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Increased Pension Savings: Blessing or Curse? Social Security Reform in a Two-Sector Growth Model

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This paper analyses the consequences of a switch to a more funded pension scheme for economic growth in an economy that consists of a capital-intensive commodity sector with endogenous growth and a labour-intensive services sector. The increased savings cause long-run growth to be higher in a closed economy, provided capital and labour are not strong substitutes. The reverse holds for a small open economy. More funding can therefore turn out to be a curse instead of a blessing for future generations, unless countries implement their reforms simultaneously or impose a tax on labour-intensive services.

INTRODUCTION

Social security reform is a prominent item on the political agenda of many countries. Indeed, upcoming demographic developments will cause serious problems in countries with extensive unfunded pension schemes. One of the solutions put forward is a switch to a more funded scheme by gradually reducing the Pay-As-You-Go (PAYG) scheme and stimulating savings (see e.g. the proposals by Feldstein 1996; Kotlikoff *et al.* 2001). This coincides with the view that a funded scheme earns a higher rate of return than an unfunded system. Moreover, the resulting increase of capital accumulation will stimulate growth (see e.g. Saint-Paul 1992; Belan *et al.* 1998; Wiedmer 1996, where productivity growth is modelled by assuming an externality in production, which is characterized by constant returns at the aggregate level).[1]

In this paper we focus on the alleged positive effects of a switch to a more funded pension scheme on economic growth. By emphasizing that higher savings affect the sectoral structure of the economy, these growth effects appear not to be as straightforward as they seem.

Most studies that analyse pension reform do not account for the effect of this policy on the aggregate consumption of different items, and therefore ignore the consequences that it will have on the economic structure. This structure can be broadly classified into two categories: commodities and labour-intensive services. The demand for these items differs with age. In particular, the need for services increases if a person grows older, as was suggested by *The Economist*:

> Older people . . . are likely to spend more on medical care and domestic services, such as those of gardeners and cleaners, that have risen sharply in price. Younger people are likely to spend more on new products, such as mobile phones or computers, which tend to fall rapidly in price during their early years. . . . In general many older people do indeed face higher inflation rates than the young. . . . Even if general inflation remains low, relative prices can shift significantly over as short a time as a decade, thanks to productivity gains brought by technological improvements, or to changes in demand; or, very often, both. (*The Economist*, 21 December 2000)

Budget surveys confirm this: the elderly spend 1.5 times as much of their total expenditures on services as younger households.[2] Therefore, one can expect the production structure to change when national savings are affected through a major

pension reform. Because productivity improvements differ between the various sectors of the economy, a change in the relative size of these sectors is another channel through which overall economic growth will be affected.

We focus on this mechanism by applying a model that combines the overlapping-generations structure of Diamond (1965) with the two-sector analysis of Baumol (1967) and endogenous growth resulting from learning by doing.

Following Baumol (1967), we group economic activities into two types: 'technologically progressive activities in which innovations, capital accumulation, and economies of large scale all make for a cumulative rise in output per man hour, and activities which, by their very nature, permit only sporadic increases in productivity' (Baumol 1967, pp. 415–16). As to the first type of activity, 'labor is primarily an instrument', whereas the second type consists of 'services in which the labor is an end in itself, in which quality is judged directly in terms of amount of labor'. So we assume two sectors: a labour-intensive service sector and a capital-intensive commodity sector. Productivity growth is determined endogenously and stems mainly from technological progress that typically takes place in the commodity (or 'high-tech') sector.

As productivity increases, wages paid in this sector also increase. Because labour is assumed to be mobile between both sectors, wages paid in the services sector will grow equally fast. The capital-intensive sector produces homogeneous consumption and investment commodities. These commodities are demanded by young individuals, whereas the elderly derive utility from labour-intensive services. Consequently, a change in the composition of income in both age categories will affect the relative aggregate demand for services and commodities. The structure of the economy, and hence the growth rate and the well-being of successive generations, are thus influenced.

Social security reform is modelled as an anticipated switch to a permanently lower PAYG tax. We find that the effects of such a policy crucially depend on the openness of the economy. In the case of a closed economy, and where capital and labour are not strong substitutes, our model confirms the standard results in the literature: that is, the long-run effect of a switch to a more funded pension scheme is positive.[3] However, the positive effects on long-run utility are larger than in exogenous growth models, as the lower social security tax leads to higher national savings, which increase domestic investments and attract labour to the commodity sector, therely stimulating growth.

In a small open economy, however, the long-run effect of social security reform that we find is completely the opposite of the standard result in the literature. That is, without additional policy measures, more funding *decreases long-run welfare* in our model, as it leads to a lower rate of economic growth. The reason for this is that a switch to a more funded scheme initially raises lifetime income, which induces a higher demand for both services and commodities. Because services cannot be imported from abroad, this implies that a higher fraction of the domestic labour supply will be employed in the services sector, which is characterized by a relatively low productivity growth potential. Pension reform then causes a 'Dutch disease', and long-run welfare decreases, despite the fact that the funded pension scheme earns a higher rate of return than the PAYG scheme.[4] This can be prevented if all small economies reform their pension systems simultaneously, or if a tax on the use of labour-intensive services is imposed.

The rest of this paper is organized as follows. Section I describes the model. In Section II we analyse the long-run consequences of a more funded pension scheme in a closed economy, and Section III focuses on a small open economy. Section IV concludes with a discussion of some extensions and modifications.

I. The Model

We use a two-overlapping-generations model for a closed economy and a small open economy. Following Baumol (1967), we distinguish between two sectors of production. In the *commodity sector* (labelled Y), homogeneous goods are produced which serve as either a consumption or an investment good and can be traded internationally. The *services sector* (labelled D) concerns the provision of labour-intensive services that are not internationally tradable. In both sectors, firms are fully competitive and maximize profits. Labour is homogeneous and perfectly mobile across sectors, so the wage in both sectors is identical.

Production of commodities

Commodities are produced with physical capital and labour according to the following standard neoclassical CRTS production function: $Y_t = F(K_t, A_t L_t^Y)$, where K_t stands for the domestic capital stock, L_t^Y is the number of people employed in the commodity sector and A_t is a productivity parameter reflecting the current state of (technological) knowledge or experience in the economy (all at time t). Production per effective unit of labour is described by $f(\kappa_t)$, with $\kappa_t \equiv K_t/(A_t L_t^Y)$ denoting the effective capital–labour ratio. The interest rate and wage are determined by the marginal productivity of capital and labour respectively; i.e. $r_t = f'(\kappa_t)$ and $w_t = A_t \omega_t$, where $\omega_t = f(\kappa_t) - f'(\kappa_t)\kappa_t$.

Labour productivity A_t grows at the endogenous rate g,[5] which is assumed to depend positively on the number of people employed in the productive sector,[6]

$$(1) \qquad A_t = A_{t-1}\left(1 + g(L_t^Y)\right).$$

This can be interpreted as learning-by-doing, or as a shortcut for explicitly modelling (labour-intensive) R&D activities or education. Alternatively, one could assume that a proportion of the employees in the commodity sector devote their time to these activities, so that the more people who are active in this sector of the economy, the more knowledge is created and the more skills are improved, which allows people to produce more final output; i.e. productivity increases (as in e.g. Romer 1990; Grossman and Helpman 1991; Mulligan and Sala-i-Martin 1993).[7]

Production of services

The production of services requires labour only and does not benefit from technological improvements.[8] For the sake of simplicity, it is assumed that one unit of labour translates into one service unit. Consequently, total provision of services equals total labour supply in this sector $\left(L_t^D\right)$ and the price of services in terms of commodities, p_t, is equal to the wage: $p_t = w_t$.

Households

The economy is inhabited by a constant large number of individuals (normalized to 1) who live for two periods, such that in each period both a young generation and an old one are alive. The lifetime utility of a representative agent born at any time t is represented by the following function:

$$(2) \qquad U(c_t, d_{t+1}) = \log c_t + \gamma \log d_{t+1},$$

where c_t stands for the consumption of commodities when young and d_{t+1} is the number of services enjoyed by the agent when old.[9] This kind of utility function ensures that the number of services demanded, and thus the allocation of labour over the two sectors, is constant for a given growth rate of wages, i.e. a given growth rate of the relative price of services. This is necessary for an equilibrium to exist, and limits the class of utility functions that can be applied. The log-linear function used here is the most straightforward type of such a utility function.[10]

Every young individual supplies one unit of labour inelastically, which would follow from including leisure in the type of utility function that has to be applied, so that the income and substitution effect of a change in the (net) wage would cancel out. The government taxes the wage at rate τ in order to run a PAYG pension scheme. A young agent spends his net income on consumption and pension savings, which are collected by an actuarially fair pension fund in which he participates and invested in annuities, yielding a return of r_{t+1}. When retired, the individual's income therefore consists of both a funded and an unfunded component η_{t+1}. The government may levy a lump-sum tax θ on retirees to finance its debt. Individual consumption possibilities are thus given by the following budget constraints:

$$c_t = (1-\tau_t)w_t - s_t, \tag{3a}$$

$$p_{t+1}d_{t+1} = (1+r_{t+1})s_t + \eta_{t+1} - \theta_{t+1}. \tag{3b}$$

Maximizing (2) subject to (3a) and (3b) results in the following individual demand and saving functions:

$$c_t = \frac{1}{1+\gamma}\left((1-\tau_t)w_t + \frac{\eta_{t+1}-\theta_{t+1}}{1+r_{t+1}}\right), \tag{4}$$

$$d_{t+1} = \frac{\gamma(1+r_{t+1})}{(1+\gamma)w_{t+1}}\left((1-\tau_t)w_t + \frac{\eta_{t+1}-\theta_{t+1}}{1+r_{t+1}}\right), \tag{5}$$

$$s_t = \frac{\gamma(1-\tau_t)w_t}{1+\gamma} - \frac{\eta_{t+1}-\theta_{t+1}}{(1+\gamma)(1+r_{t+1})}. \tag{6}$$

So a fixed share of lifetime income in terms of commodities (which is given by $(1-\tau_t)w_t + (\eta_{t+1}-\theta_{t+1})/(1+r_{t+1})$) is allocated to commodities and services. In steady state, lifetime income grows with the rate of technological progress.[11] According to (4), this will also be the case for the consumption of commodities. Note that $w_{t+1}/(1+r_{t+1})$ is the relative price of services during old age in terms of current commodities. In steady state, this relative price will grow at a constant rate. This causes a negative substitution effect on the number of services demanded, which exactly offsets the positive income effect of a higher wage, so that the number of services enjoyed is constant for a given growth rate.

Government

The government runs a PAYG scheme financed by a proportional tax τ on wage income. We allow for the possibility that this tax causes welfare-reducing distortions. As population size is assumed to be constant[12] and, for simplicity, labour supply is assumed to be inelastic, this is modelled by assuming that, for a given tax τ_t, imposed on young

individuals, a part $\zeta\tau_t$ is 'wasted', so that the tax revenues increase less than proportionally with an increase in the tax rate:

$$\eta_t = \tau_t(1 - \zeta\tau_t)w_t,$$

where ζ is a parameter reflecting the extent of the distortion.

Without additional policy measures, a decrease in the size of the PAYG scheme reduces utility of the generation that is retired at the time of the change in the tax rate. The government may want to (partly) compensate this welfare loss via a debt-financed transfer to this generation. In order to allow for this possibility, we introduce government debt in the model, which is financed by taxing the retired. As they are by definition not active on the labour market and the tax is not linked to the stock of assets accumulated by the retiree, this tax is assumed to be non-distortionary. Denoting the tax on the retired generation by θ,[13] the dynamics of government debt B can be described by

$$B_t = (1 + r_t)B_{t-1} - \theta_t.$$

We assume public debt to be proportional to GDP in the long run, implying $\theta_t = (r_t - g_t)B_{t-1}$.

Equilibrium

The model comprises four markets which are simultaneously in equilibrium at each point in time. As services are not tradable, total demand for services by the old has to be met by domestic labour supply of the young to this sector, so $L_t^D = d_t$. Labour market clearing implies that $L_t^Y = 1 - L_t^D$. These equilibrium conditions in combination with the individual first-order conditions lead to the following expressions for the employment share of the commodity sector:

$$L_t^Y = 1 - \frac{(1 + r_t)s_{t-1} + \eta_t - \theta_t}{p_t} \tag{7}$$

$$L_t^Y = 1 - \frac{\gamma(1 + r_t)(1 - \tau_{t-1})\omega_{t-1}}{(1 + \gamma)\big(1 + g(L_t^Y)\big)\omega_t} - \frac{\gamma(\eta_t - \theta_t)}{(1 + \gamma)w_t}. \tag{8}$$

Demand for commodities, which consists of consumption, investment[14] $(K_{t+1} - K_t)$ and net exports (e_t), must equal aggregate domestic production, so

$$Y_t = c_t + K_{t+1} - K_t + e_t. \tag{9}$$

The capital market clears if

$$s_t + Z_{t+1} = K_{t+1} + B_t, \tag{10}$$

where Z is net foreign debt. In the case of a closed economy, the interest rate is endogenous and $e_t = Z_t = 0\,\forall\, t$. In the small open economy version of the model, the interest rate, and thus the capital–labour ratio and the marginal product of a labour efficiency unit, is exogenously determined on the world capital market; i.e. $r_t = r$, $\omega_t = \omega\,\forall\, t$. Moreover, equilibrium in the balance of payments requires $Z_{t+1} - Z_t = rZ_t - e_t$.

Finally, five assumptions are made.

Assumption I. A steady state exists, i.e. the function $g(x)$ is such that

$$\exists\, x \in (0,1) | 1 - \frac{(1+r)\gamma(1-\tau)}{(1+\gamma)(1+g(x))} - \frac{\gamma\tau(1-\zeta\tau) - (r-g(x))b}{1+\gamma} = x,$$

where b is the steady-state ratio of debt to wage income.

Assumption II. The economy converges to the steady state.

Assumption III. Endogenous-growth effects are bounded by

$$g' < \frac{(1+\gamma)\left(1+g(L_t^Y)\right)^2}{(1+r)\gamma(1-\tau)} \;\forall\, t.$$

Assumption IV. The values of model parameters and exogenous variables are such that the economy is always dynamically efficient; i.e. $r_t > g(L_t^Y)\ \forall\, t$.

Assumption V. The elasticity of substitution between capital and labour in production (σ) is sufficiently low. In particular,

$$\sigma < \frac{r(f(\kappa)+\kappa)}{f(\kappa)(1+r)} + \frac{r(f(\kappa)+\kappa)(f(\kappa)-\kappa r)}{f(\kappa)(1+r)\kappa(r-g)}.$$

II. A Closed Economy

Uncompensated reform without distortionary PAYG tax

It is well known that a PAYG scheme is Pareto efficient, unless (the financing of) this scheme causes welfare losses. That is, abstracting from such welfare losses arising from, say, distortionary taxation,[15] it is not possible to compensate the generations harmed by a (partial) switch from unfunded to funded pensions—in particular the first generation of elderly—by issuing government debt and still have at least one generation gain (see Verbon 1988; Breyer 1989; Rangel 1997). In this subsection we assume that the generations harmed by the transition do not receive any compensation and that the PAYG tax is non-distortionary. It should be noted that the results derived here for the closed economy also apply to the case of many (small) open economies that simultaneously implement the same pension reform.

The effects of a change in the PAYG tax can be traced by linearizing (8) and (9) around the initial steady state with $B_t = \theta_t = e_t = Z_t = 0$ as is described in the Appendix, leading to the following proposition.

Proposition 1. In a closed economy, with a PAYG scheme that does not cause distortions, an anticipated and uncompensated shift to a more funded scheme will:

- decrease the utility of the generation that is retired at the time the pension reform is first implemented,
- raise lifetime utility for all later generations,
- increase employment in the commodity sector,
- stimulate economic growth,
- increase the (effective) capital–labour ratio.

The new level of the PAYG tax applies permanently as of time $t = 0$, and it is assumed that this change was anticipated at time $t = -1$. Still, the working generation at time $t = -1$ is harmed because they have to both pay the PAYG tax for the previous generation and save extra for their own old age. The additional savings imply additional

investment, so the total demand for commodities will not change and the sector structure at $t = -1$ is not affected. But at $t = 0$ the sector structure does change: because the lower PAYG benefit will not be completely compensated by higher savings, service consumption falls. At the same time, the demand for commodities rises as the lower PAYG tax implies a higher lifetime income for the generation entering the labour market at $t = 0$. Consequently, employment in the commodity sector increases, which stimulates productivity growth. Still, the capital–labour ratio in this sector rises owing to the strong increase in savings in the previous period, which raises wages (and thus the price of services) and reinforces the shift in the sector structure. This development continues in subsequent periods, and the economy gradually converges to a new stable growth path. So, except for the effect on the utility of the elderly at the time the reform is first implemented, the long-run results are quantitatively but not qualitatively different from the short-run effects.[16]

This conclusion is different if labour and capital are strong substitutes in the production process, that is if Assumption V does not hold. Extra capital then implies that labour moves to the services sector where it can be used more productively, and long-run growth decreases. However, this a very exceptional case. For a large set of parameter values, a shift to more funded pensions results in higher long-run growth (see Appendix).

Endogenous vs. exogenous growth

We consider the effect of exogenous ($g' = 0$) versus endogenous ($g' > 0$) growth. Because the economy is continuously growing, utility will also steadily grow. Figures 1 and 2 show the deviation from the initial steady growth path if there is a permanent switch to a more funded pension scheme in a closed economy.[17]

First consider the case without endogenous growth ($g' = 0$), shown in Figure 1. Lifetime utility of the generation that is retired at the time the reform is first implemented (the generation born at $t = -1$) clearly falls, while welfare of all later generations increases. It should be noted that the higher lifetime utility that the pension reform produces in the long run is due solely to the increased consumption of commodities when young.[18]

Figure 2 shows the change in utility if growth is endogenous ($g' > 0$). The stronger the endogenous growth effects are, the higher wages rise at time $t = 0$ owing to the increase

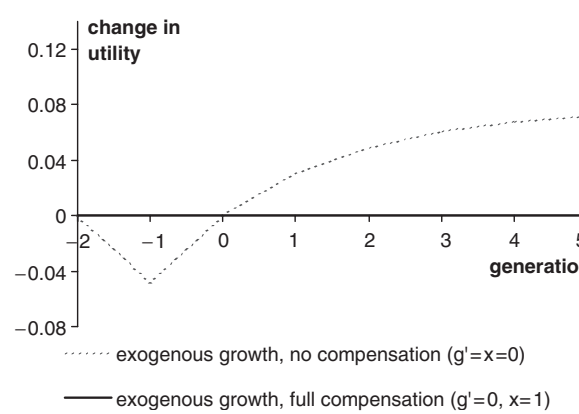

FIGURE 1. Closed economy with exogenous growth and no distortions.

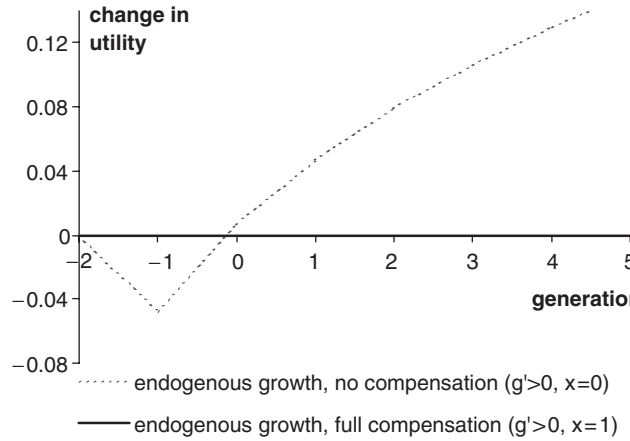

FIGURE 2. Closed economy with endogenous growth and no distortions.

of L^Y. This makes services for those who are then retired more expensive. But at the same time, the capital stock that they own becomes more productive (as the employees apply it more productively), which raises the interest rate on their savings. Compared with the case of exogenous growth, the change in utility of those who are retired at the time of the transition is therefore hardly different, with endogenous growth effects. The young generation experiences a higher wage and is therefore better off if g' is higher; naturally the same holds for all future generations. As in the case of exogenous growth, the consumption of commodities by future generations when young increases, but the amount of services enjoyed when old decreases. Endogenous growth only adds to the gap between felicity when young and old.

Compensation payments

In order to increase the political feasibility of the pension reform, the government may want to partly compensate the (living) generation that is harmed by the reform via a debt-financed transfer. We allow for the possibility that a part x $(0 \leqslant x \leqslant 1)$ of the decrease in the PAYG benefit is compensated this way. That is, $\theta_0 = x(\eta_{new} - \eta_{old}) \leqslant 0$, where η_{old} and η_{new} indicate the levels of the PAYG benefit before and after the reform, respectively. Hence public debt at the end of period 0 is $B_0 = -\theta_0 \geqslant 0$.

When the negative effects for the initial generation of the elderly are partly compensated $(0 < x < 1)$, the effects are qualitatively the same but less pronounced. When full compensation is given ($x = 1$, as shown in Figures 1 and 2), all effects disappear, irrespective of whether growth is exogenous or endogenous. In that case, a switch to more funded pensions does not have any effect: it merely replaces implicit by explicit public debt.[19] However, social security reform may still be worthwhile if the PAYG tax causes distortions, which is the case to which we will now turn.

Distortions

Of course, the positive effects of reducing the PAYG tax for current young and future generations are larger if this tax is distortionary (i.e. if $\zeta < 0$). More than that, as shown in

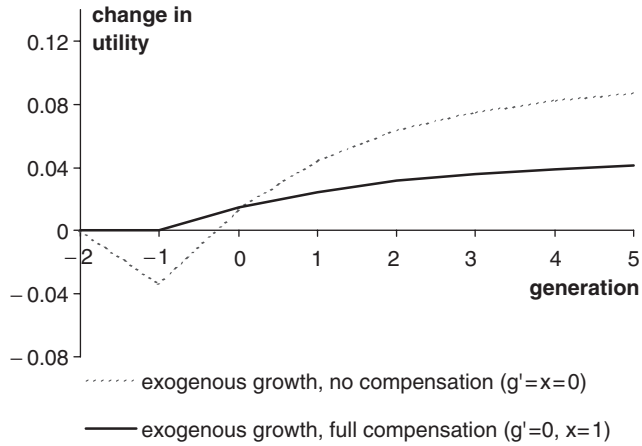

FIGURE 3. Closed economy with exogenous growth and distortions.

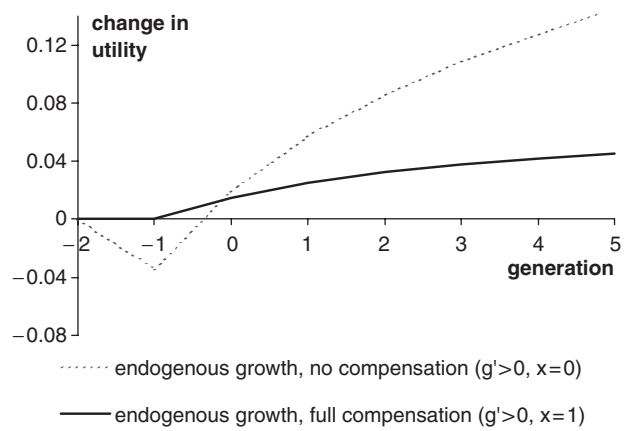

FIGURE 4. Closed economy with endogenous growth and distortions.

Figures 3 and 4, the generations born at $t = 0$ or later gain even if the initial elderly are completely compensated, since the increase in government debt necessary to compensate the first generation of the elderly in this case is smaller than without a distortion. In models with exogenous growth, this is the situation in which social security reform is a Pareto improvement (see Homburg 1990). Figure 4 shows that this result also holds in our endogenous growth model: the endogenous growth effects only reinforce the positive effects for current young and future generations.

III. A SMALL OPEN ECONOMY

Uncompensated reform without distortionary PAYG tax

This section describes the effects when a small open economy unilaterally decides to switch to a more funded pension scheme. In this case, the initial effects conform to the

initial effect in the closed economy. The long-run effects, however, are completely opposite to the standard results in the literature. That is, we find that pension reform decreases growth and eventually lowers lifetime utility.

As in the previous section, we analyse the effects of a decrease in the PAYG tax at time $t = 0$ that is announced at time $t = -1$ by linearizing equation (8) around the steady state, but now with $r_t = r$ and $\omega_t = \omega$. We start again with the benchmark case, where the first generation of the elderly is not compensated and the PAYG scheme is not distortive. Proposition 2 summarizes the short-run results.

Proposition 2. In a small open economy with a PAYG scheme that does not cause distortions, an anticipated and uncompensated shift to a more funded pension scheme will, at the time the reform is first implemented,

- decrease utility of the generation that is retired,
- raise lifetime utility of the working generation,
- increase employment in the commodity sector,
- stimulate economic growth.

Just as in the closed economy, an anticipated decrease in the social security tax at time $t = 0$ stimulates savings in the previous period. However, domestic investment does not change but capital flows out of the country, and as a result the real interest rate does not fall. As a consequence, at the time the PAYG scheme is cut down, retired individuals will not have to economize as much on services as in a closed economy. Still, demand for services will fall and the number of employees in the commodity sector will increase, which will stimulate productivity growth.[20]

If the interest rate exceeds the rate of economic growth ($r > g$), the lifetime income of generations entering the labour market at the time of the change or later increases owing to the lower social security tax, which results in a higher demand for both commodities (as of $t = 0$) and services (as of $t = 1$). Because the increased demand for (non-tradable) services has to be met by domestic production while commodities can be imported, domestic production of commodities will decrease; this releases labour from this sector, so that more people can be employed in the services sector. Lower employment in the commodity sector implies that technological progress or knowledge creation slows down, which eventually leads to a lower lifetime income than would have been the case without the reduction of the PAYG tax. Consequently, the consumption of commodities will be lower, as will the amount spent on services. Because wages decrease, so will the price of services. As can be seen from (5), the individual demand for services increases if τ is reduced (under Assumption IV), owing to both an income and a price effect. So in the long run the following proposition holds.

Proposition 3. In a small open economy with a PAYG scheme that does not cause distortions, an anticipated shift to a more funded pension scheme will eventually

- decrease lifetime utility,
- decrease employment in the commodity sector,
- reduce economic growth.

The long-run effects are therefore opposite to both the short-run consequences and the long-run results in a closed economy.

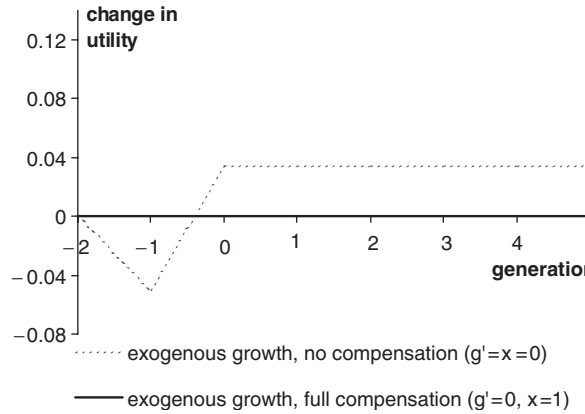

FIGURE 5. Small open economy with exogenous growth and no distortions.

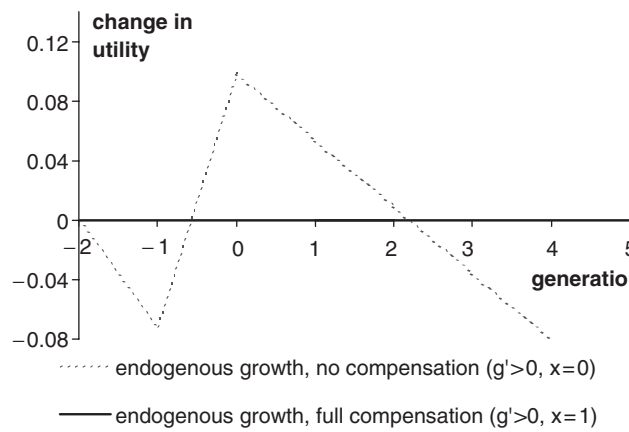

FIGURE 6. Small open economy with endogenous growth and no distortions.

Endogenous vs. exogenous growth

Figures 5 and 6 show the deviation from the initial steady growth path of lifetime utility if there is an anticipated permanent switch to a more funded pension scheme in a small open economy in the case of exogenous growth and endogenous growth, respectively.

First, consider the case without endogenous productivity changes and no compensation for the harmed generation ($g' = x = 0$). The elderly at time $t = 0$ suffer from a reduction in their pension benefit, whereas the current young and all future generations gain equally much because the wage and interest rate do not change. So when growth is exogenous, the current and future generations gain from the reform, as is the case in a closed economy.

If the production of commodities is characterized by endogenous productivity growth ($g' > 0$) the effects of pension reform are different. At the time the reform is implemented ($t = 0$), the increased productivity growth resulting from higher employment L_0^Y in the commodity sector raises wages. As there is no countervailing effect of the interest rate, endogenous growth makes the divergence of the gains and losses for the generations living at the time of the reform bigger: the retired pay the higher price for services and suffer more, whereas the young have a higher income and therefore gain more. Future

generations also benefit from the higher lifetime income that is directly caused by a lower PAYG tax, as well as from the higher labour productivity they 'inherit' from generation $t = 0$. However, these future generations all face a lower value of L^Y, so their own labour productivity will grow at a lower rate. After some time this effect will become dominant, and the consumption of commodities by the young will be lower than it would have been without the pension reform. How long it takes before this occurs depends on both individual preferences (the value of γ) and economic factors (r and g').

So endogenous growth in a two-sector model makes the long-run effects of social security reform completely the reverse of what conventional wisdom would predict and of what we find for a closed economy: future generations will not benefit but instead will suffer from such a policy.

Compensation payments

As in the closed-economy case, the effects of the policy change will be less pronounced if partial compensation is given to the retired at the time the reform is being implemented,

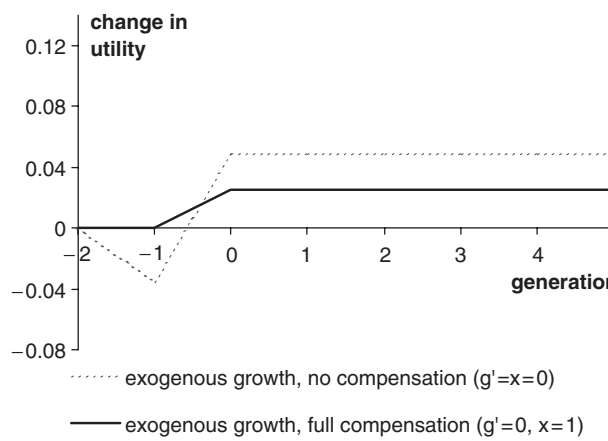

FIGURE 7. Small open economy with exogenous growth and distortions.

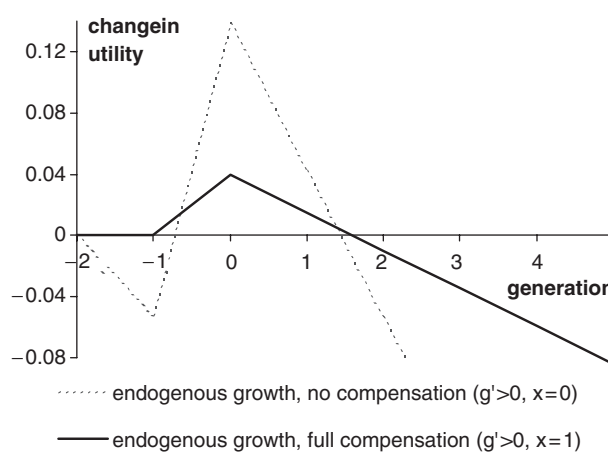

FIGURE 8. Small open economy with endogenous growth and distortions.

and will completely disappear if full compensation is given ($x = 1$). This is indicated in Figures 5 and 6 by the solid horizontal lines.

Distortions

Figures 7 and 8 illustrate the consequences of pension reform when the PAYG tax is distortionary. As in the closed economy, the positive effect for the generation born at $t = 0$ is larger with distortions. However, in the endogenous growth model this goes along with a falling growth rate, implying a smaller increase in lifetime utility for the generation born at $t = 1$ and a decrease in utility for all later generations. This holds irrespective of compensation payments. So, in contrast to the case of a closed economy, pension reform in combination with a debt-financed full compensation for the initial retirees is not a Pareto improvement. The reason is that, if current and near future generations gain from a shift to more funding, there would be a shift in the sector structure that would reduce growth and therefore eventually decrease welfare. It follows that a Pareto improvement is possible if the sector-structure change can be avoided. One way of realizing this is by overcompensating the initially retired: government debt can be raised to such a level that the burden of the debt exactly eliminates the welfare gain for the young and future generations. In that case the elderly gain, whereas the utility of all other generations is not affected.

A tax on services

From the above observations, we have learned that the government can affect the sector structure in order to prevent growth-reducing effects. There is yet another instrument which the government can use for this purpose, and that is a tax on service consumption.[21] We assume that the revenues of this tax are transferred back to the service consumers (in our model, only the retired). This implies that the service tax causes no income effect, but only a substitution effect that shifts demand from services to commodities. As can easily be seen from equation (5), the demand for services becomes $d_{t+1} = (1+\gamma)d^0_{t+1}/(1+\gamma+\chi)$, where χ is the tax on service consumption and d^0 the consumption of services without the tax.

This tax is distortionary and as such causes a welfare loss. However, it can be used to correct the external effect of service consumption on economic growth. In particular, the government can, simultaneously with the decrease of the PAYG tax, introduce a tax on services so as to keep service demand at the original level; a change in the sector structure is thus prevented and growth will not decrease. Consequently, pension reform not only will be Pareto improving, but also can benefit future generations. It should be noted, however, that the increase in welfare of future generations is realized solely through an increase in consumption of commodities. This implies that these generations will not benefit (or will benefit to a smaller extent) from the shift to more funded pensions during old age. So the rise in lifetime utility goes along with an increase in the gap between felicity when young and when old.

IV. Conclusion

We have shown that the welfare effects of reforming the pension scheme can be different from what is often suggested. Because individuals' tastes for tradable commodities and

non-tradable services differ with age, a change in the intergenerational redistribution causes a change in the production structure of the economy. Depending on the openness of the economy, this affects international trade and the extent to which the economy specializes in the provision of services. As the accumulation of (technological) knowledge typically takes place in the capital-intensive sector, the rate at which productivity grows subsequently changes, and with it the welfare of future generations. In particular, in a small open economy the welfare of future generations may fall if the pension system is reformed.

In the case of a closed economy, the effects of social security reform are positive, unless capital and labour are strong substitutes. Endogenous growth reinforces these positive effects. Increased savings raise the capital stock and thus increase the wage, which determines the price of services. As a consequence, the service sector shrinks and the commodity sector grows, which stimulates economic growth and favours the current young and future generations. However, these positive effects come at the cost of a decrease in welfare of the elderly at the time the reform is first taking place. In the absence of any distortions in the social security system, it is impossible to compensate these initial negative effects and still have at least one future generation gain; i.e. a Pareto improvement is not possible. Endogenous growth effects do not significantly change the initial negative effect. Hence in a representative democracy, in which the elderly have a significant influence on decision making, it is unlikely that current generations will implement a social security reform, assuming that welfare effects for future generations are not taken into account by current decision-makers. The presence of endogenous growth effects increases these welfare effects only for future generations.

The main result of the paper is that, in a small open economy with endogenous growth, extending funded pensions as often advocated will be detrimental for long-run economic growth and welfare. In fact, this result is more general and applies to any policy that raises saving. The rise in wealth that this causes will lead to a kind of 'Dutch disease': the import of commodities rises and the country specializes more in the production of non-tradable low-tech services, which lowers growth. This can be prevented only if the government introduces a tax on services that prevents an increase in the demand for services. However, this implies that future generations will profit from the wealth increase primarily during their youth, and not so much when they are retired.

If the effects on the sector structure in an open economy are not prevented by a service tax, endogenous growth effects not only lead to lower welfare for future generations, but also increase the welfare loss for the currently retired caused by a shift to more funded pensions, whereas the initial generation of young still gains. So introducing endogenous growth intensifies the difference in position between those who have to decide in the political arena on proposals concerning pension reform, i.e. the current young and the current old. At the same time, however, it may weaken the position of the young, as it deprives them of the argument that more funding will benefit future generations. On the contrary, it will harm future generations.

Our model thus suggests that the opposition to reform may be stronger in more open economies. Or, more generally, the model could lead us to expect a higher share of social security in more open countries. Such a positive relation between the degree of openness and the size of the PAYG scheme has indeed been observed in the data (Rodrik 1998; Persson and Tabellini 2003) and our model provides an alternative rationale for this empirical fact.[22]

Another conclusion we can draw is that for small open economies international policy coordination with respect to reforming the pension system is essential: only if

many small open economies reform simultaneously will the results for a closed economy apply and growth be stimulated. This point was also stressed by Pemberton (1999, 2000), but for another reason. In his model capital accumulation has positive international spillovers, which implies a gain in the case of policy coordination. In our model technological progress is determined completely by national learning-by-doing. It would be an interesting topic for further research to include positive international learning spillovers.

Some of the assumptions we made can be relaxed. However, this does not change the results significantly. For instance, if young individuals demand services too, the short-run effects can differ, but the conclusion for long-run growth and welfare are not affected. Another modification would be to allow for capital-induced growth; i.e. the development of labour productivity in the commodity sector depends not only on the number of employed people, but also on the capital–labour ratio. In a closed economy, the capital–labour ratio increases as the result of a switch to more funded pensions. This by itself would stimulate productivity growth, so the positive effect of pension reform on growth is stronger. In a small open economy the interest rate is exogenously given, so the capital–labour ratio is also exogenous. Consequently, the results we found would still hold.

APPENDIX TO SECTION II

In a closed economy no international trade of commodities is possible, so the total demand for commodities, which consists of consumption and investment goods, must equal the aggregate production; i.e. $e_t = 0$ in equation (9). Furthermore, equilibrium in the capital market is given by setting $Z_t = B_t = 0$ in (10). Combining this with the individual budget constraint (3a) gives

$$Y_t + K_t = (1-\tau)w_t,$$

which boils down to

$$\text{(A1)} \qquad L_t^Y = \frac{(1-\tau_t)(f(\kappa_t) - \kappa_t r_t)}{f(\kappa_t) + \kappa_t}.$$

Equilibrium in the labour and services market is given by

$$\text{(A2)} \qquad L_t^Y = 1 - \frac{\gamma(1+r_t)(1-\tau_{t-1})[f(\kappa_{t-1}) - \kappa_{t-1}r_{t-1}]}{(1+\gamma)\big(1+g(L_t^Y)\big)(f(\kappa_t) - \kappa_t r_t)} - \frac{\gamma\tau_t}{1+\gamma}.$$

Combining these equilibrium equations gives a two-dimensional nonlinear system in L_t^Y and κ_t. Because the capital stock is determined by savings in the previous period, we get a saddlepoint-stable system with one forward-looking (or jump) variable, L^Y, and one backward-looking (or state) variable, κ. The effects of a change in the PAYG tax are analysed by linearizing the equilibrium conditions around the initial steady state. We assume this steady state to be saddle-point-stable.

Linearizing (A1) yields[23]

$$\text{(A3)} \qquad \mathrm{d}L_t^Y = \delta_1 d\kappa_t + \delta_2 \mathrm{d}\tau_t,$$

with

$$\delta_1 \equiv [(1-\tau)(\sigma-1)\kappa f''(\kappa) - L^Y(f(\kappa) - \kappa r)]/[f(\kappa)(f(\kappa)+\kappa)],\ \delta_2 \equiv [\kappa r - f(\kappa)]/[f(\kappa)]$$

and σ denoting the elasticity of substitution between capital and labour, i.e. $\sigma \equiv -r[f(\kappa) - \kappa r]/[f(\kappa)\kappa f''(\kappa)]$.

Linearizing (A2) gives

$$\text{(A4)} \qquad \mathrm{d}L_t^Y = \lambda_1 \mathrm{d}\kappa_{t-1} + \lambda_2 \mathrm{d}\kappa_t + \lambda_3 \mathrm{d}\tau_{t-1} + \lambda_4 \mathrm{d}\tau_t,$$

where

$$\lambda_1 \equiv (1+g)\gamma(1-\tau)(1+r)\kappa f''(\kappa)/\{[(1+\gamma)(1+g)^2-\gamma(1-\tau)(1+r)g'][f(\kappa)-\kappa r]\}<0,$$

$$\lambda_2 \equiv -\lambda_1[f(\kappa)+\kappa]/[\kappa(1+r)]>0,$$

$$\lambda_3 \equiv (1+g)\gamma(1+r)/[(1+\gamma)(1+g)^2-\gamma(1-\tau)(1+r)g']>0 \quad \text{and}$$

$$\lambda_4 \equiv -\lambda_3(1+g)/(1+r)<0.$$

Combining these two equations yields the following first-order difference equation:

$$\text{(A5)} \qquad \mathrm{d}L_t^Y = \frac{\lambda_1}{\delta_1-\lambda_2}\mathrm{d}L_{t-1}^Y + \frac{\delta_1\lambda_4-\delta_2\lambda_2}{\delta_1-\lambda_2}\mathrm{d}\tau_t + \frac{\delta_1\lambda_3-\delta_2\lambda_1}{\delta_1-\lambda_2}\mathrm{d}\tau_{t-1},$$

which is stable if $|\lambda_1/(\delta_1-\lambda_2)|<1$. Capital market equilibrium ($s_t = K_{t+1}$) can be written as $s_t/[A_t(1+g(L_{t+1}^Y))] = \kappa_{t+1}L_{t+1}^Y$. Combining this with (6) and (A1), it can be shown that $\delta_1-\lambda_2<0$. This implies that the stability condition boils down to $\delta_1-\lambda_1-\lambda_2<0$. In line with Assumption II, we assume this condition to hold (which automatically follows from Assumption III if $\sigma \geqslant 1$).

Proof of Proposition 1

Setting $\mathrm{d}L_{t+1}^Y = \mathrm{d}L_t^Y = \mathrm{d}L^Y$ and $\mathrm{d}\tau_{t+1} = \mathrm{d}\tau_t = \mathrm{d}\tau$ in (A5) gives

$$\text{(A6)} \qquad \frac{\mathrm{d}L^Y}{\mathrm{d}\tau} = \frac{\delta_1\lambda_3-\delta_2\lambda_1+\delta_1\lambda_4-\delta_2\lambda_2}{\delta_1-\lambda_1-\lambda_2}.$$

The denominator of this equation is negative. The nominator is positive iff

$$\text{(A7)} \qquad \sigma < \frac{r(f(\kappa)+\kappa)}{f(\kappa)(1+r)} + \frac{r(f(\kappa)+\kappa)(f(\kappa)-\kappa r)}{f(\kappa)(1+r)\kappa(r-g)}.$$

In the text we have subsumed (A7) under Assumption V. This condition holds if the elasticity of substitution between capital and labour in production (σ) is sufficiently low and productivity growth (g) is sufficiently high. Then $\mathrm{d}L^Y/\mathrm{d}\tau<0$, and consequently $\mathrm{d}g/\mathrm{d}\tau = g'\mathrm{d}L^Y/\mathrm{d}\tau<0$. Furthermore, in the steady state (A4) can be written as

$$\frac{\mathrm{d}\kappa}{\mathrm{d}\tau} = \frac{\kappa(1+r)}{\lambda_1(\kappa r-f(\kappa))}\frac{\mathrm{d}L^Y}{\mathrm{d}\tau} - \frac{\lambda_3\kappa(r-g)}{\lambda_1(\kappa r-f(\kappa))}.$$

Knowing that λ_1, $\mathrm{d}L^Y/\mathrm{d}\tau<0$, $\lambda_3>0$ and $r<g$, it follows that $\mathrm{d}\kappa/\mathrm{d}\tau<0$. □

Simulations with a linear growth function ($g = \bar{g}+\rho L^Y$) show that, for a large range of (combinations of) parameter values, (A7) holds. For example, if the production function is $Y_t = [0.3K_t^{(\sigma-1)/\sigma} + 0.7(A_tL_t^Y)^{(\sigma-1)/\sigma}]^{\sigma/(\sigma-1)}$ and without exogenous growth ($\bar{g}=0$), the values of the elasticity of substitution σ for which $\mathrm{d}L^Y/\mathrm{d}\tau = 0$ are given in Table 1. For values of ρ higher than 0.5, $\mathrm{d}L^Y/\mathrm{d}\tau$ is always negative. Furthermore, a positive value of $\bar{g}$ increases the values of σ for which $\mathrm{d}L^Y/\mathrm{d}\tau = 0$. Finally, for the given values of γ, it appears that $\sigma<1.5$ is sufficient for Assumption V in the main text to hold.

APPENDIX TO SECTION III

Proof of Proposition 2

Without compensation payments, individual savings at time $t=-1$ are given by $s_{-1} = [\gamma(1-\tau_{-1})w_{-1}]/(1+\gamma) - [\tau_0 w_{-1}(1+g(L_0^Y))]/[(1+\gamma)(1+r)]$, and equation (7) boils down to

TABLE 1
VALUES OF σ FOR WHICH $\mathrm{d}Ly/\mathrm{d}\tau = 0$

	$\gamma = 0.75$				$\gamma = 1$			
$\tau \downarrow \rho \rightarrow$	0	0.2	0.4	0.5	0	0.2	0.4	0.5
0	1.7	2.4	4.9	21.0	1.5	2.0	3.3	5.7
0.1	1.9	2.6	5.6	24.0	1.7	2.1	3.5	6.1
0.2	2.1	3.1	7.0	32.2	1.8	2.4	4.0	7.1

$$L_0^Y = 1 - \frac{\gamma(1-\tau_{-1})(1+r)}{(1+\gamma)\big(1+g(L_0^Y)\big)} - \frac{\gamma\tau_0}{1+\gamma}.$$

The short-run effects on employment in the commodity sector can be seen from totally differentiating this equation, giving

$$\frac{\mathrm{d}L_0^Y}{\mathrm{d}\tau_0} = -\frac{\gamma(1+g)^2}{(1+\gamma)(1+g)^2 - \gamma(1-\tau)(1+r)g'},$$

which is negative if Assumption III holds. Consequently, $\mathrm{d}g_0/\mathrm{d}\tau_0 = g'\mathrm{d}L_0^Y/\mathrm{d}\tau_0 < 0$: economic growth increases at the time the pension reform is first implemented. This implies that the wage (w_0) increases, which together with a lower PAYG benefit decreases the utility of the generation that is retired at time $t = 0$. The generation born at time $t = 0$ has a higher lifetime income in terms of commodities because of the higher wage when young and the lower PAYG tax, but also pays a lower price for services when retired, since w_1 will decrease owing to a lower employment in the commodity sector as of time $t = 1$ (see Proposition 3). Hence this generation can consume more commodities when young and use more services when retired, so utility increases. □

Proof of Proposition 3

The long-run impact of the size of the PAYG scheme (τ) on the economy can be traced by comparative statics of (8), which yields

$$\frac{\mathrm{d}L^Y}{\mathrm{d}\tau} = \frac{\gamma(1+g)(r-g)}{(1+\gamma)(1+g)^2 - \gamma(1-\tau)(1+r)g'}.$$

This expression is positive under Assumptions III and IV, so $\mathrm{d}g/\mathrm{d}\tau = g'\mathrm{d}L^Y/\mathrm{d}\tau > 0$.

As can be seen from (5), the number of services that an individual uses will increase to a permanently higher level if τ is reduced and g is at a permanently lower level (as of time $t = 1$). In the long run, the individual consumption of commodities will continually decrease as the wage will grow at a permanently lower level. Hence long-run utility will decrease. □

Allowing for service demand by the young. The lifetime utility of a representative agent is now given by the following function:

$$(2') \qquad U(c_t, d_t^y, d_{t+1}^o) = \log c_t + \beta \log d_t^y + \gamma \log d_{t+1}^o,$$

where d_t^y (d_{t+1}^o) is the number of services enjoyed by the agent when young (old). The first-period budget constraint is

$$(3a') \qquad c_t + p_t d_t^y = w_t(1-\tau_t) - s_t.$$

This leads to the following demand for services:

$$(A8) \qquad d_t^y = \frac{\beta}{1+\beta+\gamma}\left(1 - \tau_t + \frac{\tau_{t+1}(1+g(L_{t+1}^Y))}{1+r_{t+1}}\right),$$

$$(5') \qquad d^o_{t+1} = \frac{\gamma}{1+\beta+\gamma}\left(\frac{(1+r_{t+1})(1-\tau_t)}{1+g(L^Y_{t+1})} + \tau_{t+1}\right).$$

Equilibrium in the services and the labour market is given by

$$(7') \qquad L^Y_t = 1 - d^y_t - d^o_t.$$

Assumption III becomes

$$g' < [(1+\beta+\gamma)(1+r)\left(1+g(L^Y_t)\right)^2]/[(1+r)^2\gamma(1-\tau) - \beta\tau\left(1+g(L^Y_t)\right)^2]\ \forall t.$$

The long-run effects of a reduction of the PAYG tax in a small open economy can be traced by linearizing equation (7′), taking $r_t = r\ \forall t$, which results in

$$\frac{\mathrm{d}L^Y}{\mathrm{d}\tau} = \frac{(1+g)[\beta(1+g)+\gamma(1+r)](r-g)}{(1+r)(1+g)^2(1+\beta+\gamma)+\beta\tau g'(1+g)^2 - \gamma(1+r)^2(1-\tau)g'},$$

which is clearly positive if Assumptions III and IV hold.

Taking account of the fact that at time $t = -1$ (when it is announced that the pension reform will take place one period later), savings of the previous period (s_{-2}) are given, the equilibrium condition for the services and labour market at that time is given by

$$L^Y_{-1} = 1 - \frac{\beta}{1+\beta+\gamma}\left(1-\tau_{-1}+\frac{\tau_0(1+g(L^Y_0))}{1+r}\right) - \frac{\gamma}{1+\beta+\gamma}\left(\frac{(1+r)(1-\tau_{-2})}{1+g(L^Y_{-1})}+\tau_{-1}\right).$$

Knowing that the new steady state is reached at $t = 0$, differentiating this expression gives

$$\frac{\mathrm{d}L^Y_{-1}}{\mathrm{d}\tau} = \frac{-\beta(1+g)^2[(1+g)-\tau g'(\mathrm{d}L^Y/\mathrm{d}\tau)]}{(1+r)\left[(1+g)^2(1+\beta+\gamma)-(1+r)\gamma(1-\tau)g'\right]}.$$

Because $\mathrm{d}L^Y/\mathrm{d}\tau > 0$ and Assumption III holds, this expression is negative, which leads to the conclusion that, if young individuals also demand services, the short-run effect of an expected shift to a more funded pension scheme on the number of employees in the commodity sector is positive.

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NOTES

1. Focusing on human capital as the engine of growth, however, modifies this strong conclusion that unfunded social security is harmful for economic growth. See e.g. Kaganovich and Zilcha (1999), Lambrecht *et al.* (2001) and Zhang (1995).
2. See *ONS Family Spending* 2000–01 for the United Kingdom and *CBS Budgetonderzoek* for the Netherlands.
3. Unless the welfare loss of the first generation of the elderly is completely compensated by additional government debt and the PAYG scheme does not cause any distortions. The reduction in the PAYG tax then merely replaces implicit debt by explicit government debt which does not have any real effect. See Sections II and III.
4. A similar shift of labour from the production of tradables to that of (non-tradable) services and a subsequent productivity loss is found in Smulders and van de Klundert (2001), who analyse the effects of the initial distribution of financial wealth across countries on long-run growth and cross-country productivity levels.
5. It may well be that the economy also adopts new technologies and increases its knowledge from abroad. In that case, the size of the commodity sector positively affects the *additional* productivity growth of the economy.
6. Note that we assume that A will grow instantly with the size of the sector. If, on the other hand, learning takes time, one would rather want to assume some delay in the accumulation of knowledge. However, assuming that g is a function of L^Y_{t-1} instead of L^Y_t would imply that learning takes about thirty years (i.e. one period in our model), which does not seem to be very realistic.

7. Explicitly modelling human capital investments as time-intensive activities which involve forgone wage income as opportunity costs would not change the results described in the rest of the paper.
8. Examples are nurses, GPs, gardeners, cleaners, housekeepers, hairdressers, butlers and hotel services. Note that these are not services, like bank services, which extensively use high-tech goods like computers.
9. Allowing for service demand by young individuals does not change the long-run results derived in the next sections significantly (see Appendix).
10. This is similar to the modelling of the labour/leisure choice in a model with economic growth. King *et al.* (1988) and Rebelo (1991) formulate the class of utility functions for which the number of leisure hours does not grow indefinitely (see also Barro and Sala-i-Martin 1995, chapter 9).
11. Assuming that η and θ grow at the same rate.
12. The effect of ageing in a similar model, modelled either as an increase in longevity or a decrease in population growth, is analysed in van Groezen *et al.* (2005).
13. The transfer to the retired generation at the time of the change in the tax rate is modelled as a negative value of θ.
14. We assume that capital does not depreciate.
15. Or, more precisely, if these welfare losses are unavoidable efficiency costs of a deliberate redistribution policy by the government (see Fenge 1995).
16. If the shock is not anticipated, the short-run effects are qualitatively different from the long-run effects: in that case the size of the capital stock is predetermined by the savings in period $t-1$ so that at the time of the shock only the division of labour over the two sectors can change. The short-run effects may also differ qualitatively from the long-run effects if not only the retirees, but also the young consume services.
17. All simulations are based on the assumption that productivity growth is a linear function of the number of employees in the productive sector, i.e. $g_t = \bar{g} + \rho L_t^Y$, where $\bar{g}$ has such a value that the equilibrium growth rate is equal to 1.1 (which corresponds to an annual economy wide growth rate of about 2.5%). The cases considered are $\rho \to 0$ and $\rho = 2$, respectively. The production function of commodities is given by $Y_t = (0.3K_t^{-0.33} + 0.7(A_t L_t^Y)^{-0.33})^{-3}$. Furthermore, $\gamma = 0.75$. The PAYG tax is decreased from 20% to 10%. In case of distortions, $\zeta = 1$. Either no compensation ($x = 0$) or full compensation ($x = 1$) is given.
18. The reason for this is that the only way to transfer purchasing power to old age is through investment in capital that is useful only for the production of commodities, whereas the elderly instead demand services, causing a sharp drop in the real rate of interest (r_t/p_t).
19. In that case the effect on lifetime income for the current young and all future generations is nil, because the present value of the gain in the first period of life resulting from the lower PAYG tax ($(\tau_{\text{old}}-\tau_{\text{new}})w_t$) is offset exactly by the present value of the loss in the second period of life resulting from the lower PAYG benefit and the tax necessary to stabilize the debt ratio ($[(\tau_{\text{old}} - \tau_{\text{new}})(1+g)w_t + (r-g)(\tau_{\text{old}} - \tau_{\text{new}})w_t]/(1+r)$).
20. The short-run results are more pronounced, but not qualitatively different if the policy shock is unexpected. Allowing for consumption of services by the young does not lead to qualitatively different short-run results either (see Appendix).
21. We thank an anonymous referee for suggesting that we include an analysis of such a tax.
22. We thank an anonymous referee for pointing to this empirical consequence of our model.
23. Omitting the time subscript denotes the (initial) steady-state value of the variable or parameter.

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