 1946 and 1960, the U.S. population grew at an average annual rate of 1.8%, a rate that was significantly higher than the average annual rates of 1% for the twenty years preceding 1946 and 1.1% for the twenty-eight years following 1960. Although the demographic changes associated with the baby boom are not especially large by historical standards[1] much effort has been put forth to understand its impact on the U.S. economy.[2] Moreover, the relevance of such demographic shifts goes beyond the borders of the United States. Japan and other OECD countries have a large portion of their population near retirement.

One often stated concern about the baby boom is the impact of its retirement on capital accumulation and the subsequent declines in the growth of the economy and the standard of living. Since the eventual retirement of the baby boom generation is central to most people's concerns, this paper presents a model of economic growth based on the life-cycle hypothesis to determine the path of capital accumulation and economic growth. Unlike standard neoclassical growth models, a growth model based on the life-cycle hypothesis is well suited to an examination of the effects of a large retired population because retirement is an integral part of the life-cycle hypothesis. Using the life-cycle hypothesis as the basis for an individual's saving decision, I incorporate general equilibrium considerations to determine the relationship between demographic changes and capital accumulation.

The model predicts that a baby boom causes a temporary decline of the capital-labor ratio. The temporary drop of the capital-labor ratio requires a decrease in consumption per capita but as the baby boom generation nears retirement, capital intensity increases, which raises output per worker and per capita consumption. Furthermore and perhaps counter-intuitively, the model predicts that the saving rate of the economy falls during the period of increasing consumer welfare. In the long run the welfare of individuals is no greater than it was before the entrance of the baby boom despite a period of lower saving in the economy. These results suggest that consumer welfare may increase as the baby boom generation begins to retire near the turn of the century. Thus if the individuals of the baby boom generation are fundamentally similar in their individual economic behavior and motivation

[1] The nineteenth century contains much larger fluctuations due to changing birth rates and immigration.

[2] See Auerbach, Kotlikoff, Hagemann and Nicoletti [1989], Auerbach and Kotlikoff [1990], and Auerbach, Cai and Kotlikoff [1991].

as individuals of other generations, their impending retirement should not be a cause of concern.

While this paper addresses some issues covered by Cutler, et al. [1990], the results of this paper are at odds with their predictions. Their model modifies the Ramsey-Cass-Koopmans, infinitely lived agent model by incorporating an aggregate dependency ratio. They then solve the model from a social planner's viewpoint. The social planner maximizes a utility function that weights equally all individuals alive at any given time. Due to the modification of the objective function used by Cutler, et al., the capital-labor ratio in their framework is not at all responsive to changes in the population growth rate. Consequently, consumption must adjust for all changes in the dependency ratio. They predict that per capita consumption will increase until it reaches its maximum in 2010, and decrease slightly thereafter until middle of the twenty-first century. Unlike Cutler, et al., the model presented in this paper solves a decentralized problem. The model first solves for an individual's utility maximization problem and then aggregates the individual's solution to determine the impact of the baby boom on the U.S. economy. The difference in methodology implies a slow response of the capital-labor ratio to changes in the labor force, which in turn implies that per capita consumption will continue to decrease until the turn of the century and increase thereafter.

The remainder of the paper is divided into three parts. The first section solves the individual's utility maximization problem. The second section incorporates the life-cycle hypothesis based capital accumulation model in a general equilibrium framework. The third section examines the likely impact of the baby boom generation on the U.S. economy by simulating the model presented in section two. The final section presents a few concluding thoughts along with some implications of the results for the U.S. economy as the baby boom generation ages.

II. Consumer's Maximization Problem

The life-cycle hypothesis states that an individual's lifetime path of accumulated assets reflects his saving and dissaving for retirement, gradually increasing while working and then declining once retired. This implies that an individual's age is an important determinate of how much wealth he has. If the growth rate of the population fluctuates over time, the age distribution of the population fluctuates as well. Consequently, the desired holdings of wealth of the population will vary with the age distribution of the population.

For simplicity, I assume that each consumer works and lives for T' and T years, respectively, from his time of birth, t.[3] The consumer maximizes his lifetime utility subject to the budget constraint that in each period his consumption and net saving must equal his total income. I assume lifetime utility is additively separable and isoelastic with constant relative risk aversion.

$$\max \sum_{s=1}^{T} (1+\delta)^{1-s} \frac{c_{t+s-1,s}^{1-\rho}}{1-\rho} \tag{1}$$

subject to the lifetime budget constraint

$$\sum_{s=1}^{T'} \frac{w_{t+s-1,s}}{(1+r_t)^{s-1}} + a_{t,0} \geq \sum_{s=1}^{T} \frac{c_{t+s-1,s}}{(1+r_t)^{s-1}} \tag{2}$$

$c_{t,s}$ and $w_{t,s}$ are consumption and labor income in period t of an agent s periods old, respectively, and $a_{t,0}$ is the endowment received by a new entrant to the economy. δ is the subjective discount rate. r_t is the rate of return to assets in period t.

The optimal consumption and saving paths are

$$c_{t+s-1,s} = \theta_s \left[\sum_{i=s}^{T'} \frac{w_{t+i-1,i}}{(1+r_t)^{i-s}} + (1+r_t)\, a_{t+s-2,s-1} \right] \tag{3}$$

$$a_{t+s-1,s} = \begin{cases} (1+r_t)\, a_{t+s-2,s-1} + w_{t+s-1,s} - c_{t+s-1,s} & \text{if } s \leq T' \\ (1+r_t)\, a_{t+s-2,s-1} - c_{t+s-1,s} & \text{if } s > T' \end{cases} \tag{4}$$

where

$$\theta_s = \left[1 + \sum_{i=s+1}^{T} \left(\frac{1+r_t}{1+\delta} \right)^{\frac{i-s}{\rho}} \right]^{-1}$$

and $a_{t,s}$ is the end of period wealth held by an individual s years old in period t. Finally, I assume that labor productivity varies with an individual's

[3]The model can accommodate uncertainties about life expectancy and the duration of labor force participation. However such complications add little insight into the economic impact of the baby boom generation.

age, so that productivity increases until the worker reaches middle age and declines thereafter. Given plausible values for the parameters in equation (4), the pattern of asset accumulation over an individual's lifetime reflects the familiar humped shaped asset profile of the life-cycle hypothesis.

III. Equilibrium Effects of a Baby Boom

Starting at steady state, where equilibrium interest rate, wage, and age wealth profile are stable, I first calculate the initial aggregate capital stock. I next calculate the size of the labor force. Given some production function, aggregate capital and labor yield aggregate output and capital-labor ratio, as well as equilibrium interest rates and wages. Once I know the interest rate and wage, I can then calculate the consumers consumption from equation (3).[4] Given each individual's consumption, I then calculate equilibrium asset holdings for each individual using (4). Aggregating the savings of individuals determines the size of aggregate capital for the following period.

The labor force in each period t, equals the sum of the population age distribution from 0 to T'.

$$L_t = \sum_{s=1}^{T'} \varphi_t(s) \tag{5}$$

where $\varphi_t(s)$ is the age distribution of the population in period t.

Given the asset profile of individuals, aggregate capital is merely the sum of all assets of every individual present in the economy. As before let $a_{t,s}$ be quantity of assets held by an individual aged s in period t. The aggregate level of capital equals

$$K_t = \sum_{s=1}^{T} a_{t,s}\varphi_t(s) \tag{6}$$

If the aggregate production function has constant returns to scale and markets are competitive, the equilibrium rate of return of capital is

$$r_t = f'(k_t) \tag{7}$$

[4]To simplify the simulation, I assume static expectations by the consumers, i.e., each consumer assumes that current interest rates and wages will persist into the future.

where k_t is the capital-labor ratio and $f(k_t)$ is the net production function of the economy. Under the same conditions equilibrium wages equal

$$w_t = f(k_t) - f'(k_t) k_t \tag{8}$$

In addition the economy grows at some exogenous rate γ which augments aggregate labor productivity. To close the model, I assume a simple Cobb-Douglas production function with labor augmenting productivity growth for the economy.

$$f(k_t) = (1+\gamma)^t k_t^{\alpha} \tag{9}$$

where α is capital's share of output and γ is labor productivity growth.

IV. Simulating the U.S. Baby Boom

Figure 1 shows the impact of the baby boom on the growth of the U.S. population, the growth of the population aged 18-64 and the dependency ratio as defined by the ratio of the total population to the working-age population. It clearly shows a period some fifteen years of noticeably faster population growth in the population immediately after the end of World War II. Before I simulate the impact of the baby boom on the U.S. economy, I make the following simplifying assumption about the baby boom: initially the population grows at rate n until period $t = 0$ when the growth rate changes to $n + \epsilon$, where $\epsilon > 0$ and indicates the magnitude of the baby boom. The new growth rate persists for τ periods and then the population growth rate returns to n.[5]

Table 1 presents the parameters used in the simulation.[6]

Figure 2 shows the path of output per worker and the path of the capital-labor ratio as the baby boom passes through the economy. Initially the baby boom enters the economy without sufficient capital so that the capital-labor ratio decreases. k_t continues to decline at an increasing rate until the entire

[5]The actual baby boom had a period of increasing birth rate followed by a gradual decline to a rate below the pre-baby boom era. The simplified baby boom is calibrated to the average annual population growth rate during the baby boom.

[6]The subjective discount rate, coefficient of relative risk aversion, and the Cobb-Douglas parameters are equal to the values used by Auerbach and Kotlikoff [1987]. I also specify the same productivity profile over an individual's lifetime, which equals $exp(4.47 + 0.033age - 0.00067age^2)$.

baby boom generation has entered the economy. Once the entire baby boom is within the economy, the rate of decrease of the capital-labor ratio diminishes, and after thirty years the saving of the baby boom reaches its lowest point, some four percent lower than the economy without a baby boom. Thereafter the capital-labor ratio begins to increase at an ever increasing rate, especially so as the baby boom generation begins to retire. At this point the retirement rate from the labor force is higher than the entry rate, therefore every person still in the labor force sees an increase in the capital per labor unit. The net effect increases the capital-labor ratio at even a faster rate. Eventually the dissaving of the retiring baby boomers decreases the available capital stock and the rate of increase in the capital-labor ratio slows, and as the baby boom generation dies, the growth of the capital-labor ratio slows even further, eventually returning to the capital-labor ratio to the old steady state level. Since output per worker is a simple transformation of the capital-labor ratio, the path of output per worker is very similar to that of the capital-labor ratio.

Figure 3, panel A shows the path of interest rates implied by equations (7) and (9) and figure 2, panel B. The decrease in the capital-labor ratio generated by the temporary increase in the population growth rate causes interest rates to increase, until it reaches its maximum some ten basis points higher than the baseline economy. Thereafter interest rates decrease returning to its original level after the baby boom has completely passed through the economy.

In contrast to interest rates, real wages follow the paths outlined by the capital-labor ratio, decreasing as the capital-labor ratio decreases and increasing as the capital-labor increases. The faster rate of entry of individuals into the labor force diminishes their marginal product as capital is slow to respond to the sudden increase in the growth rate. With decreasing marginal product of labor, wages decrease. The drop in real wages continues until thirty years has passed and real wages reaches its minimum, some 0.05 percent lower rate of growth than the economy without the baby boom. The decrease in wages reverses itself once the quantity of capital held by the baby boom generation becomes sufficient to reverse the decline in the capital-labor ratio.

Figure 4, panel A shows the implications of the baby boom for consumer welfare. The decline in labor productivity diminishes per capita consumption.[7] The decline in the growth of per capita consumption lasts

[7]Not all consumers suffer a drop in consumption. Individuals who are retired or are

for thirty years, dropping as much as 0.15 percent relative to the baseline economy. As real wages returns to the old steady state level, per capita consumption returns to its steady state value.

National saving rate, shown in figure 4, panel B, reflects in part the relative size of the young, working population to the older, retired population. As the baby boom enters the economy the number of young saving for retirement increases, thereby increasing the national saving rate. The saving rate continues to increase as the baby boom generation is within the labor force increasing to a rate some three percent higher than the steady state rate of saving. As the baby boom generation begins to retire, the saving rate decreases until it returns to the pre-baby boom level, soon after the entire baby boom generation has died.

V. Implications for the U.S. Economy

The model presented in this paper suggests that the influence of the baby boom on the U.S. economy is transitory. While capital intensity and wages suffer initially, the transitory nature of the baby boom implies that the decline in the capital-labor ratio will reverse itself. Given that the baby boom started in 1946 and assuming that economic life begins at twenty, the baby boom began to enter the labor force in 1965. Therefore capital-labor ratio should reach its trough in near the turn of the century. This suggests that the U.S. economy should soon see an increase in labor productivity and faster economic growth.

The model also predicts that concerns about economic hardships once the baby boom generation retires need not occur. As figures 2 and 4 show, the increase the capital-labor ratio accompanying the maturation of the baby boom generation reverses the drop in the average standard of living as measured by consumption per capita. Furthermore the generation currently entering the labor market should enjoy increasing wages relative to the baby boom generation.

The model also predicts that the increase in consumption per capita and capital intensity do not require an increase in the saving rate of the working generation. As figure 4 clearly demonstrates, national saving relative to output decreases while the capital-labor ratio, consumption per capita and

near retirement enjoy greater consumption as the returns to their saving increases. This suggests that perhaps income and wealth distributions favor individuals who hold their wealth as physical capital rather than human capital.

real wages increase. This is a result of the larger than average size of the generation near their peak lifetime wealth. As the baby boom generation's retirement progresses, they will eventually consume the large stock of capital they have accumulated.

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Table 1: Model Parameters

parameters		value
T	lifespan	60
T'	working life	45
n	initial pop. growth rate	0.01
ϵ	size of baby boom	0.01
τ	duration of baby boom	15
δ	subjective discount rate	0.015
ρ	coefficient of relative risk aversion	4
α	capital's share of output	0.25
γ	labor productivity growth	0.02

Figure 1: U.S. Population Characterisitcs

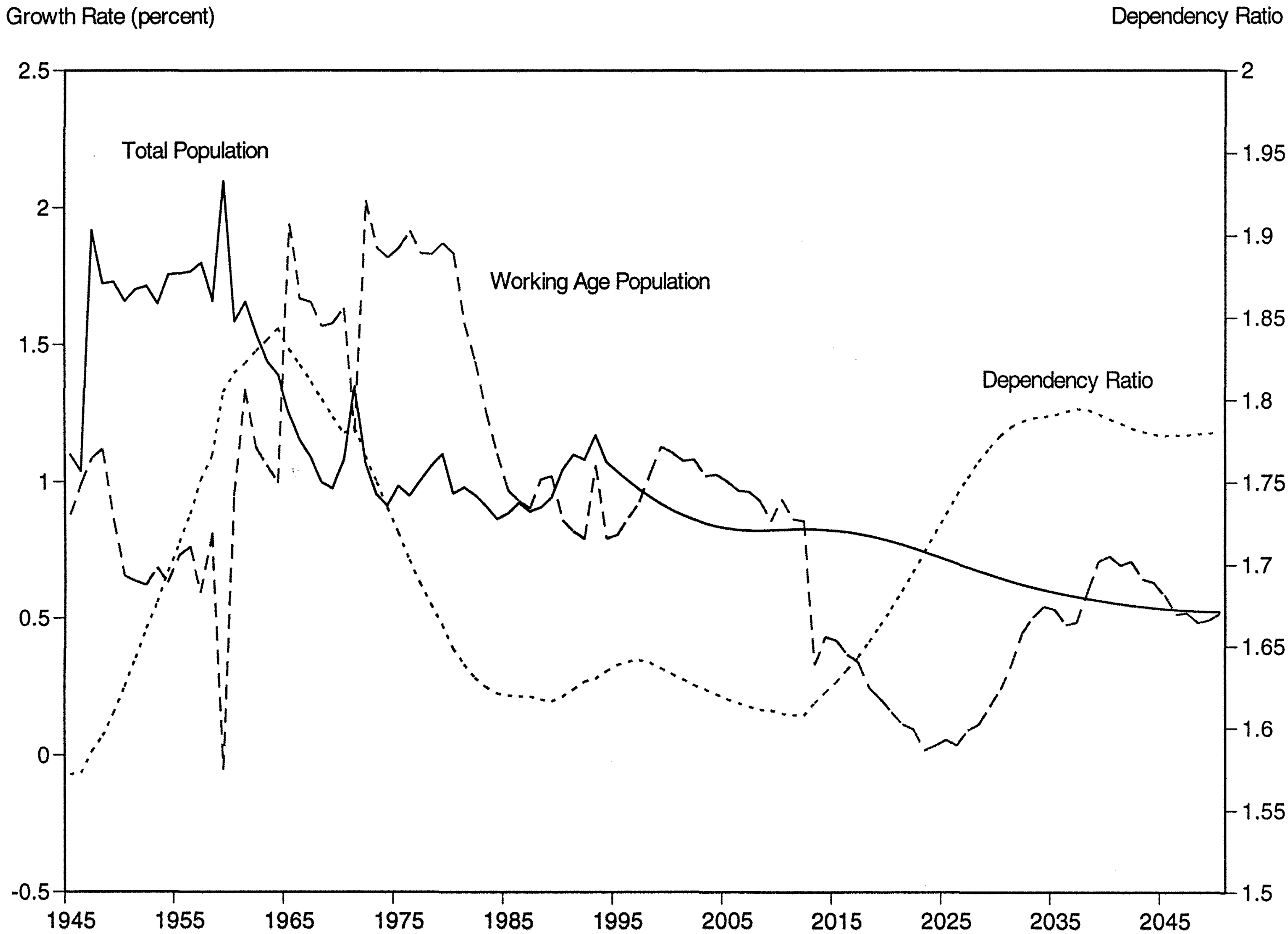
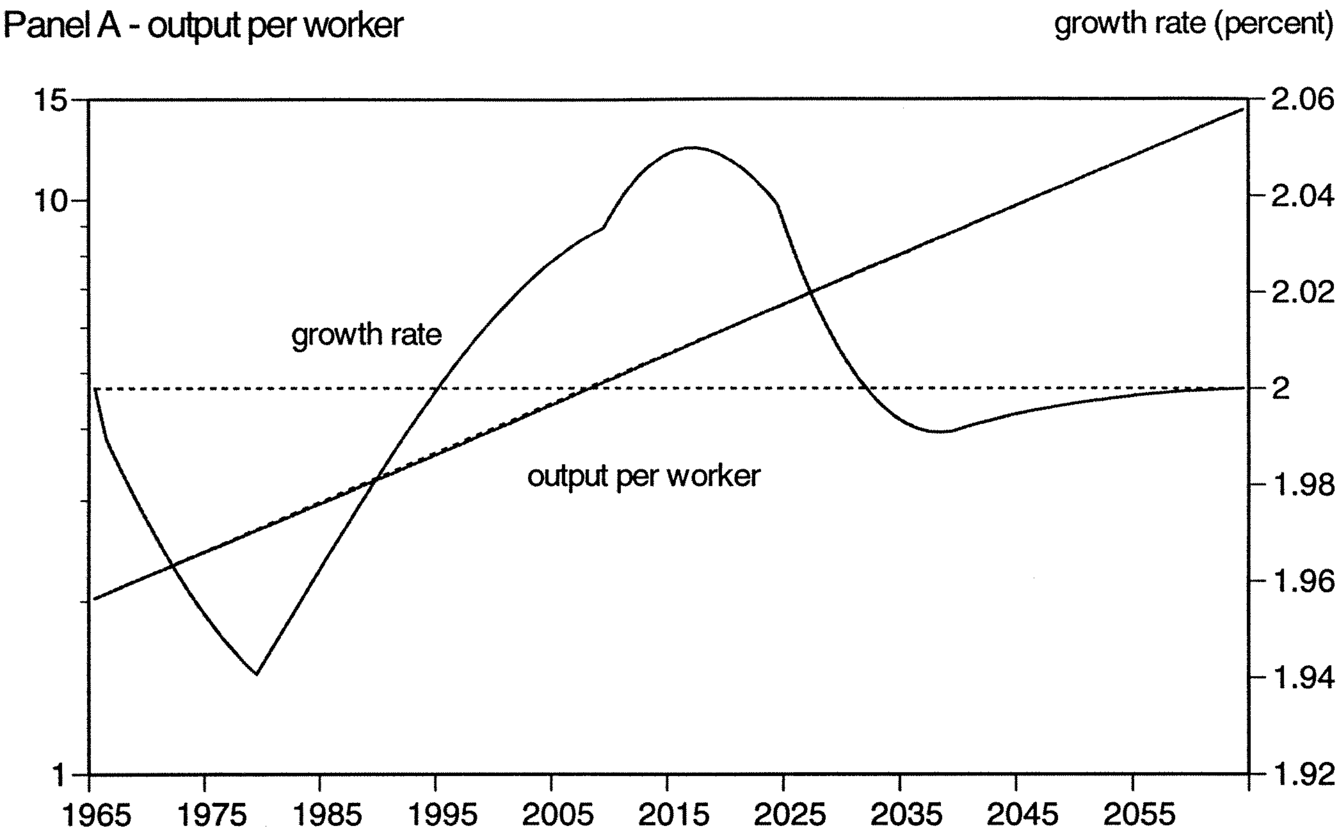
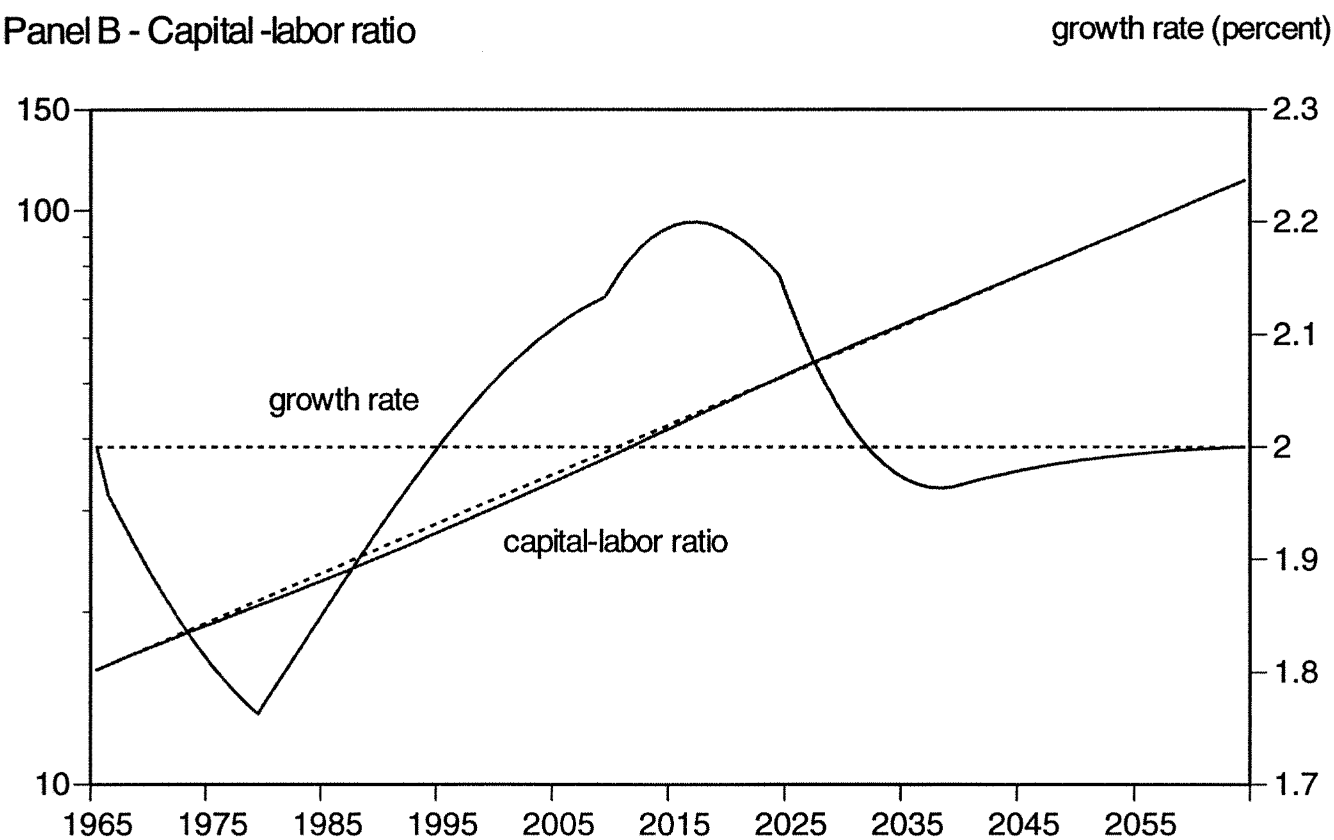


Figure 2: Output per Worker, Capital-labor Ratio

Panel A - output per worker



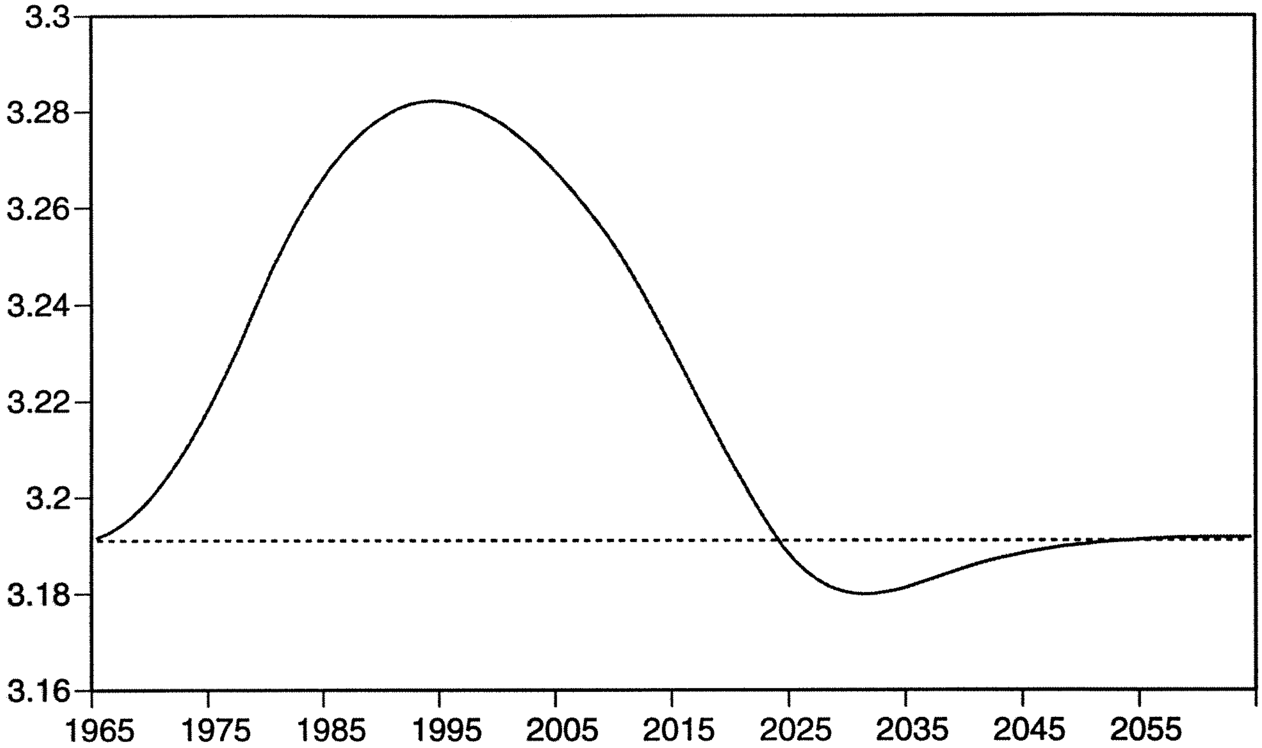
Panel B - Capital -labor ratio



solid - baby boom economy, dotted - no baby boom economy

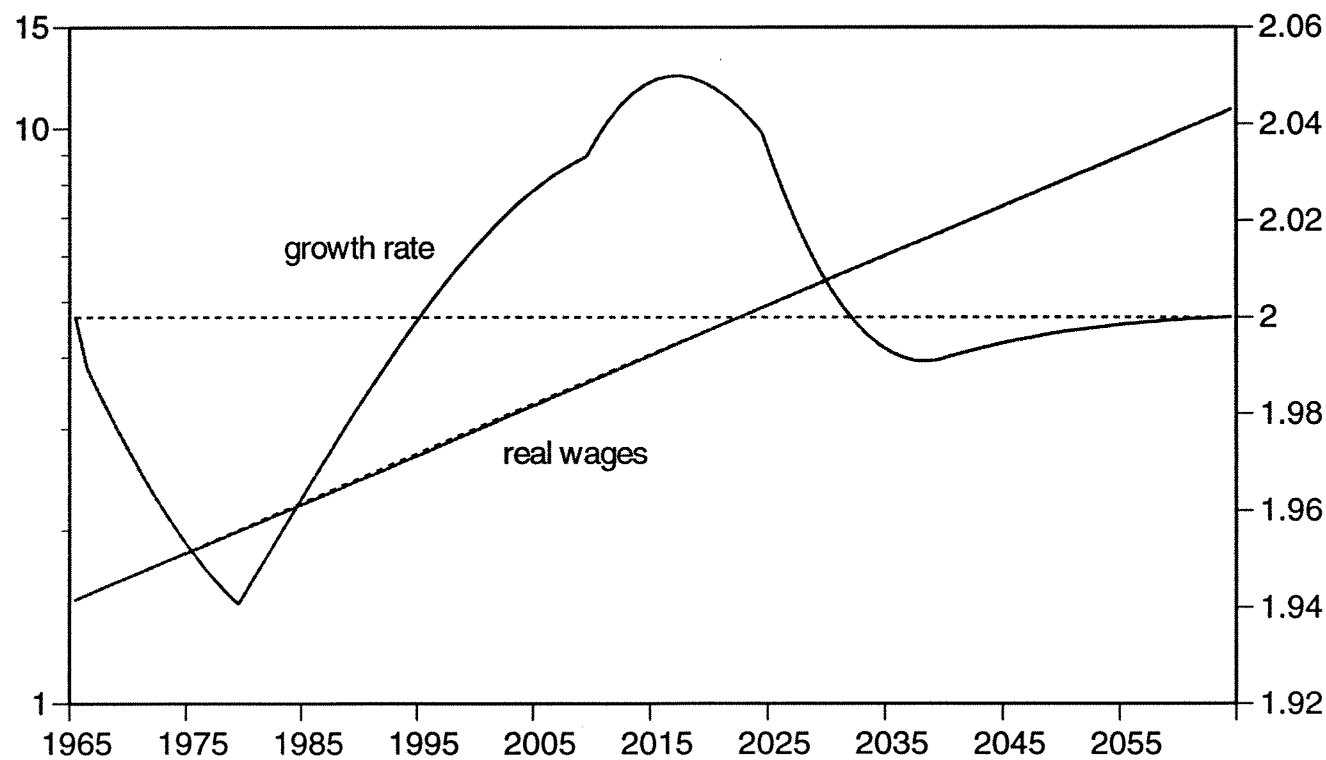
Figure 3: Returns to Capital, Real Wages

panel A - real rates of return to capital



panel B - real wages

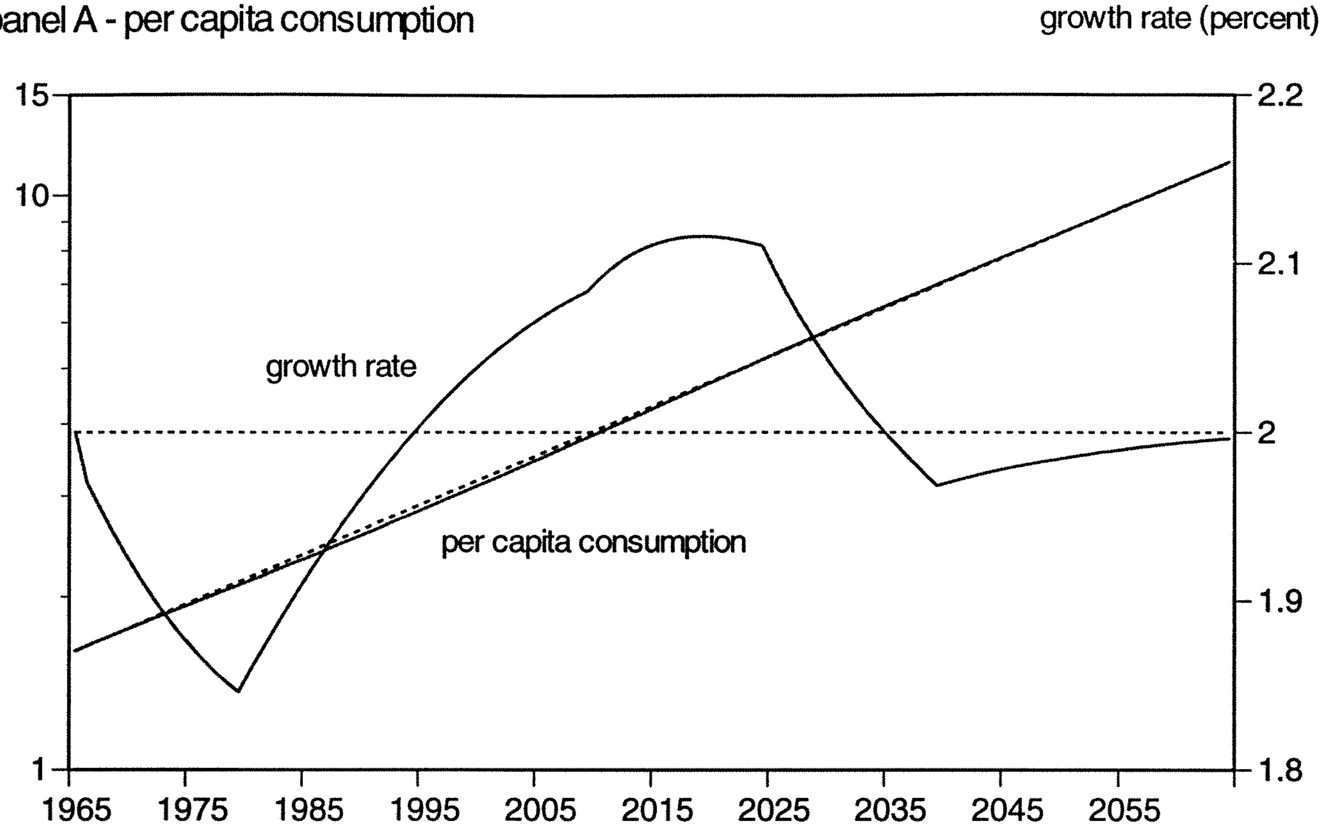
growth rate (percent)



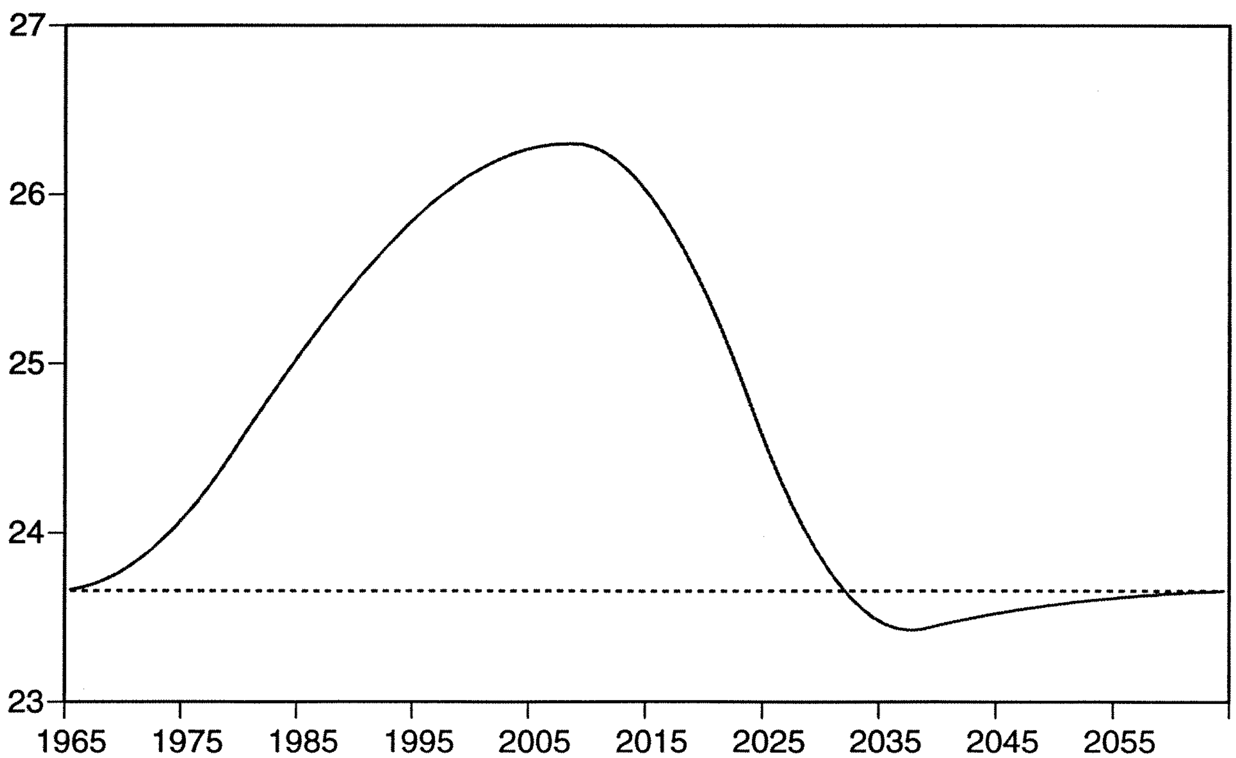
solid - baby boom economy, dotted - no baby boom economy

Figure 4: per capita Consumption, Saving Rate

panel A - per capita consumption



panel B - saving rate



solid - baby boom economy, dotted - no baby boom economy