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Boom or Bust? The Economic Effects of the Baby Boom

BETWEEN 1947 AND 1962, the population of the United States grew at an average annual rate near 2 percent, a large increase from the average annual growth rate near 1 percent during the 20 years prior to World War II. Moreover, since 1962, the average population growth rate has fallen to its pre-war level. This large but temporary increase in the population growth rate, more familiarly called the baby boom, raises an interesting and important question: How do such large changes in the population growth rate affect a developed economy? Undoubtedly, the baby boom has already had a large effect on the U.S. economy, especially on the composition of goods and services produced by the marketplace and the government. But the economic effects of the baby boom are more basic than the optimal mix of convertibles and minivans, or the number of school buildings vis-a-vis nursing homes, because such large changes in the population growth rate affect aggregate consumption and saving. Specifically, a large influx of workers requires more capital to maintain the same level of labor productivity, which in turn affects individual living standards.

Questions about growth of per capita income and consumption per capita are not limited to the entrance of the baby boomers into the economy but extend to its aging as well. In a life-cycle framework, individuals retire and consume their savings. This implies that if a large fraction of the population is retired, society will save less, perhaps even "dissave," and lower aggregate saving leads to a slower rate of capital formation. This possibility has caused a great deal of concern about the impending retirement of the baby boom generation. Lower saving, however, need not impose a drag on the economy. Just as the entry of the baby boom increases the demand for capital, the baby boomers' retirement decreases the demand for capital since their retirement decreases the labor supply. Thus, the mere retirement of the baby boom generation need not imply slower growth since the economy requires less capital. So what is the likely impact of the baby boom on the rate of capital accumulation and, thus, on the growth of income per capita and consumption per capita?

To answer this question, I turn to three models of economic growth that incorporate different aspects of demographic changes. Although the models cannot possibly capture all aspects of economic behavior that may affect the answer to the question posed above, they can provide insights about the fundamental relationship between population growth and the growth of output per capita. The models presented here, and models of economic growth in general, depend on accumulation of capital as the engine of growth of output per worker and standards of living. At any given time, agents either consume or invest their resources, so their saving-consumption decisions are critical determinants of how fast labor productivity will grow.

All three models presented here predict that a temporary and unexpected increase of population growth rate raises aggregate saving, but such an increase in saving is not necessarily large enough to maintain pre-boom rates of growth per capita income and standards of living. Once a baby boom has completely entered an economy, capital intensity tends to rise and the economy gradually returns to its pre-boom status. The three models disagree about the speed and magnitude of such changes, but all show that after a period of slow growth, per capita consumption increases. Best of all, the models indicate such improvements in the standard of living occur as even aggregate saving drops. This suggests that in isolation, the retirement of the baby boom need not imply diminishing standards of living.

The paper proceeds as follows. The first section presents a brief description of the baby boom's effect on the U.S. population. Next, I present three growth models and their predictions about the response of the economy to the baby boom. The models focus on the relationship between the population growth rate and capital accumulation since all other economic factors depend on saving and the resultant path of capital. The third section examines the recent performance of the U.S. economy to check the consistency of the models' qualitative predictions with observed economic data. The final section draws some conclusions about the baby boom and the economy.

THE BABY BOOM

Figure 1, top panel, shows Bureau of Census estimates of the annual growth rate of U.S. resident population since 1930 and its middle projections of the annual growth rate from 1994 to 2050.[1] The figure underscores the demographic importance of the baby boom. The baby boom was well under way by 1947 and lasted some 15 years. During the baby boom, the population growth rate was nearly double the 1 percent average annual growth rate during the 20 years prior to 1947. Once the baby boom ended, the population growth rate returned to an average annual rate near 1 percent. The top panel also shows the annual growth rate of the working-age population, all individuals ages 18 to 65, again based on Bureau of Census' estimates and projections. The size of the working-age population reflects the impact of the baby boom with a lag of 18 years.

The top panel does not, however, adequately reflect one of the key economic issues associated with the passage of a baby boom: What happens when the baby boom retires? From a life-cycle viewpoint, the baby boomers' retirement will dramatically increase the number of dissavers vis-a-vis savers, as well as the number of consumers relative to workers. One way to measure the relative sizes of the two segments of the population is the dependency ratio, which I define as the ratio of the number of consumers to the size of the potential labor force. The bottom panel of Figure 1 shows the dependency ratio for the United States between 1930 and 2050 based on the estimates and projections from the Bureau of Census. The ratio rises at the start of the baby boom since children only consume, falls as they pass into adulthood, and finally, rises again as they retire.

THREE MODELS

In this section, I present three exogenous growth models to analyze the effects of a baby boom on the U.S. economy:[2] the neoclassical model of Ramsey (1928); the dependency-ratio model of Cutler, Poterba, Sheiner and Summers (1992); and the overlapping generations (OLG) model of Yoo (1994). Each model provides a framework to examine the relationship between changes in the population growth rate and the capital-labor ratio, which in turn determines per capita income and consumption per capita. I present each model with its simulation results and then highlight the differences and similarities among the three models.

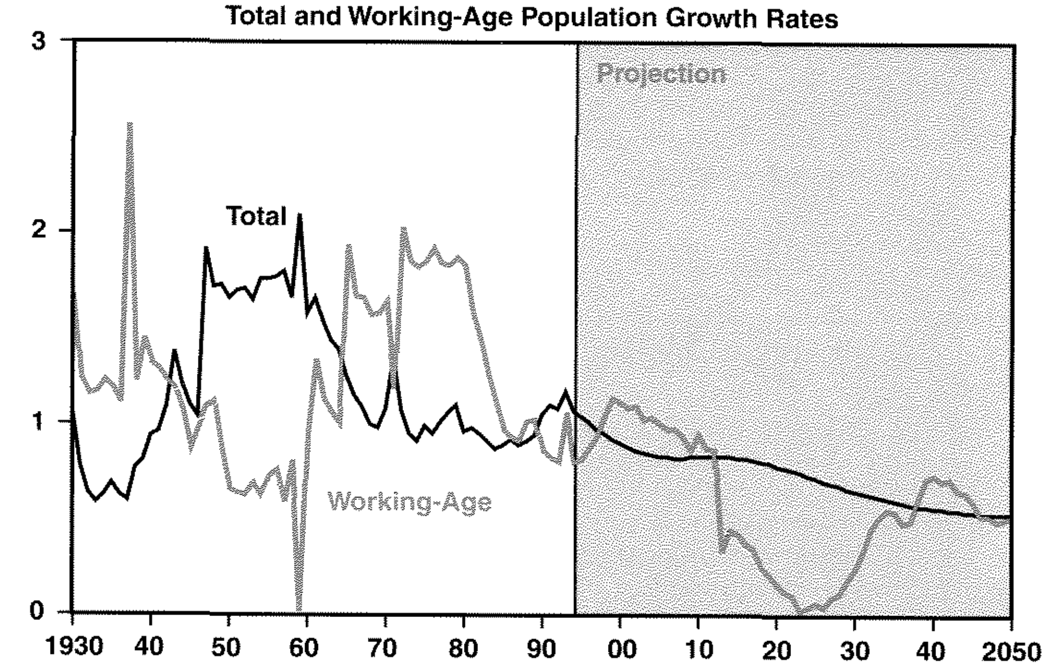
Neoclassical Growth Model

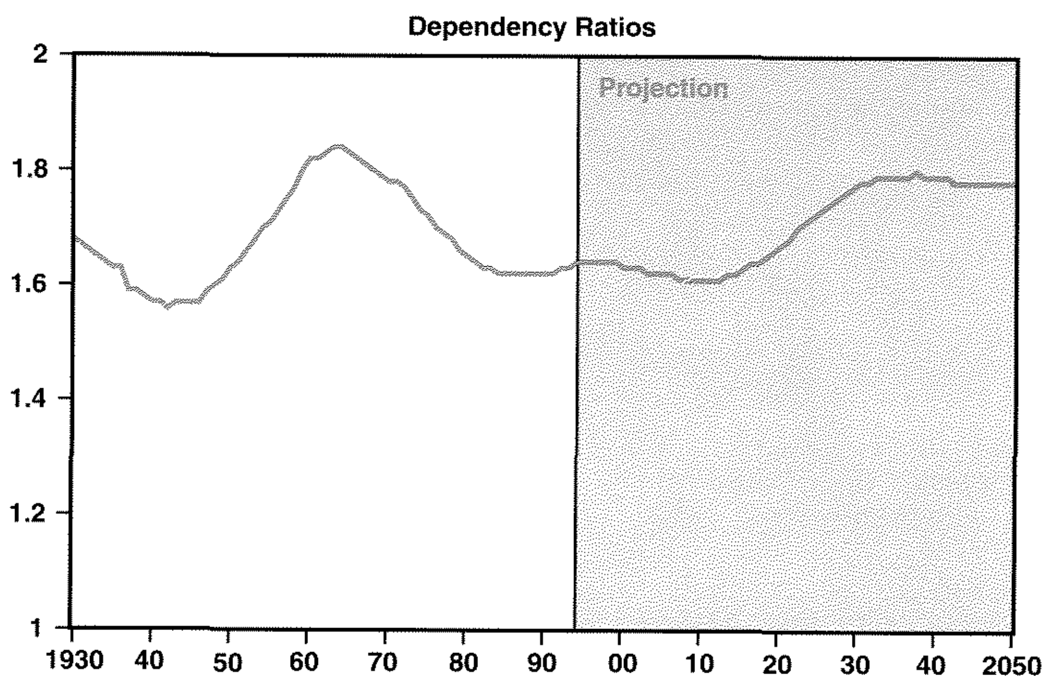
The simplest model that relates population growth rate to economic growth is the neoclassical growth model of Ramsey. The model has a benevolent social planner who, with perfect

[1] The Census Bureau regularly publishes three projections—lowest, middle and highest. They represent different assumptions about fertility, net immigration and life expectancy. See Current Population Reports, P25-1104, pp. xxxv-xxxix.

[2] Also see Auerbach, Kotlikoff, Hagemann and Nicoletti (1989) and Auerbach, Cai and Kotlikoff (1991).

Figure 1
U.S. Population Characteristics





foresight, maximizes the discounted utility function of a representative agent subject to the economy's resource constraints.[3] The solution to the social planner's problem is equivalent, under appropriate assumptions, to the competitive equilibrium in which individuals and firms maximize their utility and profits. The model also assumes each individual inelastically provides one unit of labor.

Formally, the central planner maximizes the utility function of a representative agent:

$$(1)\ \max U(c_t)=\int_0^\infty u(c_t)e^{-\delta t}\,dt,$$

subject to the budget constraint that output in each period equals consumption, net investment and capital for new entrants: [4]

$$(2)\ y_t=c_t+\dot{k}_t+n_t\,k_t,$$

where $U(c_t)$ is the instantaneous utility of a representative agent, δ is the subjective discount rate with $0 < \delta < 1$, c_t and y_t are consumption and output per unit of labor, k_t is the capital-labor ratio, and n_t is the population growth rate. I assume that the net production function of the economy is Cobb-Douglas to simplify the simulation:

$$(3)\ y_t=f(k_t)=k_t^\alpha,$$

where α is the output elasticity of output of capital, and $0 < \alpha < 1$.

The solution for the maximization problem is

$$(4)\ \frac{\dot{c}_t}{c_t}=\frac{1}{\rho}[f'(k_t)-\delta-n_t],$$

where

$$\rho\equiv-\frac{u''(c_t)}{u'(c_t)}c_t$$

is the coefficient of relative risk aversion. I assume that instantaneous utility is isoelastic with a constant coefficient of relative risk aversion, so that

$$u(c_t)=\frac{c_t^{1-\rho}}{1-\rho}.$$

This assumption also applies to all three models in this paper. In the steady state, the equilibrium capital-labor ratio yields the modified golden rule, which states that the marginal product of capital in steady state equals the sum of the subjective discount rate and the population growth rate.

$$(5)\ f'(k^*)=\delta+n^*,$$

where stars denote steady-state values of each variable. The corresponding optimum per capita consumption equals

$$(6)\ c^*=f(k^*)-n^*k^*.$$

To determine the dynamics of the economy near the steady state, I linearize equations 2 and 4 using a Taylor's series expansion. Solving the resulting system of second-order differential equations and ruling out the divergent path, the following equations describe the path of the economy near the steady state: [5]

$$(7)\ k_t=k^*+(k_0-k^*)e^{\lambda t},$$

where

$$\lambda\equiv\delta-\frac{1}{2}\sqrt{\delta^2+4\beta}$$

$$\beta\equiv-\frac{f''(k^*)c^*}{\rho}$$

and k_0 is the initial capital-labor ratio.

To simulate the economic effects of the baby boom, I assume that the U.S. economy starts at the steady state for slow population growth and introduces the baby boom. The economy then moves toward the new steady state associated with the faster population growth rate. Once the population growth returns to its pre-boom rate, the economy reverses direction and moves to the pre-boom steady state. Table 1 shows the

[3] The assumption of perfect foresight does not extend to the timing of the beginning or end of the baby boom. Rather, I assume that both the start and end of the baby boom are unanticipated shocks to the population growth rate. This assumption about the timing and the duration of the baby boom applies to all three models. This assumption affects the dynamics of the economy's response to the baby boom. If the timing of the baby boom were anticipated, the economy would react earlier to the beginning and the end of the baby boom.

[4] Multiplying the budget constraint by the size of the labor force gives the accounting identity $Y = C + I + G$, with G equal to zero.

[5] See Blanchard and Fischer (1989, chapter two) for more details.

Table 1
Simulation Parameter Values

Parameters	Description	Value
T	Lifespan (OLG model only)	60
T'	Working life (OLG model only)	45
n	Initial population growth rate	0.01
ϵ	Size of baby boom	0.01
τ	Duration of baby boom	15
δ	Subjective discount rate	0.01
ρ	Coefficient of relative risk aversion	2
α	Capital's share of output	0.33

parameters required to simulate this and the two other models.[6] Rather than using the actual population growth rates, which would unnecessarily complicate the simulations, the simulations use a stylized baby boom. As the top panel of Figure 1 indicates, the baby boom lasted approximately 15 years with an average growth rate of nearly 2 percent per annum, whereas the growth rate before and after the baby boom averaged nearly 1 percent per annum. I therefore assume that the pre- and post-baby boom population growth rate is 1 percent, the population growth rate during the baby boom is 2 percent, and the baby boom lasts for 15 years. Since the Ramsey model assumes all individuals in the economy provide one unit of labor inelastically, I also ignore childhood, pushing the start of the baby boom by 18 years to 1965.

Figure 2a shows three variables—the capital-labor ratio, the saving rate and per capita consumption—normalized by their respective paths in an economy without the baby boom. The first figure shows that an increase in the labor force depresses capital intensity; the higher population growth rate depresses the modified golden rule capital-labor ratio, which causes capital intensity to drop for 15 years until the entry of the baby boomers stops and the capital-labor ratio is some 10 percent below the pre-baby boom level. Thereafter, capital intensity converges to the pre-boom level but does so very slowly. Figure 2a also shows saving measured as fraction of output, again normalized by the no-baby boom economy. The Ramsey model shows a concentrated spike in saving, almost 20 percent higher than the no-baby boom saving rate. Once the population growth rate returns to pre-baby boom level, saving falls and eventually returns to its previous level. The last graph in 2a shows the path of consumption per capita normalized by the path of consumption in the economy without a baby boom, and it shows an initial drop in per capita consumption of 10 percent, but once the population growth rate returns to 1 percent, per capita consumption gradually returns to its original level.

The Dependency-Ratio Growth Model

One obvious problem with the Ramsey model is its inability to address the problem of the baby boomers' retirement because the model assumes that agents are homogeneous and that they are infinitely lived. Once an individual enters an economy, he or she is no different than any other individual at that time, and then has an infinitely long life. A recent paper by Cutler, Poterba, Sheiner and Summers introduces agent heterogeneity by incorporating a dependency ratio into the Ramsey model. This captures the effects of the retirement of the baby boom on the economy, albeit in a rather ad hoc manner. Cutler and others solve the model from a social planner's point of view with all individuals alive in each period weighted equally in the social welfare function. Unlike the Ramsey model, the command and decentralized solutions are not equal. The dependency-ratio model, therefore, gives a path for the economy that does not correspond to a market equilibrium.[7]

The command optimization problem is

$$(8)\quad \max U = \int_0^\infty u(c_t) N_t e^{-\delta t} dt ,$$

subject to resource constraint similar to equation 2,

$$(9)\quad y_t = \gamma_t c_t + \dot{k}_t + n_t k_t ,$$

where c_t is per capita consumption, y_t, k_t, δ and n_t are as previously defined, N_t is the population size, and γ_t is the dependency ratio at time t and equals

$$\gamma_t \equiv \frac{CON_t}{LF_t} ,$$

where LF_t is the labor force and CON_t is the number of consumers.

[6] See Auerbach and Kotlikoff (1987, chapter four) for a discussion about the selection of the preference and production parameters.

[7] The simulations presented in Cutler and others differ from the one presented here because they incorporate an age-dependent labor productivity profile into their simulations.

Figure 2a
Simulation Results: Ramsey Model

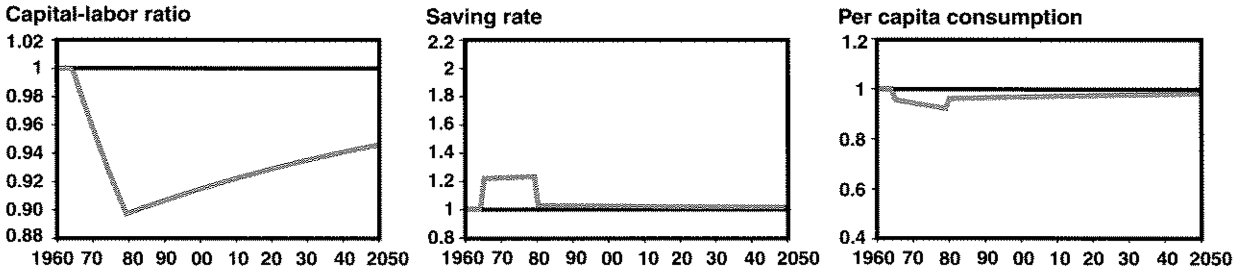


Figure 2b
Simulation Results: Dependency Ratio Model

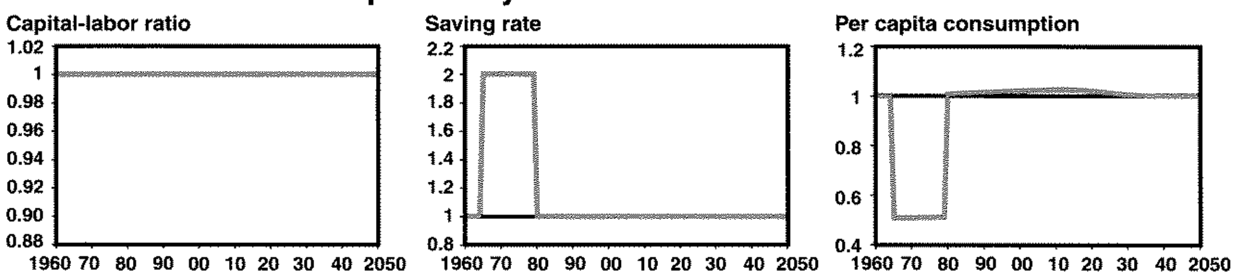
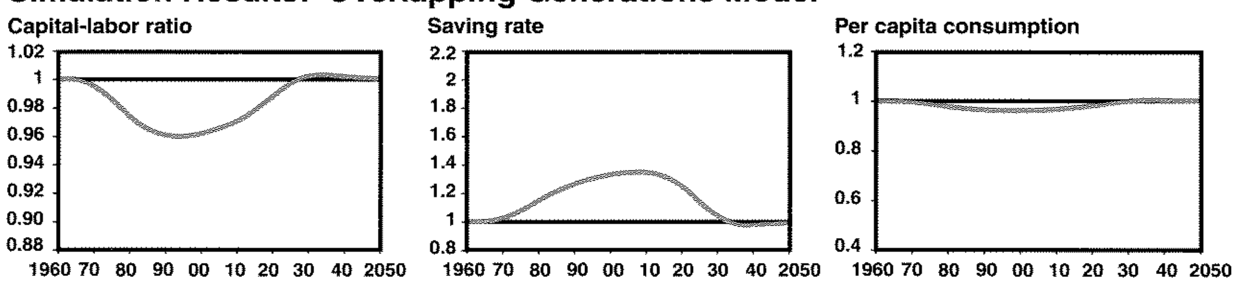


Figure 2c
Simulation Results: Overlapping Generations Model



The solution from the first-order conditions of the planner's problem is

$$(10)\quad \frac{\dot{c}_t}{c_t}=\frac{1}{\rho}[f'(k_t)-\delta].$$

In the steady state, equation 11 implicitly defines the optimum capital-labor ratio:

$$(11)\quad f'(k^*)=\delta .$$

The model has the interesting property that the steady-state capital-labor ratio is independent of all parameters except the subjective discount rate and the parameters of the production function. Thus, unlike the Ramsey model (or the overlapping-generations model), the capital-labor ratio does not adjust to changes in the population growth rate. Rather, consumption must respond to any unexpected changes in the population growth rate or to the dependency ratio, and furthermore, the response to such changes is instantaneous.

Although the dependency-ratio model of Cutler and others incorporate some agent heterogeneity into the problem, they do not consider the saving decisions of individuals, especially saving for retirement and, furthermore, Cutler and others solve the model from a social planner's viewpoint. These two facts produce a simple solution, but the solution requires substantial redistributions as the baby boom enters and exits the economy. Cutler and others use the existence of the Social Security system to justify their modeling choice and the resultant redistribution. But the redistributions required by the social optimum are not the redistribution scheme embodied by Social Security. In the model, a large unexpected increase in the population growth rate requires a large cut in consumption to finance a large increase in investment to maintain the constancy of the capital-labor ratio. Moreover, the end of the baby boomers' entry into the economy diminishes the rate of capital formation, causing a sharp increase in consumption. The transfers involved are opposite those provided by Social Security; the dependency-ratio model's solution transfers resources to the new entrants, whereas Social Security transfers wealth from the young to the elderly.

Figure 2b shows the results of the simulation from the dependency-ratio model. As before, I have normalized the results by the no-baby boom economy. As shown by the first graph and equation 11, the baby boom has no effect on the capital-labor ratio. The second graph in 2b shows saving as fraction of output, again normalized by the no-baby boom economy. Any changes in the growth of the labor force must be offset by changes in saving because the model requires a constant capital-labor ratio. Therefore, a doubling of the population growth rate requires a doubling of the saving rate to provide enough capital for the faster rate of population growth. Once the population growth rate reverts to the initial rate, saving returns to the baseline. Since output is either saved or consumed, per capita consumption reflects the path of saving. Figure 2b also shows the path of consumption per capita normalized by the path of consumption in the economy without a baby boom. Since the dependency-ratio model shows doubling of saving, consumption falls by 50 percent and indeed the third graph of 2b reflects such a drop. Once the boom is over, the increase in the number of workers supporting retirees implies less has to be saved and more can be consumed, although this does not last forever.

An Overlapping-Generations Growth Model

The model used by Yoo confronts some of the problems of the Ramsey and the dependency-ratio models by using the overlapping-generations framework. An individual with a finite lifetime and an explicit retirement period maximizes his or her utility subject to a lifetime budget constraint. I then aggregate each individual's decisions with the decisions of an optimizing firm to obtain a general equilibrium solution for the path of an economy confronted with an unanticipated baby boom. Unlike the other two models, the model uses discrete time periods, although this quantization is materially insignificant.

The individual born in period t faces the problem

$$(12)\quad \max \sum_{s=1}^{T} (1+\delta)^{1-s} u(c_{t+s-1,s}),$$

subject to the lifetime budget constraint that his or her discounted expenditures be no greater than the person's available lifetime resources:

$$(13)\quad \sum_{s=1}^{T'} \frac{w_{t+s-1}}{(1+r_t)^{s-1}} \geq \sum_{s=1}^{T} \frac{c_{t+s-1,s}}{(1+r_t)^{s-1}},$$

where $c_{t,s}$ is the consumption in period t of an agent s years old, T is the lifetime of an individual, T' represents the number of periods working and w_t and r_t are the real wage and the real returns to capital in period t.

The explicit solution comes from recursively solving the associated Euler equations, and it produces, under the assumption of static expectations, the following two equations, which describe the optimal saving-consumption decisions of an individual: [8]

$$(14)\quad c_{t+s-1,s} = \theta_s \left[\sum_{i=s}^{T'} \frac{w_{t+i-1}}{(1+r_t)^{i-s}} + (1+r_t) a_{t+s-2,s-1} \right],$$

$$(15)\quad a_{t+s-1,s} = \begin{cases} (1+r_t) a_{t+s-2,s-1} + w_{t+s-1} - c_{t+s-1,s} & \text{if } s \leq T' \\ (1+r_t) a_{t+s-2,s-1} - c_{t+s-1,s} & \text{if } s > T', \end{cases}$$

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 asset level of an agent s years old in period t which he or she holds as physical capital.

The sum of all individual savings equals the capital stock, and the number of working-age

[8] Static expectations imply that agents assume that future factor prices equal today's prices.

individuals equals the labor force of the economy:

$$(16)\ L_t = \sum_{s=1}^{T'} \varphi_t(s)$$

$$(17)\ K_t = \sum_{s=1}^{T} a_{t,s}\varphi_t(s),$$

where $\varphi_t(s)$, the age distribution, is the number of individuals age s in period t. I also assume markets are competitive and firms minimize costs so that factor prices equal their marginal product:

$$(18)\ r_t = f'(k_t)$$

$$(19)\ w_t = f(k_t) - f'(k_t)\,k_t.$$

Given a set of parameters, modeling the effects of a baby boom requires specifying the path of $\varphi_t(s)$ to reflect changes in the population growth rate. Once I have specified the parameters and $\varphi_t(s)$, calculating the effects of the baby boom becomes a series of iterations. First, equations 14 and 15 determine individual behavior, then given their saving-consumption decisions, equations 16 through 19 determine output and factor prices which become the basis for the next iteration, which again begins with 14 and 15.

Figure 2c shows the impact of the baby boom, simulated by the OLG model. An increase in the labor force depresses capital intensity, and the model shows declining capital relative to labor for a long period of time, nearly 30 years, in which the minimum is approximately 4 percent lower than the no-baby boom baseline.[9] Figure 2c also shows saving gradually increasing until all baby boomers are dead, reaching a peak near 2010 approximately one-third higher than the no-baby boom economy. The third figure shows the path of consumption per capita, and it indicates that consumption falls gradually, 5 percent below baseline. Consumption then rises for the following four decades until it reaches its initial level.

Comparing the Simulation Results

Comparing the nine graphs in Figure 2 indicates several similarities as well as several points of divergence. The figures indicate that the magnitude and the timing of the economic effects of the baby boom are the major points of divergence among the three models. Although the Ramsey and OLG models both show declining capital-labor ratios, the drop is much larger in the Ramsey model, 10 percent versus 4 percent. Furthermore, the Ramsey model predicts the trough will occur more than 10 years earlier than the OLG model, despite the fact that the Ramsey model requires substantially more time to return to the pre-baby boom steady state. The paths of saving also indicate responses of different magnitudes and timing, although the signs of the responses are the same. Both infinite horizon models show declining saving at the end of the baby boom, whereas the OLG model continues to increase until the first of the baby boomers are near retirement. Peak savings in the Ramsey and OLG models are similar in magnitude, and the much higher saving of the dependency-ratio model is attributable to the constancy of the marginal product of capital. The behavior of consumption per capita is very similar to that of saving, both in timing and magnitude; the two infinite-horizon models indicate that per capita consumption in the United States should have already rebounded from the depressed state induced by the entry of the baby boomers, with the dependency-ratio model suggesting a significantly bigger response to the baby boom. The OLG model, in contrast, suggests that we should be now near the trough of the fall in consumption.

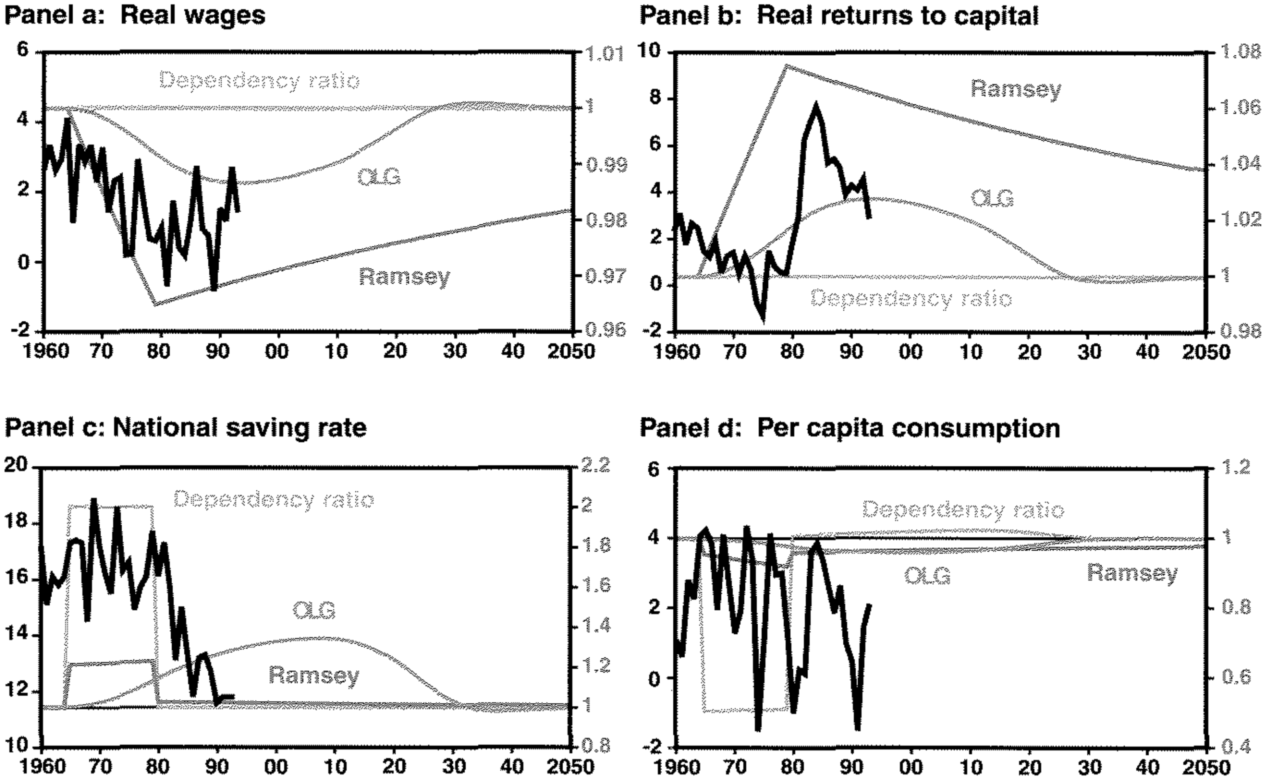
The most striking point of agreement among the three models is the response of the consumption and saving relationship to the passage of the baby boom. All three models predict that an unexpected baby boom causes a temporary increase in saving and an associated temporary drop in per capita consumption. Most importantly, the return to the pre-baby boom saving rate that occurs in all three models coincides with an increase in consumption. This counterintuitive result arises because the demand for capital diminishes as the population growth rate slows. Moreover, the overlapping-generations model shows that even with the baby boomers dissaving in retirement, consumption per capita continues to increase. These results suggest that current concerns about an economic decline following the retirement of the baby boomers may be unfounded.

U.S. EXPERIENCE THUS FAR

Figure 3 shows a series of comparisons between observed data and simulation results.

[9] The relative smoothness of the OLG model is partially attributable to the static expectations assumption.

Figure 3
Observed Data vs. Simulation Results



Scale: observed data; left, simulation; right

It is important to note that the actual data is not normalized; therefore, the magnitudes of the actual data and the simulation results are not directly comparable. Panels a and b show real wages and real returns to capital rather than capital-labor ratios. Since the two factor prices are monotonic transforms of the capital-labor ratio, they should provide a reasonable alternative to directly comparing observed and simulated capital-labor ratios. Panel a shows the annual growth of real wages, as measured by hourly compensation, compared to the wages from the three models, which I have also normalized by the no-baby boom wages. Growth of real wages has been on a downward trend that is consistent with the predictions of the Ramsey and OLG models. Panel b shows the real returns to capital, measured by long government yields less CPI inflation, compared to returns to capital from the three models, also normalized by the no-baby boom baseline. Although the rise of real long government bond yield during the 1980s is consistent with the OLG model, its relationship to the simulated returns to capital is ambiguous.

Panels c and d provide direct comparisons between observed and simulated paths of saving and consumption. Once again, I have normalized the simulated results by the baseline economy with no-baby boom. As shown in panel c, the observed saving rate, measured by the national saving rate, has fallen recently, as predicted by the Ramsey and the dependency-ratio models, but the drop does not correspond to a reversion to pre-baby boom rates. The observed behavior of the real annual growth of consumption per capita is more consistent with the paths from the three models' predictions. The growth of consumption has gradually slowed since the start of the baby boom as predicted by all three models, especially the OLG model, since the Ramsey and dependency-ratio models indicate that consumption should have already returned to near pre-baby boom levels.

PROGNOSIS

As the models show, demographic factors can play an important role in macroeconomic performance, mostly at low frequencies. Given the simple and stylized simulations reported in this paper, the correspondence between simulation and observed low-frequency movements in several important macroeconomic variables is noteworthy. Slow wage growth and diminished consumption growth are consistent with the predictions of the models, especially the OLG model. The evidence from saving rates and the real returns to capital is less clear.

What does the baby boom imply for future growth and welfare? The models suggest a faster rate of consumption growth, along with declining real returns to capital and higher wages that accompany higher labor productivity. Moreover, these benefits occur throughout the remainder of the baby boom generation's lifetime, including retirement. Thus, even as they dissave, according to the OLG model, consumption per capita will continue to increase.

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