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The marginal cost of public funds with an aging population*

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Abstract. As populations in the United States and other advanced economies grow older, the burden of social security and health care financing is expected to rise markedly. Payroll, income, and other taxes on working populations are projected to rise accordingly. The marginal welfare cost to workers of social security and other public expenditures is analyzed within the context of a two-period life-cycle model. By relaxing separability assumptions that have become common in the literature, the theoretical structure properly incorporates the effect of these public expenditures on labor supply. Comparative statics results indicate that the changing age structure is likely to raise the marginal welfare to workers of social security, education, and other public expenditures. Illustrative calculations for the United States confirm this result, suggesting that the cost to workers of incremental social security benefits may easily double by 2025–2050. The cost of education may also rise significantly. These results imply that political pressure from workers to limit social security and other spending may increase over time.

I. Introduction

The gradual aging of the populations of the United States and other advanced economies that is occurring now, and that is expected to continue until well into the next century, will affect many aspects of political and economic life.[1] As is

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[1] The fiscal and other implications of aging have attracted increasing attention recently. For more general discussion, see Bös and von Weizsäcker (1989) and Cutler et al. (1989) as well as other papers in the present issue.

well known, the number of elderly persons is expected to rise fairly rapidly relative to the number of young. These demographic changes will have especially important fiscal effects on government programs which are directed to particular age groups in the population, such as public pension programs, health care, and education. Given current benefit structures, expenditures for public pensions and related programs must rise substantially, while the base from which these programs are traditionally financed, that is, the earnings of the working population, will rise comparatively slowly. Unless other public expenditures are cut or additional borrowing is undertaken, the projected benefit stream can only be financed by higher taxes. As discussed later in this paper, the payroll tax rate required to finance future benefits could rise from the current OASDHI rate of 15.3% to a rate of 25% or more by the middle of the next century. This is one way of expressing the potential "fiscal implications of an aging population."

To be more specific, the policy options for coming years can be described as follows. (i) One possibility is to raise payroll tax rates as required to generate sufficient revenue to meet expenditure demands. This is the historical norm in the United States, where the social security system has relied (essentially) on pay-as-you-go taxation of earnings since its inception a half-century ago. (ii) Alternatively, social security benefits could be financed partially or wholly from general revenues. Changing the source of financing from payroll to other revenue sources would of course have some economic impact, as is true of any tax substitution or tax reform. The impact would be somewhat limited, however, since the individual income tax is the main source of Federal general revenues and earnings constitute the major component of taxable income for individuals. (The same would be true of a value-added tax or any other consumption tax that might be introduced. See Creedy and Disney (1989) for a discussion of social security financing in the presence of a VAT.) (iii) A third possible response to higher social security expenditure requirements in the future would be to curtail other types of public expenditure, in which case increases in payroll or other tax rates could be limited or even avoided altogether. (iv) Finally, future social security outlays could be deficit-financed.[2] In principle, nothing precludes such "negative" funding of the social security system, as opposed to the more commonly-discussed possibilities of a fully-funded or unfunded (pay-as-you-go) system. If none of the preceding options (or some combination of them) is followed, future social security benefits will have to be reduced. Given the size of the social security program, the choice among these options is of great importance for efficiency of resource allocation and for the inter- and intra-generational distribution of income.

One way to gain insight into the nature of the trade-offs that will have to be made is to examine the marginal benefits and costs of social security and other public expenditures in the context of an economy that is undergoing demographic change. This paper examines the marginal gains and losses to members of the working population in a simple overlapping-generations model with life-cycle utility-maximizing households. It is a model in which labor supply decisions in the first part of the life cycle involve a labor-leisure tradeoff which is distorted by taxes such as payroll taxes for social security. The distorting effect of taxes depends on the level of taxation as well as on the elasticity of labor supply, and, in particular, the magnitude of these tax distortions would be expected to rise

[2] One might characterize this as "pay-*after*-you-go" rather than "pay-*as*-you-go" financing.

substantially in the future as the burden of supporting a rising number of retirees increases. The task of the analysis is to develop a model in which these tax distortions can be properly and explicitly accommodated.

An explicit theoretical study of the marginal costs and benefits to members of the working population is undertaken in Sects. II and III below. This analysis bears a certain resemblance to the literature on the "marginal cost of public funds" which investigates the marginal welfare cost of raising revenue through distortionary taxation.[3] In contrast to most of that literature, however, the income effects of public expenditure on labor supply, both for social security benefits themselves and for expenditure on education (which is treated as highly substitutable for first-period private consumption by workers), are explicitly incorporated here. These effects have an important effect on the results.

The analysis explicitly incorporates demographic elements. In particular, the government budget constraint reflects the fact that expenditures on social security and education, and therefore the rate of taxation, depend on the number of young and old households in the economy. Once this dependence is built into the model, it is possible to conduct a comparative-statics analysis which shows the effect of demographic change on the marginal benefits and costs to workers of social security and education expenditures. It is shown that an increase in the number of aged, in particular, is likely to reduce the net marginal benefit to young workers of social security benefits. It is also likely to lower the net marginal benefit from education, since the high level of taxation associated with a large population of elderly implies that the marginal cost of obtaining revenue for *other* types of public expenditure will also be high.

Section IV presents estimates of the marginal benefits and costs, and especially the way that they are likely to change over time as the population ages, using US data and Social Security Administration projections of demographic structure and social security costs for the next 50 years or more. These calculations, which are based on the theoretical derivations of Sect. III, show that the marginal net gain to workers from these public expenditures will fall markedly over time as tax rates rise sharply.

These results are of interest in their own right. They also carry strong implications for the political economy of social security and other public expenditures. While it is true that the aged will become numerically more important in the population structure in coming decades, the analysis presented below shows that the young are likely to become increasingly resistant to further increases in social security benefits over time. The tax distortions in the model are not simply "social" costs. They are real costs that must be borne by individuals – for instance, the young – somewhere in the economic system. If individuals correctly perceive the real cost that they must bear from public spending, they would rationally take these costs into account in their political decisionmaking.[4] Very

[3] For a few examples, see, e.g., Atkinson and Stern (1974), Browning (1987), Stuart (1984), Wildasin (1979, 1984), and Wilson (forthcoming). Many additional references can be found in these papers.

[4] Meltzer and Richard (1981) explicitly emphasize this point in their voting model, and it is also plays a role in the Barro (1979) model of public debt determination and in the Boadway et al. (1990) analysis of social security. Wildasin (1989) and Crane (1990) emphasize that one must take tax distortions into account when analyzing the individual decision calculus for voting behavior. The earlier version of this paper contains additional discussion of the literature on the political economy of social security and of the role of distortionary taxation in such models.

simple models of the political process (simple voting models, for example) might lead one to expect higher levels of social security benefits in the future due to the increasing numbers of elderly. Models in the "political economy" tradition, by contrast, allow for intensely interested parties to intervene in the political process through lobbying, campaign contributions, or other means.[5] In such models, the sharp decreases in the marginal net benefits to the young from social security expenditures would be predicted to lead to more active participation in the political process by these households as they attempt to prevent further very costly increases in the amount of resources going to social security and other expenditures.

Section V concludes by discussing further some of the political implications of the analysis, as well as ways in which the economic analysis might be extended. An Appendix provides additional details on the method underlying the calculations of Sect. IV.

II. The model

The subsequent analysis is based on a standard overlapping generations model with two-period life-cycle utility-maximizing households, variable first-period labor supply, fixed second-period labor supply, and no operative bequest motive at death. Government policy consists of taxes imposed on the young working generation to finance transfers to the old, education for children (the young non-working generation), and possibly other public goods. Young workers undertake private consumption in the present period and the future, denoted by c_1 and c_2, and supply labor in the present, represented by l. Households may work in the second period of the life cycle, but this labor supply is assumed to be completely inelastic. For present purposes, nothing essential is lost by setting second-period labor supply equal to zero. Young workers also benefit from education for their children, where e denotes educational expenditure per child, from social security benefits that they receive when old, and from other public goods, denoted by z. (The benefits from social security are expressible in terms of income, and thus enter the budget constraint rather than the utility function.) The preferences of young workers are represented by a utility function $u(c_1, c_2, l, e, z)$. Preferences are smooth and convex.

In much of the discussion to follow, interaction between public expenditure and private market decisions will be important. For this reason, it is useful to introduce here a special form of the utility function for young workers. This special case assumes that education expenditures yield a benefit, $\psi(e)$, that is proportional to the number of children in a worker's family and that is perfectly substitutable with first-period consumption. Under this assumption, the utility function takes the form

$$u(c_1, c_2, l, e, z) \equiv \hat{u}(c_1 + (1+n_2)\psi(e), c_2, l, z) \ , \tag{A}$$

[5] See, e.g., Stigler (1971), Peltzman (1976, 1980), Becker (1983, 1985) and van Winden (1983). Von Weizsäcker (1990) presents a model in this tradition that specifically addresses the effect of aging on the political equilibrium level of social security. For an excellent survey of a wide range of models of political decisionmaking, and for many additional references to the literature, the reader may consult Inman (1987).

where $1+n_2$ is the number of children born per worker and where the function $\psi(e)$ satisfies $\psi'(e)>0>\psi''(e)$. The rationale for this special form is that education of children is a form of investment in human capital. If parents value education for this purpose, then $\psi(e)$ is just the monetized present value of education benefits, and as such, it is equivalent to private income (i.e., units of first-period numeraire). Alternatively, we might note simply that a large component of c_1, in practice, is expenditures made by parents on behalf of children. (It is clear from, e.g., Modigliani (1988) that this is a standard interpretation of consumption by young parents in life-cycle consumption analysis.) Given the aggregation of parents' and children's consumption already implied by the life-cycle model, there is no particular reason to single out educational expenditures (or services) provided for children from any other category of such expenditures. Indeed, many of these private expenditures, such as nutrition, health care, and at-home educational expenditures, also build human capital for children in much the same way as education. Condition (A), defining the utility function $\hat{u}$, simply formalizes this aggregation.

Factor markets are assumed to be perfectly competitive. To minimize general equilibrium complications that would obscure the main ideas of the analysis, assume either that the economy is closed and the production technology is linear, or that the economy is small and open. In either case, the gross factor prices of the two inputs, capital and labor, can be taken as exogenously fixed at r and w, respectively. There is only one tax instrument available to the government, that is, a proportional tax on wage income at rate τ. This tax is assumed to be comprehensive, i.e., all worker compensation is subject to tax (thus ignoring issues relating to taxation of fringes and the like). In actual tax systems, income taxes, payroll taxes assessed against workers, payroll taxes assessed against employers, and commodity taxes (such as VAT) all act like this hypothetical wage tax, since they all drive a tax wedge between the marginal productivity of labor and the net return to a worker from additional effort. If a young household expects to receive a social security benefit of b^e in retirement, its lifetime budget constraint is

$$c_1+\frac{c_2}{1+r}=(1-\tau)wl+\frac{b^e}{1+r} \ . \tag{1}$$

Let $v([1-\tau]w, b^e, e, z)$ and $l=l([1-\tau]w, b^e, e, z)$ denote, respectively, the indirect utility and labor supply functions for a young household. Let v_I denote the marginal utility of income.

It will be assumed for convenience that all *marginal* government expenditures are financed on a pay-as-you-go basis. Under this assumption, the government budget constraint that determines the tax rate facing a given generation of young workers can be written

$$\tau wl=\frac{b}{1+n_1}+z+(1+n_2)e-D \ , \tag{2}$$

where b denotes the level of social security benefits paid in the present period to the current old, b^e is the level of future benefits expected by the current young workers, $1+n_1$ is the number of young workers per current retired person, and D is the level of debt financing used in the current period, taken as exogenously given. Since the analysis deals with a perturbation around an initial situation, debt, fertility, and other variables can vary arbitrarily over time; in particular, there is no need to assume any type of steady growth for the purposes of our analysis.

The essential structure of the model is now complete. It remains to investigate the effect of marginal changes in public expenditure on the welfare of the young.

III. The welfare evaluation of public expenditure

The task of this section is to analyze the precise nature of the payoffs to young workers from a marginal change in expenditure policy, starting from some initially-given status quo.[6] On the one hand, these households may benefit from certain public expenditures. On the other hand, public expenditures have to be paid for through taxation, and these taxes are harmful to young workers. The marginal net benefit is the difference between the two.

The government budget contraint (2) defines an implicit relationship between the wage tax rate and the different categories of public expenditure. Different categories of public expenditure affect the tax rate differently because the change in the tax rate that is required to finance additional expenditures depends importantly on the way that the public expenditures affect labor supply. Therefore, there is in general a different expression for the change in the tax rate associated with a unit increase in each different category of expenditure. To calculate the tax rate changes associated with increases in social security benefits, education, or other public goods, one must substitute the labor supply function $l([1-\tau]w, b^e, e, z)$ into the government budget constraint (2) and differentiate totally. To calculate these tax rate changes requires a specification of the relationship between present and future social security benefits.

Many authors have postulated that b^e should be an increasing function of b – that is, that today's workers expect more social security support in the future, the more generous their support for social security today. The anticipation of future social security benefits, and the assumption that they are somehow contingent on existing benefits, plays a pervasive role in most models of the political economy of social security.[7] However, if such a positive relationship exists (in people's minds or in reality), it is not because of formal statutory or explicit constitutional constraints. In the United States and other countries, the level of social security benefits to current beneficiaries can in principle be reduced (or increased) at any time by simple legislative action. Nevertheless, societies sometimes appear to live in accordance with implicit constraints. One of these may be that those who contribute to social security systems during their working lifetimes should

[6] Given the structure of the model, the analysis of the gains to the old from changes in public expenditure is trivial and rather uninteresting. Each old person gains \$ 1 for every \$ 1 increase in social security benefits and \$ 0 for incremental changes in spending on education or other public goods.

[7] See, e.g., Hu (1982), Verbon (1987), Boadway and Wildasin (1989a, b). Boadway and Wildasin actually assume that decisions about social security benefits are made on a once-for-all basis, or at least that votes about social security benefits do not happen more than once in a voter's lifetime. However, this can be interpreted as saying that current benefit increases are linked to future benefit increases.

be entitled to some "reasonable level" of retirement benefits.[8] In any case, it is not necessary for present purposes to resolve this issue in a definitive way. Rather, we can allow for a range of possibilities by postulating that expected future benefits are linked to current benefits according to

$$b^e = \phi(b) \ , \quad \phi'(b) \geq 0 \ .$$

Special cases of this relationship bracket some of the most plausible possibilities. In particular, attention will be focussed in the following on the case where $\phi' = 1$ and the case $\phi' = 0$. The former can be interpreted as a situation in which decisions about social security benefits are *permanent*. The latter corresponds to the situation in which there is no implicit linkage between present and future benefits, i.e., decisions about benefits are *temporary* in nature.

It is now a straightforward task to calculate the change in the current wage tax rate implied by a unit increase in social security benefits, education expenditures, or expenditures on other public goods. Total differentiation of the government budget constraint (2) yields[9]

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8 A vague implicit promise like this may seem rather mythical. Note, however, that there is an *explicit* commitment in the United States constitution not to punish people for *ex post facto* laws. Similarly, it is standard and customary to revise tax laws in such a way as to avoid harm to taxpayers who had arranged their affairs on the basis of earlier tax law, and thus to institute new tax laws gradually and with "grandfather clauses" or transition rules. These commitments and practices suggest that a major downward revision of social security benefits is unlikely to be implemented without being announced long in advance.

9 The derivations follow easily if one notes first that the effect of a tax rate change alone on revenue is given by

$$\frac{d\tau wl}{d\tau} = wl\left(1 - \frac{\tau}{1-\tau}\varepsilon_l\right) .$$

The anticipation of future social security benefits has an income effect on the labor supply of young workers. Letting l_I denote the derivative of labor supply with respect to first-period income, one shows next that

$$\frac{\partial l}{\partial b} = \frac{l_I}{1+r}\phi'(b) \ .$$

Finally, in the special case of assumption (A), one can show that

$$\frac{\partial l}{\partial e} = l_I(1+n_2)\psi'(e) \ .$$

This result follows from the Slutsky-type decomposition

$$\frac{\partial l}{\partial e} = \left.\frac{\partial l}{\partial e}\right|_u + \frac{\partial u/\partial e}{\partial u/\partial c_1} l_I$$

found, e.g., in Drèze and Marchand (1976) or Wildasin (1979), together with the assumption of perfect substitutability between educational benefits and first-period consumption (which implies that $\left.\frac{\partial l}{\partial e}\right|_u = 0$ and that $\frac{\partial u/\partial e}{\partial u/\partial c_1} = 1$).

$$\frac{\partial \tau}{\partial b} = (wl)^{-1} \left[\frac{\frac{1}{1+n_1} - \frac{\tau w l_I}{1+r} \phi'(b)}{1 - \frac{\tau}{1-\tau} \varepsilon_l} \right] \tag{3.1}$$

$$\frac{\partial \tau}{\partial e} = (wl)^{-1} \left[\frac{(1+n_2) - \tau w \partial l/\partial e}{1 - \frac{\tau}{1-\tau} \varepsilon_l} \right] \quad \text{(in general)}$$

$$= (wl)^{-1} \left[\frac{(1+n_2) - \tau w l_I (1+n_2) \psi'(e)}{1 - \frac{\tau}{1-\tau} \varepsilon_l} \right] \quad \text{(given assumption (A))} \tag{3.2}$$

$$\frac{\partial \tau}{\partial z} = (wl)^{-1} \left[\frac{(1 - \tau w \frac{\partial l}{\partial z}}{1 - \frac{\tau}{1-\tau} \varepsilon_l} \right] \tag{3.3}$$

where $\varepsilon_l = \partial \log l / \partial \log w_n$ is the (uncompensated) elasticity of labor supply with respect to the net wage. In effect, (3.1) and the second line of (3.2) are special cases of (3.3) that reflect the way that the benefits from social security and education enter the model.

When the tax rate on wage income rises, a young working household suffers a loss of real income equal to

$$v_I^{-1} \frac{\partial v}{\partial \tau} = -wl$$

(this expression is just Roy's identity). The marginal benefit to such a household from an increase in social security benefits is $v_I^{-1} \frac{\partial v}{\partial b} = \frac{\phi'(b)}{1+r}$. An increase in education spending provides a marginal benefit equal to $v_I^{-1} \frac{\partial v}{\partial e}$ in general; in the special case of assumption (A), this reduces to $(1+n_2)\psi'(e)$. For a generic public good z, the marginal benefit is just

$$v_I^{-1} \frac{\partial v}{\partial z} = \frac{\partial u/\partial z}{\partial u/\partial c_1} \equiv MRS_z \; .$$

This expression effectively includes those for social security and educational expenditures as special cases.

Combining the above results, the total effect of changes in public expenditures on the welfare of working taxpayers, taking both benefits and costs into account are given by the following:

$$v_I^{-1}\frac{dv}{db}=\frac{\phi'(b)}{1+r}-\frac{\dfrac{1}{1+n_1}-\dfrac{\tau w l_I}{1+r}\phi'(b)}{1-\dfrac{\tau}{1-\tau}\varepsilon_l} \tag{4.1}$$

$$v_I^{-1}\frac{dv}{db}=v_I^{-1}\frac{\partial v}{\partial e}-\left(\frac{(1+n_2)-\tau w\partial l/\partial e}{1-\dfrac{\tau}{1-\tau}\varepsilon_l}\right) \quad \text{(in general)}$$

$$=(1+n_2\left(\psi'(e)-\frac{1-\tau w l_I\psi'(e)}{1-\dfrac{\tau}{1-\tau}\varepsilon_l}\right) \quad \text{under assumption (A))} \tag{4.2}$$

$$v_I^{-1}\frac{dv}{dz}=MRS_z-\frac{1-\tau w\dfrac{\partial l}{\partial z}}{1-\dfrac{\tau}{1-\tau}\varepsilon_l}. \tag{4.3}$$

These results show how much young taxpayers will gain or lose from marginal expansions of social security benefits, education, or other public goods, respectively. Consider the social security condition (4.1) as an example. Suppose that the labor supply of the young were perfectly inelastic, a simplifying assumption used in many studies of social security. Suppose further that $\phi'(b)=1$, as is true for instance for permanent changes in the level of the social security program. Under these two assumptions (4.1) reduces to

$$v_I^{-1}\frac{dv}{db}=\frac{1}{1+r}-\frac{1}{1+n_1},$$

which shows that the workers gain from the introduction or expansion of pay-as-you-go social security provided that $r<n_1$, whereas they lose in the opposite case. The case $r>n_1$ is usually thought to be empirically more relevant. If $r<n_1$, capital has been overaccumulated and all generations can benefit from the intergenerational transfer associated with an unfunded social security program. If $r>n_1$, however, young working generations lose at the expense of the retired beneficiaries. These results are well-known. If instead current taxpayers believe instead that future benefits are unconnected with current benefits, $\phi'=0$ and (4.1) shows that they definitely lose from expansion of the program.

More generally, variability of labor supply enters the picture in both the numerator and denominator of (4.1). The numerator reflects the impact of anticipated future benefits on current labor supply and thus on tax revenues. The denominator reflects the total change in tax revenue from an increase in wage taxation, taking into account any tax-induced change in labor supply. The denominator is less than 1 if $\varepsilon_l>0$; in this case, distortionary taxation raises the "marginal cost of public funds." If $\varepsilon_l<0$, i.e. if the supply curve for labor is backward-bending, then distortionary taxation *lowers* the marginal cost of public funds. Thus, in the general case, (4.1) provides a measure of the impact of incremental increases in social security benefits on the welfare of young workers that reflects both the presence of distortionary tax financing and of expectations about future benefits. The remaining expressions (4.2) and (4.3) can be interpreted in a similar fashion.

In a sense, (4.1) and (4.2) are special cases of (4.3) which reflect the special assumptions that have been made concerning the nature of the benefits that households receive from social security and education. In the literature on the marginal cost of public funds (see, e.g., Atkinson and Stern (1974), Browning (1987), Fullerton (1989), Stuart (1984), Wildasin (1979, 1984), et al.), it is well-recognized in principle that expenditures on public goods may affect the demand or supply of taxed goods or factors, and that this may affect the benefit-cost evaluation for public expenditure. However, it has become increasingly common in the literature to assume that "typical" public goods do not affect the uncompensated demands or supplies for private commodities, an assumption that is valid if the underlying direct utility function is additively separable in public goods.[10]

This assumption may seem reasonable a priori since we have little intuition, it would seem, about how public goods affect private good demands. In (4.3), the assumption of additive separability between z and private commodities would imply that $\partial l/\partial z = 0$, and hence the last term reduces simply to $1/\left(1-\frac{\tau}{1-\tau}\varepsilon_l\right)$. For the social security and education cases, the assumption of separability would be equivalent is its effect to the assumption that $\phi'(b) = \psi'(e) = 0$. This would have a major effect on the expressions in (4.1) and (4.2), however, because it eliminates an income effect on labor supply that appears in the numerators of the last terms in each. Since the income elasticity of labor supply is generally regarded to be strongly negative, these terms would be greatly reduced in magnitude if one were to impose the separability assumption. In the next section, the implications of these income effects for the estimation of the marginal welfare gains from social security and education are discussed further. For the moment, suffice it to say that both social security and education are quantitatively very important categories of public expenditure, and in both cases, plausible assumptions about the nature of the benefits that people derive from them lead to expressions for the "marginal cost of public funds" that differ markedly from those obtained under the additive separability assumption. In fact, it is quite reasonable to argue that very many types of public expenditure will have income effects rather like those appearing in (4.1) and (4.2), since a very large part of public expenditure is undertaken for programs that have an income-transfer objective. In these cases, it is more reasonable to assume perfect substitutability between public and private goods than it is to assume additive separability. The additive-separability case does not seem to be a useful benchmark case for these broad categories of public expenditure.

[10] As emphasized in Wildasin (1979), this assumption means that *compensated* demands *are* affected by public good provision. So the issue is not *whether* but *how* public goods affect private good demands.

Comparative statics analysis of demographic change

Before turning to numerical estimates, it is of interest to use the theoretical expressions in (4) to conduct some simple comparative statics analysis showing the likely effect of demographic change on the marginal net benefits of public expenditure for young workers. Since workers constitute a large and influential part of the population, changes in their evaluation of the payoff from incremental public expenditure is likely to create powerful political pressures in the same direction. To facilitate the analysis, it will be assumed demographic changes (i.e., changes in n_1 and n_2) and any associated changes in tax rates and net wage rates do not change either the uncompensated labor supply elasticity ε_l or the "total income" elasticity of labor supply $(1-\tau)w\,\partial l/\partial I$.[11]

Although it is impossible to anticipate the exact trend of demographic change over time, the broad implications of declining fertility rates are quite clear. The proportion of elderly people in the population is expected to increase substantially over time, while the proportion of young will fall. Table 1 reports projections of dependency ratios for the United States for selected years under several sets of assumptions concerning fertility, mortality, etc. Alternative I is based on "optimistic" assumptions, while Alternative III is "pessimistic". In all cases, the number of aged will rise substantially relative to the number of workers, and the total number of dependents – that is, both the elderly and children – will also increase relative to the number of workers, except possibly for a period of time in the near future where the reduction in the number of children may outweigh the increase in the number of aged. The fiscal implications of these demographic trends are illustrated by the projections of the "cost rate" for social security, that is, projected expenditures expressed as a proportion of the expected payroll. In the absence of any reserves, this is approximately the rate of payroll tax that would be needed to fund current outlays. These figures are quite striking, as they indicate that the payroll tax rate necessary to support retirees will rise considerably in the future. Under "moderate" assumptions, the cost rate for old-age pensions alone will be about 14–15% by the year 2025 and about 15–17% in the year 2050. Adding to this the cost of health insurance for the elderly results in cost rates of 20–21% in 2025 and 23–24% by 2050. These are much higher than the current rate of about 13% (combined employer and employee contribution rates). Under "pessimistic" assumptions, the cost rate for both old-age pensions and health insurance would be about 30% in 2025 and 38% (and still rising) by 2050.

Within the present model, the effect of demographic shifts on the tax rate τ can be obtained by implicit differentiation of the government budget constraint (2):

$$\frac{\partial\tau}{\partial n_1} = -\frac{\dfrac{b}{(1+n_1)^2}}{wl\left(1-\dfrac{\tau}{1-\tau}\varepsilon_l\right)} < 0 \qquad (5.1)$$

[11] Of course, these elasticities generally do change as the parameters (in particular, the net wage rate) change. However, the direction of such changes in labor supply elasticities is neither known a priori nor easy to predict from empirical studies of labor supply (which indeed leave substantial confidence intervals around the elasticities themselves). Furthermore, there is no reason to expect them to be of other than minor importance. Thus, it seems reasonable to focus attention on other factors rather than the *variability* of these elasticities.

Table 1. Dependency ratios and cost rate estimates for U.S. social security, 1985 – 2060*

Year[a]	Dependency ratio		Cost rates	
	Aged[b]	Total[c]	OASDI[d]	Total (OASDHI)[e]
Past experience				
1985	0.200	0.704	11.13	12.8 – 13.2[f]
Alternative I				
2000	0.207	0.679	9.17	12.06
2025	0.308	0.791	12.56	15.75
2050	0.314	0.811	12.09	15.72
2060	0.313	0.811	11.95	15.68
Alternatives II-A and II-B				
2000	0.214	0.676	9.89[g] 10.27	13.31 13.81
2025	0.339	0.762	14.56 15.23	20.16 21.16
2050	0.393	0.810	15.90 16.74	22.78 23.96
2060	0.411	0.831	16.35 17.19	23.38 24.59
Alternative III				
2000	0.219	0.671	11.81	16.21
2025	0.376	0.736	18.12	29.42
2050	0.514	0.851	23.49	38.19
2060	0.577	0.918	25.57	40.62

* Source: Board of Trustees (1989), Tables 17. A1 and E2

Notes:

[a] Alternatives I, II-A, II-B, and III correspond to different assumptions about future values of demographic and economic variables. The demographic assumptions for Alternatives II-A and II-B are identical

[b] Population aged 65 and over, divided by population aged 20 – 64

[c] Population aged 65 and over plus population under age 20, divided by population aged 20 – 64

[d] Cost rate for old age, survivor's, and disability insurance only

[e] Cost rate for total of old age, survivor's disability, and health insurance program

[f] 1985 figure not available. Figures shown are range of estimates for 1989, based on Alternatives I – III

[g] Upper figure for each year is for Alternative II-A; lower figure is for Alternative II-B

$$\frac{\partial \tau}{\partial n_2} = \frac{e}{wl\left(1 - \frac{\tau}{1-\tau}\varepsilon_l\right)} > 0 \ . \tag{5.2}$$

These expressions show that a large cohort, when still in the pre-employment years, requires more educational spending and thus puts upward pressure on the tax rate (shown by (5.2)), while in its working years, it is able to support the elderly with a lower tax rate than otherwise (shown by (5.1)). In these respects, the model is fully consistent with the projections shown in Table 1.

Turning now to the effect of demographic change on workers' evaluations of public expenditure, consider first the effect of a change in n_1. Using (4.1) and (5.1),

$$\frac{d}{dn_1}\left(v_I^{-1}\frac{dv}{db}\right)=\frac{\frac{1}{(1+n_1)^2}}{1-\frac{\tau}{1-\tau}\varepsilon_l}+\frac{\frac{wl_I}{1+r}\phi'(b)}{1-\frac{\tau}{1-\tau}\varepsilon_l}\frac{\partial\tau}{\partial n_1}$$

$$-\left(\frac{1}{1+n_1}-\frac{\tau wl_I}{1+r}\phi'(b)\right)\left[\frac{\frac{1}{(1-\tau)^2}\varepsilon_l}{\left(1-\frac{\tau}{1-\tau}\varepsilon_l\right)^2}\right]\frac{\partial\tau}{\partial n_1}\,. \tag{6}$$

Suppose here and in the following that leisure is a normal good so that (in accordance with empirical findings) $l_I<0$. If $\varepsilon_l>0$, the above expression is unambiguously positive, that is, an increase in n_1 makes additional social security benefits more attractive, or less unattractive, to workers. The intuition is straightforward. First, the first term in (6) shows that an increase in b by \$ 1 per beneficiary is less costly to workers when the number of workers is greater relative to the number of beneficiaries. Second, an increase in n_1 raises the size of the working population. This lowers the tax rate (as shown in (5.1)). The loss in tax revenue due to income effects associated with anticipated increases in social security benefits is thus reduced (the second term in (6)). Moreover, provided that $\varepsilon_l\geq 0$, distortionary payroll taxes raise the marginal cost of public funds, and a reduction in the tax rate associated with an increase in n_1 reduces this cost (the third term in (6)). If $\varepsilon_l<0$ (the case of a backward-bending labor supply curve), then this last effect is reversed. The total effect of n_1 thus becomes ambiguous if we allow for a backward-bending labor supply curve. Empirical findings on labor supply, however, suggest that observed values of ε_l are either positive or, if negative, close enough to zero not to change the conclusion that the young are likely to support incremental social security benefits less strongly, or to oppose them more strongly, as the number of elderly rises (i.e., as n_1 *falls*).

An environment of higher tax rates associated with greater social security benefits may be one which is "hostile" not only to incremental social security benefits, but to other categories of public spending as well. Workers may oppose many types of public expenditure it taxes are already very high because of the cost of social security. This possibility is illustrated by differentiating (4.2) with respect to n_1. We obtain

$$\frac{d}{dn_1}\left(v_I^{-1}\frac{dv}{de}\right)=\frac{(1+n_2)wl_I\psi'(e)}{1-\frac{\tau}{1-\tau}\varepsilon_l}\frac{\partial\tau}{\partial n_1}$$

$$-(1+n_2)(1-\tau wl_I\psi'(e))\left[\frac{\frac{\varepsilon_l}{(1-\tau)^2}}{\left(1-\frac{\tau}{1-\tau}\varepsilon_l\right)^2}\right]\frac{\partial\tau}{\partial n_1}\,.$$

This expression is quite analogous to (6), and detailed discussion of its components need not be repeated. If $\varepsilon_l>0$ and if leisure is normal, the whole expression is positive. Therefore, an increase in the number of dependent elderly (i.e., a *decrease* in n_1) reduces the net payoff to workers from additional education. One concludes that taxpayer resistance to *other* categories of expenditure (in this specific case, education) may rise as the population ages and public sector resources are drawn into the social security system.

To conclude the theoretical analysis, consider briefly the effect of a change in the number of children born to working taxpayers, n_2. As n_2 rises, the tax rate τ must rise, as shown in (5.2). Following the analysis already developed, one can see that such an increase in n_2 (a) increases the marginal cost of public funds for all uses, provided that $\varepsilon_l \geq 0$, and (b) also directly raises both the marginal cost and the marginal benefit of education expenditures in particular.

Thus, if $\varepsilon_l \geq 0$, an increase in the number of children would be expected to increase the opposition of young workers toward social security benefits and other public expenditure programs. Its effect on their demand for education is ambiguous. On the one hand, the cost of funds rises (if $\varepsilon_l > 0$) and this reduces the desirability of additional education spending. On the other hand, *partial* differentiation of (4.2) with respect to n_2 yields:

$$\frac{\partial}{\partial n_2}\left(v_I^{-1}\frac{dv}{de}\right) = (1+n_2)^{-1} v_I^{-1}\frac{dv}{de} \ .$$

If the initial level of education spending is such that $dv/de > 0$, then an increase in the number of children increases their parents' marginal net benefit from education. If, by contrast, $dv/de < 0$ initially, then the opposite is true. In effect, an increase in the number of children *magnifies* the marginal net benefit of education spending for young workers. In the present model, the elderly do not benefit from education, nor do they bear its cost. They have, therefore, no incentive to influence the political process in order to change the level of education spending (assuming that they do not act in a strategic way). Thus, at least within the context of the model, it is reasonable to argue that $dv/de \approx 0$ in a political equilibrium. It is of interest, therefore, to analyze initial situations in which changes in n_2, by itself, would neither increase nor decrease the marginal net benefit of education for young workers.

The preceding theoretical analysis has enabled us to derive precise expressions for the welfare effect of incremental public expenditures on young workers. The results show how demographic change can affect this generation-specific benefit-cost calculus. Changes in the age distribution directly affect the benefits and costs of providing public services for the young and the old. They also indirectly affect the desirability of these services through their effect on tax rates and on related tax distortions. It remains to investigate the potential empirical importance of these effects.

IV. Quantification

It is of considerable interest to estimate numerically the marginal net payoffs to young workers from different types of public expenditures based on Eqs. (4). The basic method behind the calculations presented below is straightforward. Take the values of benefits b and education e as exogenously given. Assume also the labor supply elasticities do not vary as parameters of the system (such as tax rates) vary.

As the preceding comparative statics analysis has shown, future demographic and economic changes will affect the marginal net benefit expressions (a) directly, through their impact on $1+n_1$ in (4.1) and $1+n_2$ in (4.2), and (b) indirectly, through their impact on the tax rate on wage income, τ. Considering only these two types of effect, how will the marginal net benefit of social security and education expenditures change as demographic variables and tax rates change? This is the question that the calculations below attempt to answer.

In order to implement this method, it is necessary to specify (a) how the demographic variables and tax rate τ change, (b) the assumed values of the labor supply parameters, (c) expectations about future social security benefits (the function ϕ), and (d) the benefits from education (the function ψ). The demographic, fiscal, and labor supply assumptions are discussed in some detail in an Appendix. In brief, the assumptions that are used concerning (a) parallel the current and projected values for demographic variables and the cost rate for social security that are displayed in Table 1. Calculations are accordingly presented for each of the years shown there, under Alternatives I, II, and III.[12] Regarding (b), labor supply estimates are drawn from the literature, with three possibilities being considered. The first possibility is that labor is perfectly inelastically supplied, so that all of the tax distortion effects in expressions (4) disappear. In addition, two further cases are considered, one in which labor supply elasticities are near the lower end of the range of plausible values found in the literature, and one in which the elasticities are somewhat higher.

The assumptions concerning expectations of future social security benefits and the return to education are much more speculative in nature. Two assumptions are considered for each. With respect to expected social security benefits, the cases of $\phi'(b)=0$ and $\phi'(b)=1$ are considered. The first of these corresponds to a *temporary* change in benefits, i.e., an increase in current benefits that is not expected to raise future benefits at all. The second corresponds to a *permanent* change in benefits, i.e., future benefits rise dollar for dollar with current benefits. For this case, the calculation is undertaken for a household of age 45 years that has a life expectancy of 85, so that the remaining working lifetime is as long (20 years) as the period of retirement. For education, the case $\psi'(e)=1$ and the case $dv/de=0$ are considered. The first of these would be accurate if education were carried out to the level at which the marginal return on \$ 1 worth of education spending were \$ 1. The second implicitly defines a value of $\psi'(e)$ such that the marginal return on education is just sufficiently high to compensate young workers for the real cost to them of an incremental \$ 1 in expenditures (financed through distortionary income taxation). The latter will typically imply $\psi'(e)>1$, since the marginal return would have to be higher than \$ 1 to compensate for the cost of raising public funds through incremental increases in the rate of distortionary taxation.

Net marginal benefits of social security

Table 2 shows the results of a series of calculations of the marginal net payoff from social security for workers under different assumptions about demographic and economic trends. In *Case 1*, the elasticity of labor supply is assumed to be

[12] The cost rates for Alternatives II-A and II-B differ little, and so are averaged together to reduce the number of distinct cases to be considered.

Table 2. Marginal net benefits from social security, 1985 – 2060*

Year	Case 1	Case 2	Case 3	Case 4
1985	−0.21	0.22	−0.27	0.15
Alternative I				
2000	−0.22	0.23	−0.27	0.17
2025	−0.33	0.10	−0.43	0.01
2050	−0.34	0.09	−0.43	0.01
2060	−0.34	0.09	−0.43	0.01
Alternative II				
2000	−0.23	0.21	−0.29	0.15
2025	−0.37	0.03	−0.51	−0.13
2050	−0.44	−0.05	−0.63	−0.29
2060	−0.46	−0.08	−0.67	−0.34
Alternative III				
2000	−0.24	0.19	−0.31	0.11
2025	−0.43	−0.11	−0.73	−0.51
2050	−0.63	−0.45	−1.95	−2.38
2060	−0.74	−0.62	−3.55	−4.79

* Source: Author's calculations, as explained in text

Case 1: $\varepsilon_l = 0.07$, $(1-\tau)wl_l = -0.20$, $\phi' = 0$
Case 2: $\varepsilon_l = 0.07$, $(1-\tau)wl_l = -0.20$, $\phi' = 1$
Case 3: $\varepsilon_l = 0.27$, $(1-\tau)wl_l = -0.17$, $\phi' = 0$
Case 4: $\varepsilon_l = 0.27$, $(1-\tau)wl_l = -0.17$, $\phi' = 1$

relatively low, and it is assumed that a hypothetical increase in social security benefits is temporary. Thus, from the worker's viewpoint, an increase in social security benefits can only be harmful. But the *degree* to which it is harmful varies widely. With the 1985 old-age dependency ratio of 0.200 and a payroll tax rate of 15.3%, an incremental increase in social security benefits would entail a real income loss of $ 0.21 – not much greater than the direct budgetary cost of assessing $ 0.20 from each worker to provide the revenue needed for $ 1.00 in benefits per retiree. In future years, however, the loss from similar incremental benefits could be much higher. By the year 2000, the cost would be about $ 0.23. This particular estimate is not sensitive to the projection used (i.e., whether one uses Alternative I, II, or III). By 2025, the cost will be much higher again. Under the most optimistic assumption, the cost to a worker of an incremental dollar's worth of social security benefits will be $ 0.33, and this could be as high as $ 0.43 under the most pessimistic assumption. By 2050–2060, the cost is likely to rise again, although under optimistic assumptions this would not be the case. The mid-range projection would put the cost at about $ 0.45 per dollar of benefits, while the cost would be around $ 0.65 – $ 0.70 under the "pessimistic" Alternative III.

These figures are derived under the assumption that the elasticity of labor supply is relatively low. *Case 3* shows what happens when the elasticity of labor supply is relatively high. As might be expected, the marginal cost to a young worker from incremental expansion of the social security program is indeed higher under this assumption; this is true for all years and under all assumptions about future economic and demographic trends. Moreover, the *change* in the magnitude of the loss from incremental social security benefits is magnified as we compare future with present circumstances. Again, in all cases, the marginal cost of social security facing young workers does not change much between 1985 and 2000, but large increases occur between 2000 and 2025. Under optimistic assumptions the cost rises from \$ 0.27 in 2000 to \$ 0.43 in 2025 and beyond – a 60% increase. Under mid-range projections, the cost rises from \$ 0.29 in 2000 to \$ 0.51 in 2025 and to about \$ 0.65 by 2050–2060. In the "pessimistic" case of Alternative III, the cost rises form \$ 0.31 in 2000 to \$ 0.73 in 2025 and \$ 2.00 or more by 2050–2060!

These calculations should be compared with the column in Table 1 showing the old-age dependency ratio. If the elasticity of labor supply were identically zero for all workers, the marginal cost per young worker of increasing social security benefits by \$ 1 would just be $(1+n_1)^{-1}$, i.e., the value of the old-age dependency ratio. The difference between this ratio and the marginal cost estimates in Table 2 reflects the impact of distortionary tax financing for social security. As is clear, this difference is non-trivial in all cases, but it becomes especially important when the elasticity of labor supply assumes a higher value (Case 3) and when the tax rate is at higher values (later years, more "pessimistic" assumptions).

To see what happens if workers expect their "contributions" to increase their own social security benefits, consider the case of an individual aged 45 with a life expectancy of 85.[13] This particular case is convenient since the duration of the remaining working lifetime is the same as that of the retirement period. The columns labelled "Case 2" and "Case 4" in Table 2 show the net welfare effect for a representative worker that results from a "permanent" incremental increase in social security benefits, assuming that future social security benefits are discounted at an annual rate of 3%.[14] As might be expected, these calculations differ from those in Cases 1 and 3 because, by including (non-zero) expected social security benefits, the marginal net benefit from social security is much higher. However, the estimated *change* in marginal net benefits over time differ little from those presented for Cases 1 and 3. In most cases, this marginal net benefit turns negative by the years 2025 and remains negative thereafter. Thus, for 45-year-old workers, voting behavior would presumably shift, during the period 2000–2025, from favoring increases in social security to opposing them.[15]

[13] Board of Trustees (1989), Table 11, gives a life expectancy at age 65 of 20–25 years for females under most demographic assumptions.

[14] The figures shown in the table are actually annual flows rather than the discounted value of 20-year streams of marginal costs and benefits. They give the marginal cost for one year's worth of taxation and the marginal benefits of one year's worth of social security benefits, the latter discounted back 20 years. By expressing everything in terms of annual flows, it is easier to compare the numbers with those shown for Cases 1 and 3.

[15] It is obvious that calculations for workers of different ages would not change the qualitative nature of the results. The underlying assumption that incremental public expenditures are financed through taxation rather than borrowing should be recalled here. Workers who might oppose tax-financed increases in social security benefits might favor debt-financed increases. This possibility has not been investigated here. A proper analysis would go beyond the scope of this paper but would in any case require some explanation for why current generations bother to pay any taxes at all. Intergenerational altruism is not part of the present model, and without it or something similar, current generations can gain by issuing debt to be repaid by future generations.

Net marginal benefits from educational expenditures

Consider now how the marginal net benefits from educational expenditures may change in future years. As shown in Table 3, the number of children per worker is expected to decline in future years from its current value of 0.504. The extent to which this will occur is obviously open to question, with a mid-range projection for 2050 of about 0.42. Table 3 shows the marginal cost and marginal net benefit to a worker from incremental educational expenditures under a variety of assumptions about tax rates, labor supply, and demographics. The marginal net benefits depend on the overall rate of taxation of earnings for all purposes, and thus depend in particular on the payroll tax rate for social security.

The figures in Table 3 for *Case 1* show the marginal net benefit from education for a worker, under the assumption that the wage elasticity of labor supply is low and under the assumption that the worker derives no benefits from education (i.e., in the notation of Sect. III, $\psi' = 0$). Thus, the worker simply bears the burden of financing additional education spending. This cost, in 1985, is estimated at $ 0.54. Reading down the column for Case 1, it is clear that this cost is unlikely to rise, and may well fall, in future years – perhaps to as little as $ 0.41 in 2025 under "pessimistic" assumptions. These figures suggest that the payoff to workers from reductions in educational spending is likely to fall in future years. Perhaps an increase in educational spending might be politically more attractive, at least to workers, than is presently the case. On the other hand, comparing the figures for Case 1 with the youth dependency ratio itself, it is clear that tax distortions and their relationship to social security financing can have a significant impact on the valuation of education spending. To see this in the most extreme case, consider

Table 3. Marginal net benefits from education spending, 1985 – 2060*

Year	Number of young per worker	Case 1	Case 2	Case 3	Case 4
1985	0.504	−0.54	−0.15	−0.69	−0.31
Alternative I					
2000	0.472	−0.50	−0.12	−0.62	−0.24
2025	0.483	−0.52	−0.14	−0.67	−0.30
2050	0.497	−0.54	−0.15	−0.69	−0.31
2060	0.498	−0.54	−0.15	−0.69	−0.31
Alternative II					
2000	0.462	−0.49	−0.13	−0.62	−0.26
2025	0.423	−0.46	−0.16	−0.64	−0.35
2050	0.417	−0.46	−0.17	−0.67	−0.41
2060	0.420	−0.47	−0.18	−0.69	−0.43
Alternative III					
2000	0.452	−0.49	−0.14	−0.63	−0.29
2025	0.360	−0.41	−0.20	−0.70	−0.56
2050	0.351	−0.43	−0.32	−1.33	−1.60
2060	0.341	−0.44	−0.36	−2.10	−2.86

* Source: Author's calculations, as explained in text

Case 1: $\varepsilon_l = 0.07$, $(1-\tau) w l_I = -0.17$, $\psi' = 0$
Case 2: $\varepsilon_l = 0.07$, $(1-\tau) w l_I = -0.17$, $\psi' = 1$
Case 3: $\varepsilon_l = 0.27$, $(1-\tau) w l_I = -0.17$, $\psi' = 0$
Case 4: $\varepsilon_l = 0.27$, $(1-\tau) w l_I = -0.17$, $\psi' = 1$

Alternative III. Under this projection, the number of young per worker will fall from about 0.50 today to about 0.35 by 2050 – a 30% decline. Yet the marginal cost to a worker of education finance will only decline from about $ 0.54 to $ 0.43 – a decline of only about 18%. If tax distortions and the rising cost of social security could be ignored, the marginal cost of education finance would be much lower in 2050 than would be the case when they are taken into account. Thus, operationally speaking, the high level of social security benefits and payroll taxation in 2025–2060, under Alternative III projections, would have the effect of making workers much less receptive to incremental spending on education than would otherwise be the case.

As might be expected, this general conclusion is much strengthened when a higher labor supply elasticity is assumed. *Case 3* parallels the calculations from Case 1, differing only in that the elasticity of labor supply is assumed to take on a relatively high value. In this case, the marginal cost borne by workers from education spending is higher in all cases. More importantly, this marginal cost is much more sensitive to changes in payroll tax rates. Under Alternatives I and II, the marginal cost to a worker from education spending falls between 1985 and 2000, but by the year 2025, the cost is once again at a level very close to the 1985 value of $ 0.69. Thus, even though the number of children to be educated falls considerably, the effective cost of finance may remain fairly steady under optimistic to mid-range projections. Of course, under the "pessimistic" Alternative III, the situation is more unfavorable for education spending because the payroll tax rate is so high. Thus, the incremental cost of education spending may actually rise in this case, perhaps to as much as $ 1.33 or even more by the year 2060.

Calculations based on a positive (rather than 0) gross return from education are presented in the figures for *Case 2*, which assumes a low elasticity of labor supply, and for *Case 4*, which assumes a high elasticity of labor supply. In both of these cases, it is assumed that $ 1 of additional educational spending yields a benefit of $ 1. The first point to note from the table is that workers' marginal net benefit from educational expenditures is still negative, even under this assumption.[16] However, more to the point for present purposes is the change in marginal net benefits from one period to the next. Under the "optimistic" Alternative I, there is little change over time. But under the mid-range projections of Alternative II and especially under the "pessimistic" assumptions of Alternative III, the marginal net benefit from education is expected to fall, in some cases quite significantly. The extent of the decline in marginal net benefits is least under the assumption of a low labor supply elasticity, as expected. Under Alternative II with a low labor supply elasticity, the marginal net benefit only falls slightly. But with a high labor supply elasticity, the marginal net benefit falls form $ –0.31 to $ –0.41 by 2050. Under Alternative III, the marginal net benefit falls from $ –0.15 in 1985 to $ –0.32 by 2050 when the labor supply elasticity is low. The corresponding drop in the high labor supply elasticity case is from $ –0.31 in 1985 to $ –1.60 in 2050.

Taken together, these results show that projected increases in payroll tax rates may reduce the marginal net benefits from education expenditures in future periods compared to what they would otherwise be. In some cases, the demand by workers for education spending would likely fall significantly, even though the

[16] This reflects the income effect of educational benefits on labor supply. If instead one assumed that $l_I = 0$, the figures for Cases 2 and 4 would simply be $ 1 higher than those for Cases 1 and 3.

number of children supported by each worker would be declining. The important general conclusion to be drawn from these calculations is that the demand for any particular type of public good cannot be analyzed in isolation from all others. Social security, education, and other public goods all are financed, to a greater or lesser extent, from direct or indirect taxes on labor. If payroll tax rates rises significantly in the future in order to maintain the social security system, other public expenditures that "compete" for the same revenue source may be "crowded out", as pressure rises to limit the tax burden on labor. Although the calculations presented in Table 3 deal with the specific case of educational expenditures, this general principle is clearly applicable to other types of public goods, as well.

V. Conclusion

As the populations of the United States and other countries get older, the cost of existing transfer programs for the elderly will rise. The preceding analysis has shown, within the context of a simple two-period life cycle model, that the marginal cost of social security for typical members of the working population is likely to rise rather sharply in the future. There will be more elderly persons to support, and the disruption of labor supply decisions resulting from higher tax rates will become increasingly costly. If the political process responds primarily to numbers of voters, the pressure to maintain or even increase social security benefits may rise over time. But if the political system responds as well to intensity of interest, the trend may well be in the opposite direction. The working population, though diminishing in relative size, will find it increasingly advantageous to limit the burden of social security. Politicians may find that proposals to limit social security benefits will capture the attention of more working-age voters, motivate them to vote in larger numbers, and induce them to contribute more money and effort to political campaigns. Higher social security taxes in the future may also raise the real cost of other types of public expenditure relative to what it would be without tax distortions. In fact, the preceding analysis has shown how this could happen in the specific case of education expenditure. Constituencies favoring spending on education, defense, agriculture, etc. may encounter increased resistance to higher tax rates as the cost of social security increases. A reduction in these other types of expenditures could result. These constituencies might favor reductions in social security expenditures as a way of freeing up additional public resources for their favored objectives.

Really large increases in payroll tax rates are still some years away in the United States, at least if the social security system continues to operate on an unfunded basis. It is during the period 2025–2050 (and perhaps later) that the trend toward an aging population is projected to have its largest fiscal impact. Nonetheless, the prospect of future social security cuts is worth considering now. Individuals born between 1940 and 1960 will have reached the ages of 65 to 85 by the year 2025. These individuals constitute a significant portion of today's working population. If political forces come into play by 2025 to restrict social security benefits, individuals who are economically active today will be affected. They may therefore act now, or soon, to limit their exposure to the risk of loss of social security benefits. They could do this by increasing private savings, whether on an individual or group basis (through private pension plans, for example).

Moreover, it is interesting to speculate about possible changes in expectations about the link between present and future social security benefit levels. To date, increases in social security benefit levels in the United States have been relatively permanent in nature. Taxpayers might be rather tolerant of increasing tax rates in such an environment. The prospect of a sharply rising real welfare cost of taxation in future decades, however, makes such expectations appear less plausible. If the current working population loses confidence in their own prospects for benefitting from the system, an unravelling of *current* political support for social security could result.

It would be of some interest to extend the foregoing analysis by generalizing the life-cycle model that underlies it. Dynamic simulation models (of the type described in Auerbach and Kotlikoff (1987), for example) would make it possible to study a much more realistic model. Simulations of such a model would be quite unlikely to overturn the major conclusions derived from the simpler model developed here, but would make it possible to explore some rather interesting questions that are too complex to handle analytically. For example, a simulation model would facilitate analysis of the marginal welfare effects of social security and other expenditures for workers of different ages, abilities, family attributes, or other personal characteristics. This could yield important insights into some of the distributional impacts of social security expenditures. It could also contribute to a better understanding of the diversity of interests within the population that may oppose or support social security and other public expenditures during coming years of demographic change.

Appendix

This Appendix is devoted to an explanation of the basis for the estimates of demographic variables and tax variables that are used in the calculations of Sect. IV.

Demographic assumptions

The data in Table 1 make it possible to obtain empirical counterparts to the expressions $1+n_1$ and $1+n_2$ that appear in the theoretical analysis. The old-age dependency ratio appearing in the "Aged" column corresponds directly with $(1+n_1)^{-1}$, while the total dependency ratio in the next column corresponds to $(1+n_1)^{-1}+(1+n_2)$, i.e., the number of elderly per worker plus the number of children per worker. The value of $1+n_2$ is thus obtained by subtracting the number of "old dependents" from the number of "total dependents."

Several different assumptions are made below concerning the values of these variables. First, the initial values for $(1+n_1)^{-1}$ and $1+n_2$ will be taken as 0.200 and 0.504 (= 0.704 − 0.200), respectively, corresponding to the 1985 values given in the table. Then the range of possible future values shown in Table 1 will be considered as alternatives that might occur in future years.

Fiscal assumptions

The relevant tax rate for households deciding whether or not to support higher expenditures for social security, education, or other public goods is the *com-*

prehensive marginal tax rate on earnings, that is, the sum of the tax wedges created by all taxes that affect the difference between the gross and net returns to labor.

The payroll tax for social security is one component of this comprehensive marginal tax rate. Of course, the distinction between employer and employee payroll taxes is irrelevant in the analysis of the distortions associated with wage taxation. The first point to note in finding an empirical counterpart to τ, therefore, is that one should consider the *combined* employer and employee payroll tax rates. At present, this rate is 15.3%, which will be taken as an initial value for base-year calculations. The payroll tax rate could rise or fall in future periods, even with the level of social security benefits held constant, depending on economic growth, demographic change, and political decisions about the extent to which the social security system should be funded.[17]

According to current projections (see Board of Trustees [1989, Table E2]), the social security trust funds should have positive reserves until about the year 2010.[18] It is therefore reasonable to assume that the current benefit structure could be maintained from that time onward only by increasing the payroll tax rate to a level equal to the cost rate, or by increasing income or other taxes to a comparable degree. Thus, the cost rate projections in Table 1 are used as the projected values for τ in the years 2025 and beyond. Although perhaps more debatable. the same assumption is used for the year 2000 as well.[19]

In addition to payroll taxes, the gross and net return to labor are driven apart by income and consumption taxes. Marginal Federal income tax rates in the United States currently range from 0% to 35%. Combined state and local income tax rates can be as low as 0% for some taxpayers or in some states, and as high as 10% or more in others. Income support programs for the poor give rise to implicit marginal tax rates on earnings well in excess of 50%. General sales taxes at the state and local level can range from 0% to 7% or even higher, and of course specific excises are often considerably higher still. The effective marginal tax rate on all of these taxes should in principle be combined and added to the payroll tax rates in order to estimate the current and projected future values of τ. Clearly, calculating an appropriate weighted-average comprehensive marginal tax rate is a most difficult task even for the present period, and estimating the future value of such a tax rate is far more difficult still. (Among many other factors, future tax rates will depend on such considerations as economic growth and the level of

[17] The analysis ignores the caps on payroll taxes and on social security benefits, assuming for simplicity that they do not bind for the "representative worker." At present, relatively few workers have earnings that exceed the maximum level of taxable earnings for payroll tax purposes. It is conceivable that such caps could affect a higher proportion of earnings or the labor force in future years.

[18] The exact year in which the funds are expected to be depleted depends on the economic and demographic assumptions used. Under Alternative I, exhaustion of the funds occurs in 2025, while under Alternative III it occurs in 1997.

[19] The difference between the projected cost rates and the currently scheduled tax rate of 15.3% is not too large, so the use of the latter would not change the results for the year 2000 very much. In any event, the latest trends in political discussions (especially the Moynihan proposal) suggest that payroll tax rates in the United States may soon be cut in order to eliminate any accumulation of social security trust fund reserves. If this occurs, then there would be no reserves to cover a discrepany between the cost rate and the payroll tax rate, and the two would have to coincide. This provides some additional rationale for the use of the cost rate in 2000.

public expenditures for defense and for domestic purposes other than social security.)

A detailed analysis of effective marginal tax rates on labor income for present and future periods is well beyond the scope of this study.[20] Such an analysis is not really essential for present purposes in any event. The main objective here is to illustrate the direct and indirect effects of demographic change on the net payoffs from social security and education. For this limited purpose, it is sufficient to consider several different values for the other taxes that contribute to the effective tax on wage income. A very rough estimate of the combined marginal tax rate facing workers at present, excluding the payroll tax (which has already been separately accounted for) might be about 35%. For the sake of sensitivity analysis, one could easily consider higher and lower rates such as 25% or 45%, but the results from such calculations are readily anticipated. They are not presented here for the sake of brevity. This 35% rate will be added to the estimated payroll tax rates under differing demographic and economic assumptions, as already discussed, to arrive at the final estimates of τ for present and future years.

Labor supply parameters

For the purposes of the calculations in Sect. IV, two labor supply parameters are needed. One is the uncompensated wage elasticity of labor supply, ε_l. The other is the "total income elasticity" of labor supply, wl_I.[21] These parameters have frequently been estimated in static labor supply models, both for male and for female workers. There is considerable variation in the estimates that have been obtained, however. Pencavel (1986, p. 82) concludes a recent survey of male labor supply by saying "If a single number has to be attached to each of the behavioral responses, then for American prime-age men the (uncompensated) wage elasticity of hours of work is -0.10 and their [total income elasticity of labor supply] is -0.20." Killingsworth and Heckman (1986, pp. 185–192) report many estimates of female labor supply elasticities, stressing the high variation that is found among them: "All in all, most of the estimates suggest that female labor supply elasticities are large both in absolute terms and relative to male elasticities. ... However, the range of estimates of the uncompensated wage elasticity of annual hours is dauntingly large." They point out that this elasticity has been estimated to be as low as -0.30 but as high as $+14.00$. Clearly different values of the female labor supply should be considered in the present analysis. Values of the uncompensated wage elasticity of $+0.4$ and $+1.0$ provide reasonable "low" and "high" estimates, respectively. Studies with uncompensated wage elasticities around $+0.4$ also report total income elasticities of around -0.2, while a total

[20] Many prior studies have conducted such analyses in varying degrees of detail. None has provided estimates for future periods that would be suitable for the particular purposes of the present paper, however. Prior studies of the "marginal cost of public funds" or of the deadweight loss from taxation all have had to come to grips with this question. See, e.g., Browning and Johnson (1984), Browning (1987), Stuart (1984), Hausman (1986), etc. In a recent study, Cutler et al. (1990) have examined the tax-smoothing argument for prepayment of taxes now in anticipation of higher future social insurance expenditures. They find that the welfare gains from doing so are small, but that they also assume that average and marginal tax rates are equal. This may account for their findings.

[21] Of course, these two parameters are related to the compensated wage elasticity of labor supply by the Slutsky equation, $\varepsilon_l = \varepsilon_l^* + wl_I$, where ε_l^* denotes the compensated elasticity. Thus, what is really needed are estimates of any two of these three parameters.

income elasticity of −0.1 would be consistent with the results of studies finding wage elasticities of around +1.0.

The theoretical analysis of Sect. III is formulated in terms of representative households and does not distinguish between male and female labor supply. To aggregate the labor supply elasticities for men and women, one can weight them by effective quantities. Assuming that the number of workers in the female labor force is 80% of the number in the male labor force and that the effective labor supply per woman is 65% that of a man,[22] the overall labor supply elasticity can be estimated as a weighted average of those for males and females, with a weight of 0.66 for men and 0.34 for women.[23] This results in uncompensated wage elasticities of labor supply of +0.07 and +0.27 for the low and high elasticity cases, and corresponding values of −0.20 and −0.17 for the total income elasticities of labor supply.

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[22] The US Department of Commerce (1988, Tables 608, 561, and 653) provide the following data: The 1988 male labor force participation rate was 76% and a female labor force participation rate was 55% (72% of the male rate). The number of male workers in 1986 was about 46 million, while the number of female workers was about 32.5 million (85% of the number of males). Median weekly earnings in 1986 for males employed full-time was $ 358, while the corresponding figure for females was $ 290 (81% of male earnings). Median annual earnings for all males was $ 18782 and $ 10016 for all females (53% of male earnings).

[23] The total effective female labor force is the male labor force plus and effective labor force of 0.80 (0.65) = 0.52 of the male labor force. The corresponding weights are 1/1.52 and 0.52/1.52.

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