Generational conflict, fiscal policy, and economic growth

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Abstract

Worldwide, dependency ratios are forecast to increase dramatically in the next 50 years. A great deal of attention has been devoted to understanding the changes in fiscal policies that “must” take place to accommodate these changes and maintain desirable rates of economic growth. In contrast, less effort has been concentrated on studying the fiscal shifts that will endogenously result from demographic pressures. In particular, will a more elderly population support spending for those programs (e.g., education) that most directly augment the earnings of the young? If not, will this reduce economic growth? We investigate the effect of demographic transition on the endogenous determination of productive public spending. A demographic transition alters the identity of the median voter, leading to a preference for less spending. While this may reduce productive spending, it may also reduce tax rates and raise capital per worker. Simulations, calibrated to empirical estimates of the economic return to education, suggest that demographic transition will reduce output, despite a larger capital stock, unless education services become more productive in raising human capital.

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1. Introduction

It is now widely understood that through a combination of lower fertility rates and longer life expectancies, most economies will “age” in the 21st century. The old-age dependency ratio (defined as the ratio of elderly persons to non-elderly adults) is forecast to increase by 75% between 1990 and 2040 in the United States, by 116% in Germany, and by 133% in Japan. The phenomenon, however, is confined neither to the West, nor to rich countries. For example, the newly industrialized countries of Southeast Asia, which have relatively low initial dependency ratios, face a 128% increase in their average level of dependency.

The strain this transition will place on social security systems, and saving rates more broadly, has been well documented (for example, Cutler et al., 1990; Börsch-Supan, 1992, 1996). In these studies, the neoclassical growth model is used to illustrate the “necessary” changes in saving and growth that policymakers should contemplate to address the demographic transition.

However, demographic transition itself will likely alter public support for government programs, and thus endogenously alter fiscal policy. It is surprising that the implications of an aging population for productivity-enhancing public programs has received less attention. For example, recent research has emphasized the important role of human capital in economic growth (see, e.g., Mankiw et al., 1992), the accumulation of which depends in part on public programs. Alternatively, social expenditure for basic research may be a key determinant of technological progress. In general, if the elderly do not support programs from which they do not directly benefit, it raises the possibility that demographic transition may undermine the level of public spending for productivity-enhancing social infrastructure and, hence, harm long-run economic welfare.

Our goal is to examine the link between aging populations, old-age preferences for public programs, and economic performance. To focus squarely on the role of endogenous spending and the impact of aging, we base our analysis on a standard overlapping-generations model of economic growth. We use a simple median-voter framework to represent the political process. In this context, a
slowdown in the population growth rate raises the average age of the population and alters the level of public spending. In the interests of simplicity alone, we refer to the government spending program as “education,” and this certainly is one possible avenue for the effects. However, we emphasize that our analysis applies to any social program whose direct effect is to raise the labor productivity of the working-age population. In the education example, the change in spending alters the level of human capital, saving, and consequently the level of per-capita income.

The next section presents our modeling strategy and derivation of individuals’ policy preferences. The third section describes the political process and majority voting. In the fourth section, we characterize the equilibrium and trace the evolution of the economy. Next we investigate the effects of demographic transitions on steady states. In the sixth section, we simulate the steady-state effects; the seventh section presents simulations of the transitional dynamics. The final section contains concluding comments and suggestions for further research.

2. Modeling strategy and policy preferences

We base our analysis on a conventional overlapping-generations model (Diamond, 1965) in which individuals live for two periods. Each period, a cohort of size \( N_t \) is born, where \( N_t = (1 + \eta)N_{t-1} \). The population at any point consists of a large number of “old” and “young” and, thus, is of size \( N_t + N_{t-1} \). Note that \( \eta \) determines both the growth rate of the total population and the ratio of old to young, which equals \( \frac{1}{1+\eta} \). Demographic transition is introduced as a decrease in \( \eta \), which raises the dependency ratio.

We focus our discussion of fiscal policy on a single type of government spending financed by a flat income tax on the labor income of the young and the capital income of the old. To highlight the possibility for generational conflict, we posit that the public good enhances the productivity of labor. There is no consumption demand for the public good per se; demand derives solely from its effect on the income of the young. Moreover, there are no deliberate transfers from the old to the young or vice versa. With these modeling choices, there is no gain in utility for the currently
old cohort from the provision of public services to the young and generational conflict is maximized.  

The conventional overlapping-generations framework provides a rather sterile theory of public choice: the young will all want the same, positive level of the publicly provided good while the old will want none. A median-voter representation of the political process leads to a simple counting of generational size. With positive population growth, the young will always outnumber the old, the young will always determine the political outcome, and (because the young are identical), there will be a single level of human capital.

To address these shortcomings, we posit a distribution of abilities within each generation. The ability of individuals ranges from 0 to 1, and the density function of abilities for each generation is denoted by \( f(a) \). By definition, the density function satisfies \( \int_{0}^{1} f(a) \, da = 1 \). As described below, high-ability individuals benefit more (acquire more human capital) from a given amount of government spending than do low-ability individuals. Thus, the economy will display a distribution of human capital and income. For this reason, the distribution of ability leads to a distribution of preferred spending levels.

Turning to specifics, each individual is assumed to have a lifetime utility function given by

\[
U = \ln c_j + \left[ \frac{1}{1 + \delta} \right] \ln c_{j+1},
\]

where \( c_j \) is consumption of a member of generation \( j \) when young, \( c_{j+1} \) is consumption when old, and \( \delta \) is the pure rate of time preference. When young, the individual supplies one unit of “time” to the economy. However, “effective” labor units (\( e \)) are dependent upon \( a_i \), the ability level of individual \( i \). That is, effective labor

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8 Notice that despite our use of the term “dependency ratio,” our model does not contain explicit provision of old-age consumption via government programs (e.g., Social Security). Meijdam and Verbon (1996), in contrast, analyze the effect of aging on the political decision making for public pensions in an overlapping-generations model. As in the current paper, they find that with growth an increase in the political power of the old may not alter fiscal choices in the direction expected in the absence of growth. Kaganovich and Zilcha (1999) study the effect of various allocations of tax revenues to education and social security benefits on growth. Their model does not, however, permit this allocation to be endogenously determined.

9 We assume that the distribution of abilities is the same in all generations so as not to confound the effect of changes in size of generations (demographic shift) with changes in the composition of generations.

10 An alternative strategy is to model the life cycle using three (or more) periods. This approach permits richer life-cycle profiles for earnings and demands for public programs. It comes at the expense, however, of clarity and tractability, and does not alter the basic analysis of demographic pressures.

11 Holtz-Eakin (1993), in an overlapping-generations framework, obtains a distribution of preferences for a publicly provided good by introducing the possibility that not all individuals born at time \( t \) survive to time \( t + 1 \). This assumption generates “accidental bequests” inherited by members of the next generation and induces a distribution of incomes within the younger generation.

12 Our choice of logarithmic utility simplifies the analytics, but does not affect our substantive findings. We return to this in our sensitivity analysis below, where we compare results from the logarithmic utility case to the constant-relative-risk-aversion case.
Labor income is thus $w_t e_t(a_i)$, where $w_t$ is the wage at time $t$. The individual pays taxes on labor income and capital income at the rate $\tau_t$. Given these arrangements, the young person of ability $a_i$ is faced with a budget constraint of the form

$$c_j(a_i) + s_j(a_i) = \theta_t w_t e_t(a_i),$$  \hspace{1cm} (2)

where $\theta_t = (1 - \tau_t)$ and $s_j$ is first-period saving. Old-age consumption is financed by saving:

$$c_{j+1}(a_i) = (1 + r_{t+1}\theta_{t+1})s_j(a_i),$$  \hspace{1cm} (3)

where $r_{t+1}$ is the return to capital in the economy. Effective labor units are also dependent upon human capital acquisition. We assume that labor productivity depends on the interaction of ability and productivity-enhancing expenditures by the government (“education”). The production function for human capital shows the dependence of human capital acquired on the interaction of ability and educational spending:

$$e_t(a_i) = A_H [a_i g_t + 1]^{\psi},$$  \hspace{1cm} (4)

where $A_H$ is an efficiency index, and $e_t(a_i)$ is the human capital acquired by a person of ability level $a_i$ when provided with $g_t$ of education spending per young person. \(^{14}\)

To rule out increasing returns in public service provision, we restrict the value of $\psi$ to be less than unity. The form of (4) ensures that individuals of the lowest ability ($a_i = 0$) provide some productive labor to the economy and that higher ability individuals provide an amount dependent on their own ability level and $g_t$.

The young maximize (1) subject to (2)–(4). Taking $g_t$ as given, the first order condition for the choice of $c_j$ is

$$c_j(a_i) = (1 + \delta) s_j(a_i).$$  \hspace{1cm} (5)

Using Eq. (5) and the budget constraint, the optimal saving of a young person in generation $j$ is given by

$$s_j(a_i) = \left[ \frac{1}{2 + \delta} \right] \theta_t w_t e_t(a_i),$$  \hspace{1cm} (6)

which does not depend on fiscal policy in future periods. \(^{15}\)

\(^{13}\) In the context of our model, allowing an endogenous allocation of time between “schooling” and supplying labor does not change our analysis. All young workers, regardless of ability, will choose to allocate the same proportion of time to supplying labor.

\(^{14}\) We assume education services are equally distributed among all ability types, as in Epple and Romano (1996b). Equal division introduces a distortion in that the marginal product of educational services is not equalized across young people of different abilities.

\(^{15}\) This independence is a direct result of our choice of logarithmic utility, and greatly simplifies the analytics. We relax this restriction in our simulation analysis. That saving does not depend on future fiscal policy is also due to the absence of transfers from young to old, such as social security. As noted in the text, we abstract from such transfers to highlight the political economy of expenditures that benefit the young.
Thus far, fiscal policy has been taken as given. However, each member of the young generation will have a preferred policy mix that balances the benefits of spending with the tax-associated costs. To characterize this preferred policy, we substitute the consumption functions (7) and (8) into the utility function (1), yielding the indirect utility function

\[ V_t(a_i) = \ln(1 + \delta) - \frac{2 + \delta}{1 + \delta} \ln(2 + \delta) + \frac{2 + \delta}{1 + \delta} [\ln \theta_t + \ln w_t + \ln e_t(a_i)] \]

\[ + \frac{1}{1 + \delta} \ln(1 + r_{t+1} \theta_{t+1}). \]  

(9)

In this economy, each voter has measure zero, so individual voters cannot view their decisions as influencing the aggregate political outcome. Because voters see no strategic gain from misrepresenting preferences, however, we assume each voter chooses her most preferred tax rate. In doing so, we assume that each voter views herself as small relative to the economy, and thus takes \( w_t \) and \( r_{t+1} \) and \( \theta_{t+1} \) as given. 16 As a result, the preferred value of \( \tau_t \) will maximize current after-tax income, subject to the government budget constraint, \( \tau_t y_t = g_t \), where \( y_t \) is income per young person, which is also taken as given by an individual voter. This preferred tax rate is

\[ \tau_t(a_i) = \frac{a_i \psi y_i - 1}{(1 + \psi)a_i y_i}. \]  

(10)

Note that the preferred tax rate depends directly only upon the current level of aggregate income per worker and the individual’s ability. 17 It is straightforward to verify that \( \tau_t(a_i) \) is increasing in \( a_i \). Also, higher-ability individuals will have higher individual incomes and receive a disproportionately higher marginal value of addi-

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16 Voters are assumed to be myopic concerning the impact of their decision on future macro variables. This myopia matches the one-shot nature of the interaction between generations: there are no transfers in future periods implied by this period’s taxation. Voting occurs each period and a majority benefits from current period policy. In contrast, Cooley and Soares (1999b) investigate an intergeneration transfer scheme (social security) in which sustainability of a pay-as-you-go system derives from a reputational mechanism. Without future payoffs, a majority will not benefit from non-zero taxation. Because of their emphasis on sustainability, Cooley and Soares assume forward-looking, rather than myopic, agents.

17 It is useful to note that the solution for the preferred tax rate is the same for all utility functions of the constant-relative-risk-aversion form. In particular, our solution is not specific to logarithmic preferences.
tional spending. Combining these two effects, (10) implies a positive income elasticity for the preferred tax rate.\footnote{In the United States, where education is funded primarily by local property taxes, the income elasticity of demand for education expenditures is positive but less than unity. Measured income elasticities are in the range of 0.40–0.65 (Fisher and Papke, 2000). The income elasticity implied by the preferred tax rate (10) is positive and may be less than or greater than unity depending on the value of \(\psi\) and the ability of the voter.}

Decision making by the old is trivial. They receive no benefits, but face taxes on capital income from their first-period saving. As a result, every member of the old generation has the same preferred tax rate of
\[
\tau_{j-1,t} = 0. \tag{11}
\]
Note that older voters do not incorporate general-equilibrium impacts on the return to capital into their voting strategies, consistent with each voter being small relative to the economy.

3. The political process

Following a long tradition dating to Black (1948), we adopt a median-voter approach to public choice. The median-voter model is appropriate in the context of our model for several reasons. First, the choice facing voters is over a single dimension and voters’ preferences have a single peak. Thus, it is possible to define a median voter. Second, in the context of the overlapping-generations model, our use of the median-voter model in effect assumes only that over relatively long periods the public sector is responsive to voter preferences. It need not rule out short-run rigidities, bureaucratic agency problems, or monopoly power that are important aspects of criticisms of the median-voter model.\footnote{See Romer and Rosenthal (1983) for an overview of the model’s uses and limitations.}

The median voter is that voter whose preferred tax and spending policy would win a majority of votes against any other feasible alternative. To win a majority, a proposed fiscal combination must achieve votes equal to \((N_{t-1} + N_t)/2\). Because the preferred tax rate of the old is zero, there will be \(N_{t-1}\) voters who will always prefer the smaller of two proposed tax rates.\footnote{Note that it is not important that the preferred tax rate of the older generation be exactly zero. In practice some older voters will have a positive preferred spending level. For purposes of solving the model, however, assuming that individuals follow only their narrow economic self-interest makes it easy to identify the median voter precisely and solve the political–economic equilibrium explicitly.} Among the young, those with lesser ability prefer a lower tax rate than those with greater ability. Thus, the median voter, denoted by her ability level \(a_m\), is defined by
\[
N_{t-1} + N_t \int_0^{a_m} f(a) \, da = \frac{N_{t-1} + N_t}{2}. \tag{12}
\]
Given a value for \(a_m\), the actual budget and spending policies of the economy may be calculated using (10) and the government budget constraint. The tax and spending
values that determine consumption, saving, and human capital accumulation are those of the median voter.

4. Production, equilibrium and dynamics

Total output in the economy is governed by the production function

\[ Y_t = A_Y K_t^x H_t^{1-x}, \]  

so that output per young person is

\[ y_t = A_Y k_t^{x} h_t^{1-x}, \]

where \( A_Y \) is a productivity index, and lower-case quantities are per young person, i.e., \( k_t = K_t / N_t \) and \( h_t = H_t / N_t \). Total human capital depends on government spending and the distribution of ability. The aggregate supply of human capital is defined as

\[ H_t = N_t \int_{0}^{1} e(a) f(a) \, da. \]  

Using (4), human capital per young person is

\[ h_t = A_H \int_{0}^{1} [ag_t + 1]^{\psi} f(a) \, da. \]  

Given levels of human capital, labor is supplied inelastically and the labor market clears when the wage is equal to the marginal product of labor:

\[ w_t = (1 - \alpha) A_Y \left[ \frac{k_t}{h_t} \right]^x. \]  

Similarly, equilibrium in the market for capital inputs occurs when the real rental price of capital equals the marginal product of capital:

\[ r_t = \alpha A_Y \left[ \frac{k_t}{h_t} \right]^{x-1}. \]  

Because of differences in human capital within a generation, supplies of capital (saving) differ across individuals. Aggregating individual saving (6) using (15), saving per young person is

\[ s_t = \left( \frac{1}{2 + \delta} \right) \theta w_t A_H \int_{0}^{1} [ag_t + 1]^{\psi} f(a) \, da. \]  

Capital market equilibrium requires

\[ k_{t+1} = \frac{s_t}{1 + \eta}. \]
Combining (18) and (19), capital per young person evolves according to

$$k_{t+1} = \left[ \frac{1}{(1 + \eta)} \right] \left[ \frac{1}{2 + \delta} \right] \theta_t w_t A_H \int_0^1 (a g_t + 1)^\eta f(a) da. \tag{20}$$

As can be seen directly from Eq. (20), fiscal policy choices ($\theta_t, g_t$) have an important influence on the evolution of capital in the economy. Moreover, the evolution of the economy itself affects the adopted tax policy, as Eq. (10) shows that the preferred tax rate of any individual depends on income per person. These dynamics are potentially quite complicated, but our choice of logarithmic preferences makes it possible to describe analytically the effects of population aging on the steady state of the economy. Once we have examined these steady-state effects, we use numerical simulations to gauge the sensitivity of our steady-state analysis to different values for several key parameters. We also employ numerical simulations to trace out the transition path between steady states that results from a rise in the dependency ratio.

5. Steady-state implications of demographic transition

As in the conventional overlapping-generations model, the steady state is characterized by $k_{t+1} = k_t$. This equality simultaneously implies constant values for human capital per worker, income per worker, education spending per young person, preferred tax rate of the median voter, and ability of the median voter. The steady state will be disrupted by a demographic transition, i.e., by a decrease in $\eta$. To see how a decrease in $\eta$ alters the steady state, we begin by differentiating (12) to show that the ability of the median voter will fall:

$$\frac{da_m}{d\eta} = \frac{1}{2} \frac{1}{(1 + \eta)^2} \frac{1}{F'(a_m)} > 0. \tag{21}$$

The location of the median voter in the ability distribution changes because when $\eta$ decreases the number of old people relative to the number of young people rises. With relatively more old voters, a majority can be formed with fewer young voters, and the median voter becomes a young person with a lower ability. Note that as a consequence, the median-voter’s preferred tax rate will immediately be lower, even at the income level of the initial steady state.

To pursue further analytic solutions for the effect of a decrease in $\eta$ on the steady state of the economy, we are forced to choose a specific distribution for ability. Thus, we assume that ability among the young follows a uniform distribution. While the uniform distribution is special, the key insights of the model do not depend on it. As we have just shown, a decrease in the population growth rate creates a median voter with a lower ability. Therefore, regardless of the ability distribution, the tax rate chosen (at any given average income level) will be lower when the population

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21 In a related model, Glomm and Ravikumar (1995) show that the overlapping-generations model may yield multiple equilibria. Our choice of utility function eliminates this possibility.
grows more slowly. It is this reduction in desired tax rates, rather than the specific ability distribution, that produces our key results.

5.1. Steady-state comparisons

The condition for capital market equilibrium holds in both the initial and the post-transition steady state. Noting that \( k_t = k_{t+1} \) in the steady state and denoting steady-state values by the absence of time subscripts, total differentiation of (19) yields

\[
\hat{k} = \hat{s} - (1 + \eta),
\]

where \( \hat{x} = \frac{dx}{x} \) indicates the proportionate change from one steady state to another. Saving per young person is given by (18), which can be totally differentiated to yield

\[
\hat{s} = \hat{w} + \hat{h} - \Delta \hat{x},
\]

where \( \Delta = \tau/(1 - \tau) \). The change in human capital depends on the adjustment in steady-state education spending. Recalling our assumption that the ability distribution follows a uniform distribution, and integrating (15), human capital per worker, defined as the aggregate stock of human capital divided by the number of workers, is

\[
\hat{h}_t = \frac{A_H}{(\psi + 1)g_m} \left[ (1 + g_m)^{\psi+1} - 1 \right],
\]

where \( g_m \) is the level of spending preferred by the median voter at time \( t \). Totally differentiating and evaluating at the steady state,

\[
\hat{h} = \varepsilon_{hg} \hat{g}_m,
\]

where \( \varepsilon_{hg} \) is the elasticity of human capital per worker with respect to government spending \(^{22}\).

Government budget balance restricts the change in the steady-state level of spending:

\[
\hat{g}_m = \hat{\tau}_m + \hat{\gamma}.
\]

The change in steady-state spending must also conform to the new political equilibrium. Differentiating the expression for the median voter’s preferred tax rate (10),

\[
\hat{\tau}_m = \varepsilon_{\tau_a} \hat{a}_m + \varepsilon_{\tau_\gamma} \hat{\gamma},
\]

\(^{22}\) Given the form (4), the relationship between aggregate human capital and educational spending is

\[
\varepsilon_{hg} = \frac{1}{(1 + g_m)^{\psi+1} - 1} \left[ (\psi g_m - 1)(1 + g_m)^{\psi} + 1 \right].
\]
where the elasticities of the preferred tax rate with respect to ability and income are:

$$
\varepsilon_{ea} = \varepsilon_{ey} = \frac{1}{a_m \psi y} - 1,
$$

(28)

and these elasticities are positive for positive. Finally, turning to steady-state production, differentiation of (13) yields

$$
\dot{y} = \alpha \dot{k} + (1 - \alpha) \dot{h}.
$$

(29)

The change in the wage also depends on adjustments to physical and human capital; using (16),

$$
\dot{w} = \alpha (\dot{k} - \dot{h}).
$$

(30)

5.2. Demographic transition without endogenous politics

Since we wish to highlight the importance of endogenous policy, it is useful to establish as a baseline the effect of demographic transition without politics. Thus, we begin by deriving the effect of a change in $g$ on the steady-state capital stock and income, assuming that the level of education spending per young person remains fixed. 23

Because $g$ is fixed, the level of human capital is fixed. Consequently,

$$
\dot{y} = \alpha \dot{k}.
$$

(31)

Also, by assumption, the tax rate is affected only by income changes that make it easier or harder to finance $g$:

$$
\dot{\tau} = -\dot{y}.
$$

(32)

Noting that wages grow at the same rate as income, and using (22), (23), (31) and (32),

$$
\dot{k} = -\frac{1}{1 - \alpha (1 + \Delta)} (1 + \eta).
$$

(33)

Stability of the intertemporal equilibrium requires $1 > \alpha (1 - \Delta)$ so a decrease in leads the economy to a steady state with a higher level of capital per worker. 24 In keeping with this result, steady-state income per young person, consumption, and the wage also rise. This is a well-known result from the conventional neoclassical growth model. Lower population growth reduces break-even investment, the amount of investment necessary to keep $k$ constant, without affecting saving at any

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23 Alternatively, we could fix the tax rate. However, because inefficiencies derive from choosing a suboptimal value of $g$ and not from tax-based distortions, it is more instructive to fix $g$.

24 See Appendix A.
given level of capital. Public finance matters only in that the tax rate affects the slope of the saving function.

5.3. Demographic transition with endogenous politics

Recognizing individuals’ political incentives broadens the effect of demographic transition to encompass tax rate changes for reasons other than those due to national income. Slower population growth reduces the tax rate preferred by the median voter, *ceteris paribus*, leading to changes in government outlays and human capital. Feedbacks via physical capital will, in turn, further influence the political equilibrium.

Changes in the steady-state capital per worker derive from changes in after-tax income and changes in the number of workers. Using (22) and (23),

\[ \hat{k} = \hat{w} + \hat{h} - \Delta \hat{\tau} - (1 + \eta). \]  

(34)

Substituting using Eqs. (25)–(27), and (29) and (30) yields the quasi-reduced form expression

\[ \hat{k} = \frac{((1 - \alpha)\epsilon_{bg} - \tau)M_K}{1 - \tau} \epsilon_{tr} a_m - \frac{M_K}{M_Y} (1 + \eta), \]  

(35)

where

\[ M_Y = \frac{1}{1 - (1 - \alpha)\epsilon_{bg}(1 + \epsilon_{cy})} \]

and

\[ M_K = \frac{1}{(1 - \alpha)(1 - \epsilon_{bg}(1 + \epsilon_{ry})) + \alpha \Delta \epsilon_{cy}}. \]

Local stability of the political equilibrium requires \( M_Y > 0 \) while local stability of the intertemporal equilibrium requires \( M_K > 0. \)

To gain a feel for the importance of endogenous political responses, consider first the case in which the ability of the median voter, \( a_m \), is fixed, but government spending is not. That is, due to changes in the economic steady state, the same pivotal voter alters the demand for government spending. Looking at the second term on the right side of (35), we see that a decrease in population growth raises steady-state capital per worker, holding \( a_m \) fixed.

What lies behind this result? \( M_Y \) is the multiplier effect of an autonomous increase in output (say due to a productivity change or shift in \( A_Y \)) on steady-state output,

\[ \text{A comparison of Eqs. (35) and (33) shows that only when } \epsilon_{bg} = 0 \text{ and } \epsilon_{ry} = -1, \text{ will the effect be identical to the exogenous politics case.} \]
while $M_K$ is the corresponding multiplier effect of a windfall of capital on steady-state capital per worker. Consequently, the coefficient on $(1 + \eta)$ in (35) is the effect of an initial increase in capital per worker (due to a decrease in the size of the working population) on income and the effect of this rise in income on capital accumulation. Because stability requires $M_K/M_Y$ to be positive, a decrease in $\eta$ raises steady-state capital per worker when the identity of the median voter is held fixed. As noted above, however, a decrease in $\eta$ changes the identity of the median voter to that of a lower ability person. This voter-identity effect has an indeterminate influence on steady-state capital per worker, as can be verified by looking at the coefficient on $a_m$ in (35), where the effect depends on the sign of $(1 - z)\bar{c}_{hg} - \tau$.

To see why the voter-identity effect is indeterminate, consider a social planner who is constrained to offer the same amount of education to everyone, regardless of ability. This constrained social optimum is characterized by the first order condition

$$(1 - z)\bar{c}_{hg} = \tau. \quad (36)$$

The planner chooses a level of spending that equates the marginal benefit of education, measured as its proportionate impact on income, $(1 - z)\bar{c}_{hg}$, with its marginal cost, also measured as its proportionate impact on income, $\tau$. The coefficient on $a_m$ can be interpreted in this light. If the median voter initially chooses spending on education that is “too high,” the coefficient will be negative, and a reduction in the median-voter’s ability will raise capital per worker in the steady state. Effectively, the decline in $a_m$ will reign in inefficient spending—that spending whose marginal contribution to total income is less than its marginal cost in terms of lost consumption. On the other hand, if spending is initially “too low,” the decrease in the median-voter’s ability exacerbates the inefficiency. Because the ability of the median voter is below that of the average (mean) voter, if $\eta$ is low enough, spending must initially be too low. In this case, capital per worker in the new steady state may be lower than that obtaining in the former, more populous, long-run equilibrium.

Even if capital per worker is higher in the new steady state, however, there is no assurance that income per worker will rise, as human capital per worker may fall when a lower tax rate is chosen. A useful reduced form expression for the change in education spending is

$$\dot{g} = M_Y \left[ \varepsilon_{ca} a_m + \varepsilon(1 + \varepsilon_{cy})k \right]. \quad (37)$$

Because $\varepsilon_{ca}$ is positive, as is $M_Y$, a reduction in the median-voter’s ability may result in lower steady-state government spending even if there is an increase in capital per worker. Consequently, human capital per worker may fall and the economy’s human-to-physical capital ratio may fall.

The change in steady-state income per worker depends on the change in $h$ and $k$, and may be expressed as

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26 It can be shown that a larger response of human capital to government spending (a larger $\varepsilon_{hg}$) implies a larger response of steady-state capital to a change in $\eta$ if $(1 - \tau) > \varepsilon_{cy}$. This condition restricts the effect of higher government spending on after-tax income to be positive.
\[ \hat{y} = M_Y \left[ (1 - \alpha) z_{hk} e_{ta} \hat{a}_m + \alpha \hat{k} \right]. \] (38)

The coefficient on \( \hat{a}_m \) is positive, so a fall in the median-voter’s ability may reduce income even when it raises steady-state capital per worker. If capital per worker falls, the demographic transition must produce an immiserizing outcome, as then long-run income per worker must be lower. This immiserizing outcome is more likely to occur the larger is the elasticity \( e_{ta} \), the response of the preferred tax rate to a change in ability. Ceteris paribus, the more effective public education is in raising human capital (defined as larger \( \psi \)), the smaller \( e_{ta} \) will be, implying a smaller decrease in the equilibrium tax rate resulting from demographic transition.

6. Simulation methods and steady-state sensitivites

To better understand the implications of the model, we use numerical simulations to gauge the sensitivity of our steady-state analysis to values for key parameters. We also undertake a series of numerical simulations to investigate the dynamics of transition between steady states. A necessary price of doing so, however, is that we must adopt specific functional forms and parameters for our model.

To begin, we set \( \delta \) equivalent to an annual rate of time preference of 4\%. 27 Under the crude assumption that one “period” in the model equals 30 years, the 4% rate of time preference translates into a value of \( \delta \) equal to \( (1.04)^{30} - 1 = 2.24 \). Alternatively, \( 1/(1.04)^{30} = 0.308 \) is the rate at which the future is discounted in the model.

We begin with the assumption that the population growth rate (\( g \)) is 2.0% annually, a bit more rapid than the recent United States experience. This annual rate corresponds to growth of 81.1% over a model period. In the context of the model, \( \eta \) serves as well as the key parameter for analyzing generational shifts. The ratio of the old to young generations is given by \( 1/(1 + \eta) \); in our base case, this is equal to 0.55. We investigate the dynamics resulting from a shift in the population growth rate from 2.0% (annually) to 1.0%. Thus, in the model the dependency ratio rises to 0.74, an increase of roughly 35%. We assume that ability, \( a \), is distributed uniformly in the interval \([0, 1]\). 28 Finally, we set the elasticity of output with respect to capital input equal to one-third (\( \alpha = 0.33 \)). 29

The parameter \( \psi \) plays a crucial role in the model. As discussed above, this parameter determines the elasticity of human capital with respect to inputs of government spending and ability. A lower \( \psi \) value, ceteris paribus, increases the range of values over which demographic transition leads to lower income per worker. For our simulations, we employ a range of \( \psi \) values drawn from the empirical liter-

\[ \text{27 See Coronado et al. (2000) for a discussion of discount rates in the context of Social Security analysis.} \]

\[ \text{28 The uniform distribution is appealing for its tractability, but does not provide a realistic distribution of post-education earnings (which display a log-normal distribution). Thus, an extension for future research is the use of alternative specifications of the ability distribution.} \]

\[ \text{29 Laitner (2000a) argues that } \alpha = 0.33 \text{ is consistent with recent United States data.} \]
nature on the economic return to education. Card and Krueger (1996) provides a survey of estimates of the elasticity of earnings with respect to expenditures per pupil. This elasticity from the literature is the best match for the model’s elasticity of individual human capital with respect to government spending, as earnings is defined as the wage times the human capital of the individual. For our simulations, we match this elasticity to the central values in Card and Krueger, and we solve for the implied by these elasticities. 30

Card and Krueger present 24 estimates of the elasticity of earnings, all of which show a positive effect of additional school spending on earnings. 31 The mean of these elasticity estimates is 0.152, while the median is 0.125. In Table 1, we present comparative steady-state results for ψ values 0.32, 0.34, and 0.36, which have associated implied earnings elasticities of 0.13, 0.15, and 0.18, respectively.

Entries in the first column serve as our “exogenous policy” baseline. They are derived by holding government spending fixed when the population growth rate is reduced. Looking at the results, demographic transition always causes the tax rate to decline, capital per worker to grow, and income per worker to grow, regardless of the

Table 1
Comparative steady-state analysis of demographic transition: Cobb–Douglas utility (percentage change in steady-state value)

<table>
<thead>
<tr>
<th>ψ</th>
<th>Implied elasticity</th>
<th>Exogenous fiscal policy</th>
<th>Endogenous fiscal policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.32</td>
<td>0.13</td>
<td>16.7</td>
<td>−3.8</td>
</tr>
<tr>
<td></td>
<td>y (output per worker)</td>
<td>59.7</td>
<td>44.3</td>
</tr>
<tr>
<td></td>
<td>k (capital per worker)</td>
<td>0.0</td>
<td>−21.3</td>
</tr>
<tr>
<td></td>
<td>h (human capital per worker)</td>
<td>−14.0</td>
<td>−90.4</td>
</tr>
<tr>
<td></td>
<td>g (government spending per worker)</td>
<td>0.0</td>
<td>−91.0</td>
</tr>
<tr>
<td>0.34</td>
<td>0.15</td>
<td>16.9</td>
<td>3.2</td>
</tr>
<tr>
<td></td>
<td>y (output per worker)</td>
<td>60.6</td>
<td>51.8</td>
</tr>
<tr>
<td></td>
<td>k (capital per worker)</td>
<td>0.0</td>
<td>−14.7</td>
</tr>
<tr>
<td></td>
<td>h (human capital per worker)</td>
<td>−14.3</td>
<td>−61.7</td>
</tr>
<tr>
<td></td>
<td>g (government spending per worker)</td>
<td>0.0</td>
<td>−60.6</td>
</tr>
<tr>
<td>0.36</td>
<td>0.18</td>
<td>17.1</td>
<td>7.0</td>
</tr>
<tr>
<td></td>
<td>y (output per worker)</td>
<td>61.5</td>
<td>55.7</td>
</tr>
<tr>
<td></td>
<td>k (capital per worker)</td>
<td>0.0</td>
<td>−11.0</td>
</tr>
<tr>
<td></td>
<td>h (human capital per worker)</td>
<td>−14.5</td>
<td>−46.7</td>
</tr>
<tr>
<td></td>
<td>g (government spending per worker)</td>
<td>0.0</td>
<td>−42.6</td>
</tr>
</tbody>
</table>

See text for a description of simulation methods used.

30 We use the elasticity of individual human capital with respect to government spending and evaluate it at the ability level of the median voter and the associated equilibrium level of government spending.
31 See Card and Krueger (1996, Table 1).
value chosen for $\psi$. The decline in the tax rate varies only slightly as $\psi$ increases, reflecting only $\psi$’s effect on average income.

In contrast, consider the column marked “endogenous fiscal policy,” in which government spending is determined by a median voter. Here, a larger value for $\psi$ has a direct effect on the desired amount of government spending. Demographic transition causes the tax rate to fall dramatically for all values of $\psi$, always exceeding the tax decline in the exogenous policy case. This decline in the tax rate implies lower service provision and a decline in human capital per worker.

The decline in the tax rate, however, raises the after-tax return to capital, and capital per worker rises for all values of $\psi$. For values of $\psi$ above 0.34, which implies earnings elasticities at or above the median estimate cited in Card and Krueger (1996), this increase in the capital stock is sufficient to overwhelm the decline in human capital and output per worker rises. In these cases, spending was initially “too high” in that a reduction in the tax rate increased output per worker in the steady state.

The results show, however, that this result (lower tax rate, higher output) is very sensitive to the productivity of public spending. If the elasticity of human capital with respect to government spending is only slightly lower than the Card–Krueger median estimate, a lower tax rate reduces human capital so much and raises the capital stock so little that output per worker falls. When we simulate the transition using a utility function with constant relative risk aversion rather than Cobb–Douglas, as shown in Table 2, this immiserizing outcome obtains for a wider rather of elasticity

### Table 2
Comparative steady-state analysis of demographic transition: Constant-relative-risk-aversion utility (percentage change in steady-state value)

<table>
<thead>
<tr>
<th>$\psi$</th>
<th>Implied elasticity</th>
<th>Exogenous fiscal policy</th>
<th>Endogenous fiscal policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.32</td>
<td>0.15</td>
<td>y (output per worker)</td>
<td>10.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>k (capital per worker)</td>
<td>36.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>h (human capital per worker)</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$\tau$ (tax rate)</td>
<td>-10.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>g (government spending per worker)</td>
<td>0.0</td>
</tr>
<tr>
<td>0.34</td>
<td>0.17</td>
<td>y (output per worker)</td>
<td>10.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>k (capital per worker)</td>
<td>36.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>h (human capital per worker)</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$\tau$ (tax rate)</td>
<td>-9.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>g (government spending per worker)</td>
<td>0.0</td>
</tr>
<tr>
<td>0.36</td>
<td>0.20</td>
<td>y (output per worker)</td>
<td>11.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>k (capital per worker)</td>
<td>37.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>h (human capital per worker)</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$\tau$ (tax rate)</td>
<td>-9.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>g (government spending per worker)</td>
<td>0.0</td>
</tr>
</tbody>
</table>

See text for a description of simulation methods used.
values, including the median value of 0.15. These results suggest the important role played by productivity of public services for the young in determining the economic consequences of population aging.

7. Transition paths

Of course, comparative steady states may provide a misleading picture of the actual events that transpire during the process of demographic shift. To shed light on the dynamics, Figs. 1–4 depict the transition paths obtaining for a case in which the demographic transition leads to lower steady-state income, specifically for $\psi = 0.34$. 

Fig. 1. Government spending transitions (Cobb–Douglas, $\psi = 0.34$).

Fig. 2. Human capital transitions (Cobb–Douglas, $\psi = 0.34$).
0.34. In computing the transition paths we begin with an economic and political long-run equilibrium and reduce the population growth rate after period 0. The transition paths trace out the movement of key variables before the economy reaches a new steady state.

In response to the initial demographic shock, the ability level of the median voter declines and remains unchanged. As shown in Fig. 1, the level of spending preferred by the median voter initially declines but rises gradually somewhat as income per

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32 The transition paths look similar for a CRRA utility function and the same $\psi$ value.
worker recovers from its initial drop. However, education spending never recovers its initial level, in sharp contrast to the case of a fixed level of government spending. As shown in Fig. 2, the level of human capital per worker mimics this pattern, dropping precipitously in the first period and rising slightly as physical capital (Fig. 3) and output rise (Fig. 4) in subsequent periods. In comparison to the case of exogenous government spending, demographic transition with endogenous policy leads to lower human capital and output per worker, despite a higher level of capital per worker. As we discussed above, however, the long-run effect of the population shift depends on both the value of $\psi$ (the effectiveness of government spending in raising productivity) and on the degree to which the initial conditions are characterized by an inefficiently large (or small) public sector.

8. Conclusions

As dependency ratios increase over the next 50 years there will be corresponding shifts in the political pressures that determine fiscal policy. Accordingly, the degree to which a more elderly population will support public spending on productivity-enhancing programs is of particular interest. In the context of a median-voter model of the political process, embedded within an overlapping-generations model of economic growth, we have shown that there is no automatic link between the preference for lower spending by older individuals and either the long-run scale of programs for young workers, or economic performance. Instead, when the demographic transition alters the identity of the median voter, the resultant political and economic dynamics will exacerbate underprovision if the public sector is inefficiently small. Simulations show that given the current effectiveness of education services in raising human capital, lower taxes may imply poorer economic performance. However, it is also possible that such a shift may trim an inefficiently large government, reduce tax rates and raise capital per worker enough to raise the long-run level of output per worker.

Our findings highlight the importance of three issues for future research. First, a key parameter in our model is the mapping between government inputs and the productivity of workers, making clear the value of additional research in this area. Second, our model focuses on the provision of public spending at the expense of a detailed description of the full transfer and financing structure. To the extent that non-neutral income taxes and other financing schemes alter the incentives to acquire human capital, it would be useful to embody these effects in future research. Further, transfers from the young to old are also influenced by demographic transition and adjustments to these programs should be considered simultaneously with adjustment on programs that primarily benefit the young. Finally, our results are derived in the context of a closed economy. In the presence of internationally mobile capital, two additional features may be important. To begin, capital will flow internationally in pursuit of the highest return, altering the dynamics of capital accumulation. However, the simultaneous aging of other counties will induce political pressures for altered fiscal policies and capital flows across the globe.
Acknowledgements

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Appendix A. Stability analysis

A.1. Stability of the political equilibrium

Analysis of the stability of the political equilibrium obtaining in any given period allows us to sign the term $M_Y$ in the text. The political equilibrium is defined to be locally stable if, starting from a given level of $g$, the economy moves automatically to equilibrium. To analyze stability, we posit a Marshallian-type adjustment rule for government spending of the form

$$\dot{g} = c \left[ \frac{\tau_p}{\tau} - 1 \right] = \varphi(g), \quad (A.1)$$

where the $c$ is a positive constant and the dot above a variable represents its time derivative. The variable $\tau$ is the actual tax rate, as necessitated by the government budget constraint. It is a function of $g$ and the contemporary level of income per young person. The variable $\tau_p$ is the tax rate desired by the median voter at the given level of education spending and income. The rationale behind (A.1) is that education spending will increase if the desired tax rate exceeds the actual tax rate needed to balance the government’s budget. The equilibrium level of spending, $\bar{g}$, solves $\varphi(\bar{g}) = 0$. $\bar{g}$ is locally dynamically stable if and only if $\varphi'(\bar{g}) < 0$.

Using (25), (27), and (29) and noting that within a generational period the capital stock is given,

$$\hat{\tau}_p = (1 - \alpha)e_{kg}e_{cy}\hat{g}, \quad (A.2)$$

where the elasticities are defined in the text and $\hat{x}$ is defined as $\dot{x}/x$. Rearranging the differentiated government budget constraint and using (25) and (29), the actual tax rate changes according to

$$\hat{\tau} = [1 - (1 - \alpha)e_{kg}]\hat{g}. \quad (A.3)$$

Differentiating (A.1) and using (A.2) and (A.3), stability of the political equilibrium requires that

$$\varphi'(\bar{g}) = (1 - \alpha)e_{kg}(1 + e_{cy}) - 1 < 0. \quad (A.4)$$

Condition (A.4) implies that $M_Y$, as defined in the text, is positive if the within-generation political equilibrium is stable.
A.2. Intertemporal stability with endogenous politics

With Cobb–Douglas production technology and logarithmic preferences, the evolution of the capital stock is a function of the contemporaneous tax rate, wage, and human capital level. Since the tax rate, wage, and human capital level are functions of the contemporaneous capital stock, the evolution of the capital stock takes the form

\[ k_{t+1} = G(k_t). \]  \hspace{1cm} (A.5)

A sufficient condition for a locally dynamically stable steady state is that \(|G'(k)| < 1\) when evaluated at the steady-state value of \(k\). Using (22) and (23),

\[ \hat{k}_{t+1} = \hat{\omega}_t + \Delta \hat{t}_t, \]  \hspace{1cm} (A.6)

where \(\hat{x}\) indicates \(\frac{\_x}{x}\). Substituting by using (25), (27), (29) and (30), letting \(\hat{y} = 0\), and evaluating at the steady state,

\[ G'(k) = a(1 - D \epsilon_y)M_y, \]  \hspace{1cm} (A.7)

where \(M_y\) is defined in the text and is positive because we assume a stable political equilibrium. Using (A.7), the definition of \(M_y\), and rearranging, stability implies

\[ (1 - a)(1 - D \epsilon_y)(1 + \epsilon_y) + a D \epsilon_y \]  \hspace{1cm} (A.8)

Therefore, if the economy exhibits intertemporal stability, the expression defined as \(M_K\) in the text is positive.

A.3. Intertemporal stability with fixed government spending

With \(g\) fixed, using (23)

\[ \hat{k}_{t+1} = \hat{\omega}_t + \Delta \hat{t}_t. \]

Using (32) and the fact that wages grow at the same rate as income,

\[ \hat{k}_{t+1} = a \hat{k}_t - \Delta \hat{k}_t = a(1 - \Delta) \hat{k}_t. \]

Stability requires \(G'(k_t) < 1\) when evaluated at the steady state. Consequently, stability requires

\[ a(1 - \Delta) < 1. \]

This permits us to sign the denominator of (33) when the economy exhibits intertemporal stability.

References


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33 For a discussion of stability in the overlapping-generations context, see Azariadis (1993).


