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Working Paper

The international spillover effects of pension reform

CESifo Working Paper, No. 1540

Provided in Cooperation with:
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Suggested Citation: Adema, Yvonne; Meijdam, Lex; Verbon, Harrie A. A. (2005) : The international spillover effects of pension reform, CESifo Working Paper, No. 1540, Center for Economic Studies and ifo Institute (CESifo), Munich

This Version is available at:
https://hdl.handle.net/10419/19004

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THE INTERNATIONAL SPILLOVER EFFECTS OF PENSION REFORM

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CESIFO WORKING PAPER NO. 1540
CATEGORY 1: PUBLIC FINANCE
SEPTEMBER 2005

An electronic version of the paper may be downloaded
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CESifo *Working Paper No. 1540*

THE INTERNATIONAL SPILLOVER EFFECTS OF PENSION REFORM

Abstract

This paper explores how pension reforms in countries with PAYG schemes affect countries with funded systems. We use a two-country two-period overlapping-generations model, where the countries only differ in their pension systems. We distinguish between the case where a reform potentially leads to a Pareto improvement in the PAYG country, and where this is impossible. In the latter case the funded country shares both in the costs and the benefits of the reform. However, if a Pareto-improving pension reform is feasible in the PAYG country, a Pareto improvement in the funded country is not guaranteed.

JEL Code: F21, F41, F47, H55, H63.

Keywords: international spillover effects, pension reform.

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1 Introduction

In many developed countries ageing has led to a debate on reforming unfunded pay-as-you-go (PAYG) social-security systems. One of the most discussed reform proposals is to switch to a more funded pension system where people save for their own pensions, and realise a higher expected rate of return on their contributions (see for example Feldstein (2005)). Many countries with PAYG-financed pension schemes actually (are planning to) implement such pension reforms. In a multicountry world with integrated capital markets, this switch to funding will engender spillover effects to other countries. The aim of this paper is to look at these international spillover effects of pension reform. More specifically, we will analyse how countries with funded pension systems are affected when countries with PAYG pension schemes reform their pension system.

Some papers (e.g. Fehr et al. (2003), Börsch-Supan et al. (2003) and INGENUE (2001)) that address pension reform issues in an open-economy framework develop large multi-country overlapping-generation models to study the effects of pension reform. These large-scale general equilibrium models are particularly useful in case one wants to obtain reliable forecasts on several key economic variables. An important drawback of these models is, however, that analytical solutions are not feasible. We use a simple two-country two-period overlapping-generations model with an integrated capital market, where one country has a PAYG pension system and the other country has a fully funded retirement scheme. By keeping the model this simple, we are able to derive an analytical solution for the transition path of the common capital-labour ratio. Other variables, like consumption and utility, can be derived from the development of the capital-labour ratio.

In analysing the effects of a pension reform in the PAYG country, we first assume that collecting contributions in the PAYG country does not involve any distortions. It is well-known that in such a case the PAYG system is Pareto efficient, see Verbon (1989) and Breyer (1989). That means that in case, e.g., a conversion policy goes along with a compensation for the elderly, financed by public debt, the gains of future generations are at best neutralized or, worse, turned into losses by the higher future taxes needed to service the debt. On the other

hand, if future generations are allowed to gain from the conversion policy, it is unavoidable that current generations have to incur a loss. So, in the reforming country a choice has to be made which generations are allowed to gain from the reform and which not. One conclusion that will emerge from our two-country model is that in a common capital market this choice spills over to the other non-reforming country. In particular, if the reforming country decides that future generations will gain from the reform, future generations in the non-reforming country will gain as well.

We then proceed by assuming excess burdens in tax collection. In that case it has been shown that a Pareto-improving pension reform is possible (Homburg (1990)). The idea is that if the contribution rate is decreased net welfare gains are incurred which make it possible to compensate the elderly for the loss of their benefits. Additional features for implementing a Pareto improvement can be added. Pemberton (2000) and Belan et al. (1998) assume externalities in production on top of excess burdens in taxation, and Köthenbürger and Poutvaara (2005) assume an increase in the value of a fixed factor that goes along with a decrease of taxation. These additional features, however, though making it more likely, are not necessary for reaching a Pareto-improving conversion. Therefore, we will restrict ourselves to assuming excess burdens resulting from taxation only. Let us note that we merely conclude that the existence of an excess burden offers the scope for introducing a Pareto-improving reform. However, we do not go into the issue here whether this is a 'good' or 'bad' reason for reform[1].

The excess burden of taxation has been modelled in at least two ways in the literature. Homburg (1990) and Breyer and Straub (1993) assume that taxes distort the labour-leisure decision so that a decrease in the contribution rate for the PAYG system will increase labour supply, and, therefore, restrict the loss in revenue for financing the pension benefits. Pember-

[1]It should be noted here that the existence of excess burdens in taxation cannot be the prime motive for converting the PAYG system into a fully funded system. The excess burden arises because the individual link between pension benefits and contributions is broken. The reason for this is that the pension system is also used for intragenerational redistribution. As proved by Fenge (1995) and Brunner (1996), in a PAYG system in which such a link exists the system is Pareto efficient, even if contributions are a proportional tax on labour income. Such PAYG systems exist. For instance, as noted by Sinn (2000), Germany has had a PAYG system since 1957 where benefits are proportional to contributions, and so a Pareto improving transition to a funded system is not possible in Germany. Sinn (2000) and Belan and Pestieau (1999) give overviews of the issue. Their conclusion in the words of the last authors is that "reduced distortions can be achieved without privatization".

ton (2000), however, considers the case where a conversion policy goes along with an income tax being replaced by a consumption tax. Then young individuals under the conversion policy have an incentive to save more than under the income tax, which provides the means to compensate the older generations when the PAYG system is abolished. Analogously, Belan et al. (1998) offers the first generation a subsidy on the return on its savings. Our specification will be more in line with the first type of modelling (labour-supply effects), but our model allows the introduction of the second type (savings incentives) just as well.

Given that taxes imply an excess burden in the PAYG-country, we implement a Pareto-improving policy in our two-country world. It appears again that the long-run gains in the PAYG-country are transferred to the funded country. However, although in the PAYG-country the policy is carefully shaped such that no generation loses in both the short run and the long run, in the funded country some generations might lose in the short run. The reason for this is that in the open capital market the additional savings that emerge during the conversion policy in the PAYG country will depress the interest rate, and especially harms the generations that are alive in the funded country when the PAYG country starts the conversion policy. As these generations do not, or do not fully, incur the gains that result from increasing wages, they are not able to compensate themselves against the negative utility effects of the lower interest rate.

The rest of the paper is organized as follows. Section 2 presents the benchmark model and shows how the pension reform is modelled. In Section 3 we analyse different types of reform scenarios under the assumption that the PAYG scheme is Pareto efficient. While Section 4 considers the effects in case the reform is Pareto improving in the PAYG country. The final section concludes.

2 The model

We will use a two-period overlapping-generations model of an open economy. Following Buiter (1981) and Persson (1985), the world consists of two countries, country P and country F. The only difference between the two countries is the way the pensions are financed. Country

P uses a pay-as-you-go (PAYG) system and country F has a fully funded retirement scheme. The countries are identical in all other respects[2]. We assume a constant population size and dynamic efficiency in both countries.

2.1 Production

Production per young individual is described by a standard neoclassical constant-returns-to-scale production function, $f(k_t^i)$, where k_t^i stands for the amount of capital per young individual in period t in country i, $i = P,\ F$. Perfect competition among producers gives the usual equilibrium conditions, $r_t^i = f'(k_t^i) - \delta$ and $w_t^i = f(k_t^i) - k_t^i f'(k_t^i)$, where r_t^i is the interest rate, w_t^i denotes the real wage, and δ is the depreciation rate of capital. There is perfect capital mobility between the two countries, but labour is immobile. Since capital can freely move across countries, the interest rates will be equalised, i.e., $r_t^P = r_t^F = r_t,\ \forall t$. And because both countries are endowed with the same production technology, we have $k_t^P = k_t^F = k_t$, and consequently $w_t^P = w_t^F = w_t$.

2.2 Modelling pensions and reform

Initially the government in country P runs a balanced PAYG pension system, that is, taxes of the young (τ_t^P) are used to finance the pension benefits of the elderly (z_t^P). As explained in the introduction we distinguish between the case where the PAYG system is efficient and the case where the PAYG scheme leads to distortions in the economy. In the latter case the PAYG tax implies an excess burden. Instead of explicitly specifying how behaviour is affected when the excess burden of the premium contributions is lifted, we assume that the tax base is constant and independent of the size of the contribution. The existence of an excess burden under the PAYG system is modelled by assuming that for a given tax imposed on young individuals, only $\tau_t^P - (\tau_t^P)^2$ can be redistributed, so $(\tau_t^P)^2$ is 'wasted' (see Perotti (2001) who uses an analogous specification). For a tax on elderly individuals, however, such a waste does not occur. This specification of the excess burden of the tax is thus a short cut for the labour-supply interpretation. Regarding this interpretation, it should be the case,

[2]So we assume both economies to be of equal size. The model is easily generalized to allow for scale differences between the two countries. This does not qualitatively change our results, however.

as we assume, that taxing the young leads to tax revenue losses if the young curtail their labour-supply efforts as a result of the tax. But, when the elderly are retired, taxes cannot have an effect on their labour-supply behaviour, and so, there is no excess burden.
In general, in the initial steady state the pension benefits of the elderly are equal to[3]:

$$z^P = \tau^P - \xi(\tau^P)^2 \tag{1}$$

where $\xi = 1$ implies that the PAYG tax leads to an excess burden, and where $\xi = 0$ refers to the situation where the financing of the PAYG scheme is not distortionary. For the moment we develop the model in the absence of distortions so that $\xi = 0$ and $z^P = \tau^P$ in the initial steady state. In Section 4 we consider the case where $\xi = 1$.

At $t = -1$ the government in country P announces that it will reform its pension system in the next period ($t = 0$). Individuals take the economic consequences of the reform into account when they make their optimising decisions in period $t = -1$. A pension reform leads to a lower contribution level and lower benefits. We model this as follows:

$$\tau_t^P = \mu_t \, \tau^P \tag{2}$$

$$z_t^P = \lambda_t \, \tau^P \tag{3}$$

where $\mu_t < 1$ and $\lambda_t \leq 1$.

One of the crucial issues in pension reform is whether or not the (partial or complete) switch to funding is accompanied by a compensation for the older generations. We consider both possibilities. In the first case there is no compensation: benefits and contributions simultaneously decrease by the same amount. The elderly individuals at the time of the reform lose as a consequence, while the current and future young individuals fully gain from the higher rate of return on their contributions under the funded system.
In the second case the elderly are compensated, implying that $\mu_t < \lambda_t$ will hold during the initial periods of the reform. We assume that public debt, (b_t^P), is used to finance the shortfall

[3]By omitting time subscripts we denote the initial steady state value of the respective variable.

in contributions. It is assumed that the government issues one-period debt, which yields the same rate of interest as capital. At a later stage, additional contributions (τ_t^B) are raised to finance the interest obligations on the debt, so as to keep debt per worker constant. With debt, therefore, the budget constraint of the government (public debt dynamics) in per capita terms is:

$$b_{t+1}^P = (1 + r_t)b_t^P + z_t^P - \tau_t^P - \tau_t^B \tag{4}$$

If part of the benefits are financed by government debt, we assume that at a certain point in time benefits match contributions again, i.e. the benefits should have decreased as: $\lambda_t = \mu_t < 1$. So the PAYG system is balanced again, but at a permanently lower level. Furthermore, we assume that there is no government debt in the initial steady state ($b^P = 0$), so that τ^B is zero too.

In country F the government invests the contributions of the young (τ_t^F) and returns them with interest in the next period in the form of transfers to the then old agents (z_{t+1}^F)[4]:

$$z_{t+1}^F = (1 + r_{t+1})\,\tau_t^F \tag{5}$$

2.3 Households

Lifetime utility of a representative individual born at t is given by the following utility function:

$$U\left(c_t^{y,i}, c_{t+1}^{o,i}\right) = \log c_t^{y,i} + \frac{1}{1+\rho}\log\left(c_{t+1}^{o,i}\right) \tag{6}$$

where $\rho > 0$ stands for the (constant) pure rate of time preference of an individual, $c_t^{y,i}$ is consumption when young, and $c_{t+1}^{o,i}$ is consumption in the second period of life.

Young agents inelastically supply one unit of labour. The consolidated lifetime budget con-

[4]We assume that in country F the contribution τ_t^F does not imply an excess burden, due to the system being actuarially fair for every individual.

straints in the two countries are as follows:

$$c_t^{y,P} + \frac{c_{t+1}^{o,P}}{1+r_{t+1}} = w_t - \tau_t^P - \frac{\tau_{t+1}^B}{1+r_{t+1}} + \frac{z_{t+1}^P}{1+r_{t+1}} \tag{7a}$$

$$c_t^{y,P} + \frac{c_{t+1}^{o,P}}{1+r_{t+1}} = w_t - \tau_t^P - \tau_t^B + \frac{z_{t+1}^P}{1+r_{t+1}} \tag{7b}$$

$$c_t^{y,F} + \frac{c_{t+1}^{o,F}}{1+r_{t+1}} = w_t - \tau_t^F + \frac{z_{t+1}^F}{1+r_{t+1}} \tag{8}$$

The government in country P can either levy τ_t^B on the elderly (eq. (7a)) or on the working people (eq. (7b)). Maximizing lifetime utility with respect to the lifetime budget constraints gives the following expressions for individual optimal savings in both countries:

$$s_t^P = \frac{1}{2+\rho}\left[w_t - \tau_t^P\right] - \frac{1+\rho}{2+\rho}\left[\frac{z_{t+1}^P}{1+r_{t+1}} - \frac{\tau_{t+1}^B}{1+r_{t+1}}\right] \tag{9a}$$

$$s_t^P = \frac{1}{2+\rho}\left[w_t - \tau_t^P - \tau_t^B\right] - \frac{1+\rho}{2+\rho}\frac{z_{t+1}^P}{1+r_{t+1}} \tag{9b}$$

$$s_t^F + \tau_t^F = \frac{1}{2+\rho}\, w_t \tag{10}$$

Note that optimal savings in country F do not depend on the interest rate. The reason for this is that with logarithmic utility, the intertemporal substitution elasticity is equal to one. For the same reason, optimal savings in country P only react to the interest rate because it changes the net present value of the pension benefit (and taxes possibly paid in the second period of life).

2.4 Equilibrium international capital market

Individuals invest their savings either in their own country or abroad, their portfolios will be composed such that interest rates are equalised. Equilibrium in the international capital market is given by:

$$s_t^P + s_t^F + \tau_t^F = 2k_{t+1} + b_{t+1}^P \tag{11}$$

From equations (9) and (10) it can be seen that country F has higher savings than country P, implying that country F exports capital abroad.

3 Pension reform under Pareto efficiency

This section investigates the spillover effects of a pension reform in the PAYG country, under the assumption that the PAYG system is Pareto efficient, i.e. taxes are non distortionary. We consider three different types of reforms. In the first reform, the government in the PAYG country does not compensate the elderly at the time of the reform (Section 3.1). In the second and third reform we analyse the effects in case the government fully compensates the current old. In that case government debt is created and the extra tax needed to pay the interest obligations on the debt can either be levied on the pensioners (Section 3.2) or on the working people (Section 3.3).

For all cases considered we are able to calculate analytically the effect of a pension reform on the common capital stock. We employ the method of comparative dynamics, adopted from Judd (1982). The processes for μ_t and λ_t are given by:

$$\mu_t = 1 + \pi g_t \tag{12}$$

$$\lambda_t = 1 + \pi f_t \tag{13}$$

where $g_t < 0$ and $f_t \leq 0$ describe the time pattern of a perturbation of μ_t and λ_t from their steady-state values and π reflects the magnitude of this perturbation. The effects of a pension reform can be traced by linearising the capital-accumulation equation (11) with respect to π around the initial steady state. The resulting first-order difference equations for k_t describe the capital-labour ratio changes over time and the determining factors. Moreover, we produce numerical simulations in order to illustrate the mechanics of the model. The qualitative results of these simulations are robust for changes in the adopted values of the parameters[5].

[5] We derived numerically the non-linear transition path, and compared the numerical results with those

3.1 No compensation for the current old

At $t = -1$ the government announces that it will decrease both the contributions to the PAYG system (τ_t^P) and the pension benefits (z_t^P) permanently in the next period ($t = 0$)[6]. So the old at $t = 0$ bear all the costs of the reform.

The change in the capital-labour ratio

Using the method described above we obtain the following first-order difference equation for the evolution of the capital-labour ratio[7]:

$$\frac{\partial k_{t+1}}{\partial \pi} = -\frac{2kf''(k)}{\Delta}\frac{\partial k_t}{\partial \pi} - \frac{\tau^P}{\Delta}g_t - \frac{(1+\rho)\tau^P}{\Delta(1+r)}f_{t+1} \tag{14}$$

with $\Delta \equiv 2(2+\rho) - \frac{(1+\rho)z^P f''(k)}{(1+r)^2} > 0$.

Equation (14) shows the change in the capital-labour ratio after a pension reform in country P when the two economies have a joint capital market. To analyse the international spillover effects we derive the same kind of equations for the situation where the two economies are closed. In country F nothing happens when it is a closed economy, because it is not reforming its pension system. The first-order difference equation for country P when it is closed is given by:

$$\frac{\partial k_{t+1}^P}{\partial \pi} = -\frac{kf''(k)}{\Delta^P}\frac{\partial k_t^P}{\partial \pi} - \frac{\tau^P}{\Delta^P}g_t - \frac{(1+\rho)\tau^P}{\Delta^P(1+r)}f_{t+1} \tag{15}$$

with $\Delta^P \equiv (2+\rho) - \frac{(1+\rho)z^P f''(k)}{(1+r)^2} > 0$. Notice the difference with equation (14): in that equation the nominator of the first term and the first term of Δ are multiplied by 2. So $\Delta^P < \Delta$, which implies that for a given pension reform, that is, for a given process for g_t and f_{t+1} the change in the capital-labour ratio is larger in case country P does not have capital mobility with country F.

The spillovers follow from comparing the change in the variables in the open-economies case

found with the method of comparative dynamics. The accuracy of the linearised path was quite satisfactory with a relative error of one percent at most. This is in line with the findings by Meijdam and Verhoeven (1998). They conclude that using comparative dynamics in a dynamic model is just as accurate as using comparative statics in a static model.

[6]This means that $g_0 = g_1 = \ldots = g_\infty < 0$ and $f_t = g_t < 0$. This could either be a full privatisation ($g_t = f_t = -1$) or a partial privatisation ($-1 < g_t = f_t < 0$).

[7]In Appendix A we show the derivation of this expression.

with the closed-economies case. Considering the effects of pension reform in a closed economy has the same effect as assuming that the two countries have a PAYG system. Because we want to focus solely on the international spillover effects when the two countries have integrated capital markets before the pension reform, we assume that the amount of capital in the initial steady state is the same when both countries have a PAYG system (closed-economy case) and when they have different pension systems (so that equation (14) holds). By comparing the capital-labour ratio changes in case the two countries have the same pension system (eq. (15)) with the change in the capital-labour ratio when the two countries have different pension schemes (eq. (14)), we derive the pure spillover effects of pension reform in a common capital market.

From equation (14) it follows that, in case of a joint capital market, the reform leads to a positive change in the capital-labour ratio at $t = 0$, as $\frac{\partial k_0}{\partial \pi} = -\frac{(1+\rho)\tau^P}{\Delta(1+r)} f_0 > 0$. The reason for this is that at the time of the announcement ($t = -1$), young individuals living in country P decide to increase their savings because they know they will receive a lower pension benefit when they are old.

The increase in the common capital-labour ratio at $t = 0$ leads to higher wages, which engenders higher savings in both countries. Due to these higher savings the capital-labour ratio continues to rise (the first term in eq. (14)).

Citizens in the PAYG country have an additional incentive to save more, because, as of from $t = 0$ contributions to the PAYG system fall (second term in eq. (14)), and they will receive lower benefits. When the two countries have a common capital market part of these extra savings flow to country F, so that the capital-labour ratio in country P increases less compared to the closed economy case. This can also be seen in Figure 1 in Appendix C.1 where we show the change in the capital-labour ratio for both closed and open economies.

The change in consumption and utility

When we know the change in the capital-labour ratio we can derive the changes in all other variables. The analytical derivations do not produce any additional insight, however. Therefore we only show simulation graphs. The change in consumption when young in the two

countries is displayed in Figures 4 and 6. As explained, individuals in country P and born at $t = -1$ save more, therefore their consumption when young decreases. For individuals born at $t = 0$ wages will go up and taxes go down, so that their consumption when young increases. Wages rise more when the PAYG country is closed, so $c_t^{y,P}$ increases more in that case. It might be emphasized here that as the reform in country P implies an increasing capital-labour ratio and higher wages, the consumption possibilities for the young in country F are also enhanced.

Figures 5 and 7 show the change in old-age consumption. Obviously, the fall in pension benefits and the lower return on savings cause the consumption of old people living in country P at $t = 0$ to decrease. Because wages and savings increase over time, $c_t^{o,P}$ increases from $t = 1$ onwards. If country P is closed, the initial decreases of the interest rates will be stronger than if country P is open. The elderly will, therefore, be hurt more. After three periods, however, the stronger wage effect in the closed economy will lead to a stronger increase in old-age consumption.

The fall in the interest rate at $t = 0$ also lowers the return of the savings of old people living in country F, therefore their old-age consumption falls at $t = 0$. In the period after the shock the increased savings in the previous period are not enough to offset the further decrease in the interest rate, so that consumption of the old decreases more. Notice that while in the long run elderly in country P see their consumption increase due to the reform, the elderly in the non-reform country F get less consumption possibilities.

The changes in lifetime utility are shown in Figures 2 and 3. This type of pension reform, in which benefits are decreased without compensation, will obviously hurt the elderly in country P at the time of the reform. It is, however, interesting to note that this loss spills over to the elderly in country F as well. Even stronger, the young generation in country F at the time of the reform, $t = 0$, experiences a loss, while this is not the case for the young generation in country P at $t = 0$. Later generations in country F gain from the pension reform in country P, but the consumption gap between young and old people has increased.

3.2 Compensation: tax levied on the future old

In the pension reform described in the previous section the current elderly bear all the costs of the reform. It is probably more realistic to assume that the government compensates the current old, so that individuals have more time to adjust their behaviour to the smaller PAYG system. Therefore, in this and the next subsection we assume that while contributions to the PAYG scheme fall permanently at $t = 0$, benefits are kept constant in that period. This is again communicated one period before the reform actually takes place (at $t = -1$). The government also announces that at $t = 1$ pension benefits will fall as much as the contributions, so that the PAYG system is balanced again from then on[8]. Since taxes are lower than the benefits during one period ($t = 0$), there will be government debt in country P at $t = 1$. At the moment that contributions and benefits are equal again ($t = 1$), the government introduces an extra tax (τ_t^B) to pay the interest obligations on its debt, such that debt per worker is stabilised from then on. This extra tax can either be levied on the working people or on the elderly. In this subsection we analyse the effects when τ_t^B is levied on the elderly, starting at $t = 1$. In that case the pension reform is Pareto neutral, that is, there is no generation that gains or loses from the pension reform.

We find the following first-order difference equation for the change in the capital-labour ratio in case of integrated capital markets:

$$\frac{\partial k_{t+1}}{\partial \pi} = -\frac{2f''(k)k}{\Delta}\frac{\partial k_t}{\partial \pi} - \frac{\tau^P}{\Delta}g_t - \frac{1+\rho}{\Delta(1+r)}\left(\tau^P f_{t+1} - \frac{\partial \tau_{t+1}^B}{\partial \pi}\right) - \frac{2+\rho}{\Delta}\frac{\partial b_{t+1}^P}{\partial \pi} \tag{16}$$

where Δ has the same definition as in the previous subsection. Comparing this equation with equation (14) we see that there are two extra terms, $\frac{\partial b_{t+1}^P}{\partial \pi}$ and $\frac{\partial \tau_{t+1}^B}{\partial \pi}$, because of the government debt created to compensate the old at $t = 0$. As can be seen debt has a direct negative impact on the change in the capital-labour ratio. However, because τ_t^B is levied on the pensioners, they will increase their savings when young which has a positive effect on the

[8]This means that $g_0 = g_1 = \ldots = g_\infty < 0$ and $f_0 = 0$, $f_t = g_t < 0$ for $t > 0$.

capital-labour ratio. The linearised version of equation (4) is:

$$\frac{\partial b_{t+1}^P}{\partial \pi} = (1+r)\,\frac{\partial b_t^P}{\partial \pi} + \frac{\partial z_t^P}{\partial \pi} - \frac{\partial \tau_t^P}{\partial \pi} - \frac{\partial \tau_t^B}{\partial \pi} \tag{17}$$

where we used the assumption that $b^P = 0$. From $t = 1$ onwards the PAYG system is balanced again: $\frac{\partial z_t^P}{\partial \pi} = \frac{\partial \tau_t^P}{\partial \pi}$, implying that $g_t = f_t$. At the same time an extra tax is introduced to keep debt per worker constant. From that moment on $\frac{\partial \tau_t^B}{\partial \pi}$ is:

$$\frac{\partial \tau_t^B}{\partial \pi} = r\,\frac{\partial b_t^P}{\partial \pi} \tag{18}$$

In Appendix B.1 we show that with this pension reform scenario the capital-labour ratio remains constant. This implies that consumption and utility also do not change. Moreover, there are no international spillover effects for the funded country. The reason for these results is that with this reform savings in the PAYG country increase exactly by the same amount as the government debt. All that has happened is that the implicit debt of the PAYG system has been made explicit. This is a standard result in the pension reform literature, see for example Verbon (1989), Breyer (1989) and Homburg (1990).

3.3 Compensation: tax levied on the future young

Instead of imposing τ_t^B on the elderly, the government can also levy the tax on the working people, starting at $t = 1$. In that case the first-order difference equation for k_t is:

$$\frac{\partial k_{t+1}}{\partial \pi} = -\frac{2f''(k)k}{\Delta}\,\frac{\partial k_t}{\partial \pi} - \frac{1}{\Delta}\left(\tau^P g_t + \frac{\partial \tau_t^B}{\partial \pi}\right) - \frac{(1+\rho)\tau^P}{\Delta(1+r)} f_{t+1} - \frac{2+\rho}{\Delta}\,\frac{\partial b_{t+1}^P}{\partial \pi} \tag{19}$$

As can be seen this equation looks almost the same as equation (16), the only difference is that τ_t^B now has a negative impact on the change in the capital-labour ratio. Notice, however, that the first young generation under the reform, born at $t = 0$, does not have to pay the debt tax, i.e. $\tau_0^B = 0$. Like the future young generations, they get the lower PAYG tax, but, unlike the future young generations, they do not have to contribute to the compensation the elderly at $t = 0$ receive. The young generation at $t = 0$, therefore, will get a windfall gain. As a

result, the capital-labour ratio will decrease at $t = 1$, as $\frac{\partial k_1}{\partial \pi} = \frac{(1+\rho)\tau^P r}{\Delta(1+r)} g_0 < 0$, see Appendix B.2 for the derivation. The intuition for this result is obvious. The first young generation under the reform consumes part of its gain in the first period, and saves part of it. As the gain this generation receives equals the created debt, the increase in savings at $t = 0$ is lower than the created debt, and part of the debt has to be financed by savings that, without the reform policy, would have been available for financing the capital stock. In other words, the public debt crowds out part of the capital stock.

At $t = 1$ the working generation gets the lower PAYG tax again, but this generation also starts contributing to the stabilisation of the debt by paying a debt tax τ_t^B. Moreover, they inherit a lower capital-labour ratio, which leads to lower wages. Therefore, the gap between savings and the created debt will even more widen compared to $t = 0$. The government debt will crowd out a larger part of the capital stock and, as a result, the capital-labour ratio and the wage rate continue to decline. Because country P can finance part of its government debt with savings of country F in case of open economies, the capital-labour ratio falls more when country P does not have integrated capital markets with country F. This can be seen in Figure 8 in Appendix C.2.

Notice that the results of this reform are exactly the opposite of the pension reform described in Section 3.1: the capital-labour ratio falls over time instead of rises. This implies that the effect on the other endogenous variables is also reversed. Actually, all simulation graphs are almost the mirror images of those of the pension reform in Section 3.1, the peaks are only one period later, because young individuals in the PAYG country do not adjust their behaviour at $t = -1$. This means that the pension reform in country P leads to less consumption possibilities for the young in country F (Figure 13), while the elderly in this country gain (Figure 14). At the time of the reform the young in country P gain from the lower tax, which enables them to get a higher return than they would have obtained under the unchanged PAYG tax (Figure 9). All next generations in both country P and country F however, experience a lower wage, which makes them the losers of this reform policy (Figures 9 and 10). However, the fact that they form a monetary union with country F protects the generations

living in country P to some extent, as part of the burden of this reform policy is transmitted to country F via the capital market.

3.4 Concluding remarks

It is well known that when the PAYG system is Pareto efficient, a pension reform can only lead to gains for some generations, if at least one generation incurs losses. If no generation has to be made worse off, the best a reform can lead to is making the implicit debt inherent to a PAYG system explicit. In our two-country model this implies that there are no spillover effects for the funded country. However, when the government in the PAYG country implements a reform that leads to gains and losses for at least one generation, these gains and losses will be transmitted to the funded country via the capital market. In particular, when at the start of the pension reform the elderly are not allowed to lose, future generations will lose when one (or more) early generations under the reform will get a (windfall) gain. The losses of future generations will occur in both the PAYG country and the country with the funded pension scheme. On the other hand, when the first generation is losing under the reform policy, future generations in both countries will gain.

The pension reforms analysed in this section are extreme, in the sense that no compensation at all or full compensation is granted at the time of the reform. Of course it is possible to have pension reforms where the elderly are *partly* compensated. Such scenarios will not change the general conclusion from our analysis, however, i.e. that choices on the implementations of a reform policy in one country unavoidably spills over to other countries.

4 Pareto-improving pension reform

In this section we analyse the international spillover effects of a pension reform in the PAYG country in case there is scope for a Pareto improvement, due to a distortionary PAYG tax. According to equation (1) we model the excess burden as a (quadratic) loss of tax revenue, i.e. $z^P = \tau^P - (\tau^P)^2$, so $(\tau_t^P)^2$ is wasted. We start from the Pareto neutral pension reform scenario of the previous section. So the government compensates the elderly at the time of

the reform completely, and then from $t = 1$ onwards imposes an extra tax on the pensioners to pay the interest obligations on the debt in order to keep debt per capita constant. The budget constraint of the government (eq. (4)) changes to:

$$b_{t+1}^P = (1 + r_t)b_t^P + z_t^P - (\tau_t^P - (\tau_t^P)^2) - \tau_t^B \tag{20}$$

As argued earlier, we assume that the debt tax on the elderly, τ_t^B, does not imply an excess burden, as, given the labour-supply motivation for the excess burden, the elderly do not supply labour.

The change in the capital-labour ratio

In principle the capital-accumulation equation looks the same as equation (16). However, we do not have that $\frac{\partial z_t^P}{\partial \pi} = \frac{\partial \tau_t^P}{\partial \pi}$ from $t = 1$ onwards, but $\frac{\partial z_t^P}{\partial \pi} = (1 - 2\tau^P)\frac{\partial \tau_t^P}{\partial \pi}$. This implies that $f_t = (1 - 2\tau^P)g_t$ instead of $f_t = g_t$ from $t = 1$ onwards. The linearised equation for government debt (17) changes to:

$$\frac{\partial b_{t+1}^P}{\partial \pi} = (1 + r)\,\frac{\partial b_t^P}{\partial \pi} + \frac{\partial z_t^P}{\partial \pi} - (1 - 2\tau^P)\,\frac{\partial \tau_t^P}{\partial \pi} - \frac{\partial \tau_t^B}{\partial \pi} \tag{21}$$

In Appendix B.3 we show that in case there is an excess burden, the capital-labour ratio increases at $t = 1$ instead of staying constant. This in turn leads to higher wages and savings, so that the capital-labour ratio continues to increase. We also show this in Figure 15 in Appendix C.3. The intuition behind this result is that when PAYG taxes induce an excess burden, abolishing (part of) the PAYG system leads to efficiency gains, so that the capital-labour ratio actually rises, instead of staying constant (as was the case in Section 3.2).

The change in consumption and utility

In Figures 18 and 19 we can see that both consumption of the young and old-age consumption increase. The main reason for this is that the higher capital-labour ratio results in higher wages and savings. It is then obvious that this reform leads to a Pareto improvement in the

PAYG country. This can indeed be seen in Figure 16, all generations get a higher utility[9]. In the funded country, however, only consumption of the working people increases (see Figure 20). The elderly in the non-reforming country get less consumption possibilities (see Figure 21), mainly because the interest rate decreases after an increase in k_t. For the generation born at the time of the reform consumption when young does not change, while they can consume less at their old-age. This necessarily implies that this generation loses from the pension reform in the other country (see Figure 17). All later generations in country F gain from the pension reform in country P. So the pension reform in the country with the PAYG pension scheme does not lead to a Pareto improvement in the funded country. There is one generation that is hurt by the pension reform in the PAYG country, while in the PAYG country itself all generations gain from the reform.

5 Concluding remarks

Currently, in many countries with an extensive pay-as-you-go (PAYG) financed public pension system reforms are considered to finance a larger part of the future pension benefits by accumulated funds. A central conclusion emerging from our paper is that in a common capital market the effects of such a pension reform in a PAYG country spills over to countries with a fully funded pension system. In Europe, e.g., differences in financing methods of pension systems abound. For instance, countries like Germany and Italy have extensive PAYG-financed parts in their pension system, while in the UK and the Netherlands the larger part of the pension benefits are financed out of accumulated assets. The message of our paper is that the latter countries cannot insulate themselves from the effects of reform measures in the former countries. In the European pension debate these spillover effects of pension reform have not been an issue till now, as far as we know. Yet, the consequences of pension reform in a PAYG country can be rather adverse for a funded country as we have shown in this paper. Some key results illustrate this.

First, consider the case where the PAYG country compensates the elderly during the transition

[9]The explanation for the difference between closed and open economies is exactly the same as the one in Section 3.1.

phase, and the PAYG system is Pareto efficient. The introduction of public debt, necessary to finance the compensation during the transition phase of the reform, will lead to crowding out of the capital stock in both the PAYG and the funded country, as soon as one generation is allowed to gain during the transition. As a result, future generations in both types of countries will lose under this reform policy.

Second, if a PAYG country reforms its public pension system such that their own future generations gain, then, although future generations in the funded country gain as well, the distribution of consumption between young and old individuals at a certain time will change at the expense of old individuals. In the funded country the elderly will even consume less in absolute amounts after the reform. Although the deterioration of old-age consumption is the result of free choice by individuals in the funded country, the resulting consumption allocation between young and old individuals might not be desirable from a societal point of view.

Third, we have shown that if excess burdens in tax collection enable a Pareto-improving pension reform in the PAYG country, during the transition phase some initial generations in the funded country might suffer a loss under the reform nevertheless. In other words, a reform policy that appears to be Pareto improving for the PAYG country considered separately, does not have to be Pareto improving after taking into account the international spillover effects.

Obviously, our model has oversimplified the real world in many ways, and the issue of spillover effects of pension reform merit further study in especially larger and more applied models. Yet, we think that our central result, i.e. that pension reform in PAYG countries can have adverse effects on the welfare of some generations, or some type of individuals in funded countries will remain to stand out even in a more general model. The obvious policy conclusion from our model is, therefore, that in a common market like the EU, pension reform should not be decided upon in isolation by separate member countries, but requires some coordination or even centralisation of decision making.

A Derivation first-order difference equation capital-labour ratio

In this appendix we derive the first-order difference equation for the evolution of the capital labour ratio given in equation (14). Linearising the capital-accumulation equation (11) with respect to π around the initial steady state gives:

$$\frac{\partial s_t^P}{\partial \pi} + \frac{\partial (s_t^F + \tau_t^F)}{\partial \pi} = 2\,\frac{\partial k_{t+1}}{\partial \pi} \tag{22}$$

Then we derive expressions for $\frac{\partial s_t^P}{\partial \pi}$ and $\frac{\partial (s_t^F + \tau_t^F)}{\partial \pi}$, using equations (9) and (10):

$$\frac{\partial s_t^P}{\partial \pi} = \frac{1}{2+\rho}\left[\frac{\partial w_t}{\partial \pi} - \frac{\partial \tau_t^P}{\partial \pi}\right] - \frac{1+\rho}{2+\rho}\left[\frac{1}{1+r}\,\frac{\partial z_{t+1}^P}{\partial \pi} - \frac{z^P}{(1+r)^2}\,\frac{\partial r_{t+1}}{\partial \pi}\right] \tag{23}$$

$$\frac{\partial (s_t^F + \tau_t^F)}{\partial \pi} = \frac{1}{2+\rho}\,\frac{\partial w_t}{\partial \pi} \tag{24}$$

$\frac{\partial w_t}{\partial \pi}$ and $\frac{\partial r_{t+1}}{\partial \pi}$ are given by:

$$\frac{\partial w_t}{\partial \pi} = -k f''(k)\,\frac{\partial k_t}{\partial \pi} \tag{25}$$

$$\frac{\partial r_{t+1}}{\partial \pi} = f''(k)\,\frac{\partial k_{t+1}}{\partial \pi} \tag{26}$$

Combining equations (22) - (26) and simplifying gives:

$$\frac{\partial k_{t+1}}{\partial \pi} = -\frac{2f''(k)k}{\Delta}\,\frac{\partial k_t}{\partial \pi} - \frac{1}{\Delta}\,\frac{\partial \tau_t^P}{\partial \pi} - \frac{(1+\rho)}{\Delta(1+r)}\,\frac{\partial z_{t+1}^P}{\partial \pi} \tag{27}$$

with $\Delta \equiv 2(2+\rho) - \frac{(1+\rho)z^P f''(k)}{(1+r)^2}$. Using equations (2) - (3) and (12) - (13) we know that:

$$\frac{\partial \tau_t^P}{\partial \pi} = \tau^P g_t \tag{28}$$

$$\frac{\partial z_{t+1}^P}{\partial \pi} = \tau^P f_{t+1} \tag{29}$$

Filling in these two last expressions into equation (27) we obtain equation (14).

B Change in k_t at $t = 1$

In this appendix we show that the pension reform where there is full compensation and the extra tax introduced to finance the interest obligations on the debt is levied on the elderly does not lead to a change in the capital-labour ratio in the standard case (B.1) and leads to an increase in the capital-labour ratio in case there is an excess burden (B.3). Moreover, we show that as soon as τ_t^B is levied on the young in the standard case, there is crowding out of capital (B.2).

B.1 Compensation: tax levied on the future old

Using equations (17) and (18) into equation (16) we can show that with this pension reform scenario the capital-labour does not change over time. At $t = 0$ we have that:

$$\frac{\partial \tau_0^P}{\partial \pi} = \tau^P g_0$$
$$\frac{\partial z_0^P}{\partial \pi} = 0$$

Then

$$\frac{\partial b_1^P}{\partial \pi} = -\frac{\partial \tau_0^P}{\partial \pi} = -\tau^P g_0$$

So that we can write:

$$\frac{\partial k_1}{\partial \pi} = -\frac{\tau^P}{\Delta}\, g_0 - \frac{1+\rho}{\Delta(1+r)}\left(\tau^P f_1 + r\,\tau^P g_0\right) + \frac{2+\rho}{\Delta}\,\tau^P g_0$$

Noting that $f_1 = g_0$, it is easy to verify that $\frac{\partial k_1}{\partial \pi} = 0$. And when this is the case for $t = 1$, this holds for all following periods. So indeed the capital-labour ratio stays contant with this pension reform scenario.

B.2 Compensation: tax levied on the future young

The change in the capital-labour ratio at $t = 1$ is:

$$\frac{\partial k_1}{\partial \pi} = -\frac{\tau^P}{\Delta}\, g_0 - \frac{(1+\rho)\tau^P}{\Delta(1+r)} f_1 + \frac{2+\rho}{\Delta}\, \tau^P g_0$$

The only difference with the previous pension reform is that τ_t^B is not introduced yet. This equation can be simplified as follows:

$$\frac{\partial k_1}{\partial \pi} = \frac{(1+\rho)\tau^P r}{\Delta(1+r)}\, g_0 < 0$$

So we know that as soon as τ_t^B is levied on the future young, the capital-labour ratio decreases at $t = 1$. A lower capital-labour ratio leads to lower wages and from $t = 1$ onwards the working people have to start paying τ_t^B, so that the capital-labour ratio continues to decrease.

B.3 Pareto-improving pension reform

The change in government debt at $t = 1$ is equal to:

$$\frac{\partial b_1^P}{\partial \pi} = -(1-2\tau^P)\frac{\partial \tau_0^P}{\partial \pi} = -(1-2\tau^P)\tau^P g_0$$

We can then write:

$$\frac{\partial k_1}{\partial \pi} = -\frac{\tau^P}{\Delta}\, g_0 - \frac{1+\rho}{\Delta(1+r)}\left[(1-2\tau^P)\tau^P g_0 + r(1-2\tau^P)\tau^P g_0\right] + \frac{2+\rho}{\Delta}(1-2\tau^P)\tau^P g_0$$

which can be written as:

$$\frac{\partial k_1}{\partial \pi} = -\frac{1}{\Delta}\, 2(\tau^P)^2 g_0 \;>\; 0$$

A higher capital-labour ratio at $t = 1$ leads to higher wages, so that the capital-labour ratio continues to increase.

C Simulations

The graphs in this appendix are based on simulations where half of the PAYG system is privatised, that is, from $t = 1$ onwards both the contributions and the benefits fall with 50% permanently[10]. Moreover, we used the following production function, $f(k_t) = k_t^{0.3}$ and assumed that $\rho = 0$ and $\delta = 0$.

C.1 Reform without compensation

Figure 1: Change in k_t

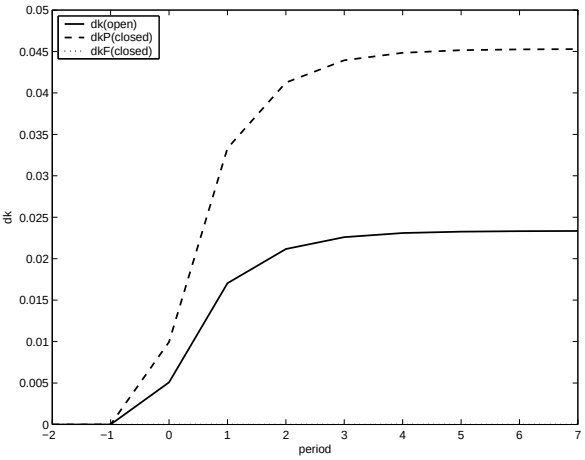


Figure 2: Change in U_t^P

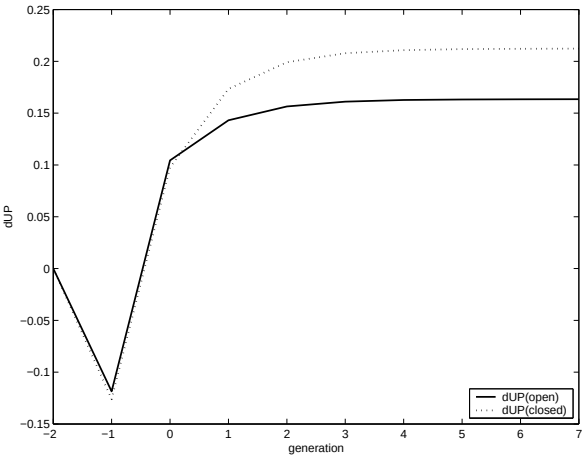
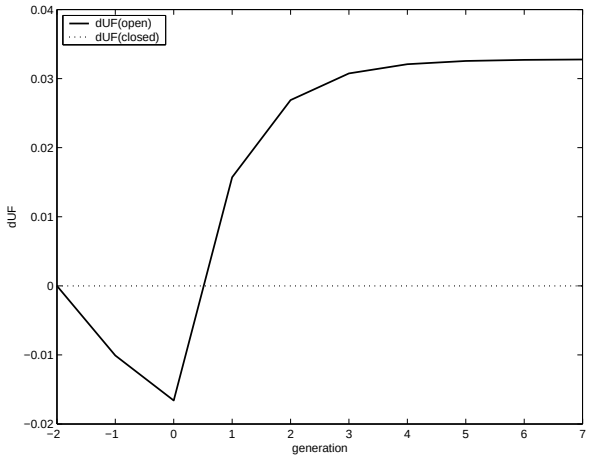


Figure 3: Change in U_t^F



[10]The results do not qualitatively change when the PAYG system is totally privatised.

Figure 4: Change in $c_t^{y,P}$

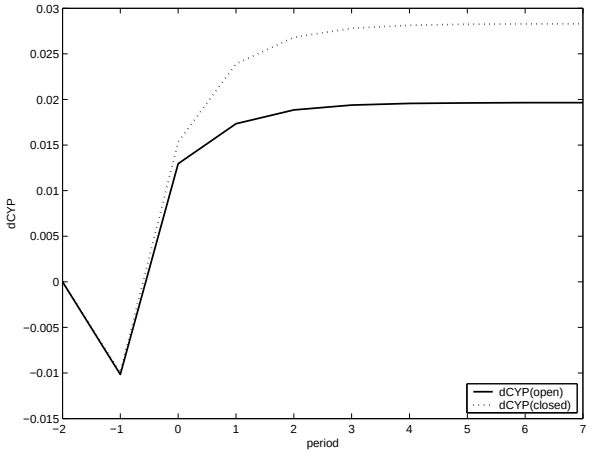


Figure 5: Change in $c_t^{o,P}$

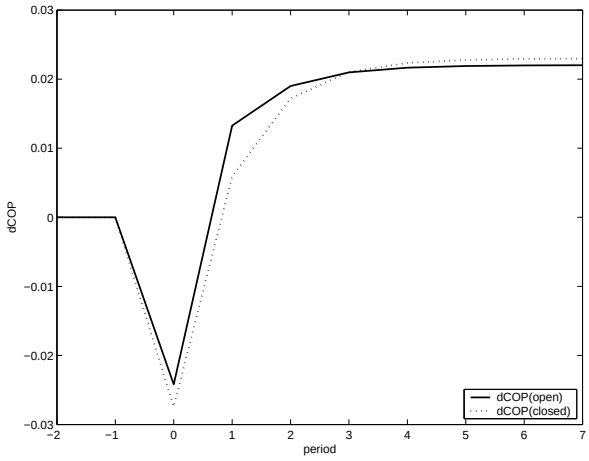


Figure 6: Change in $c_t^{y,F}$

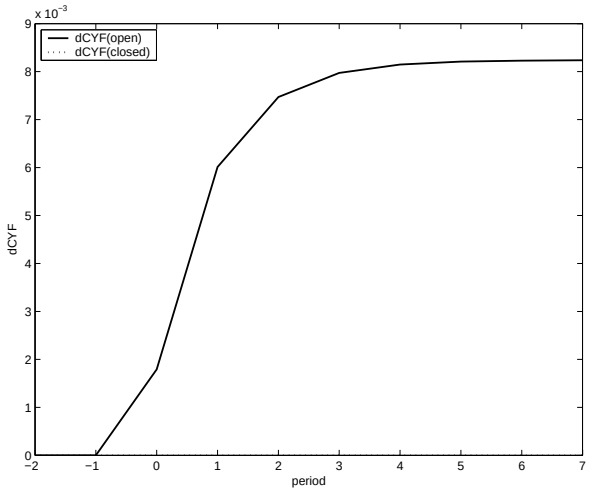
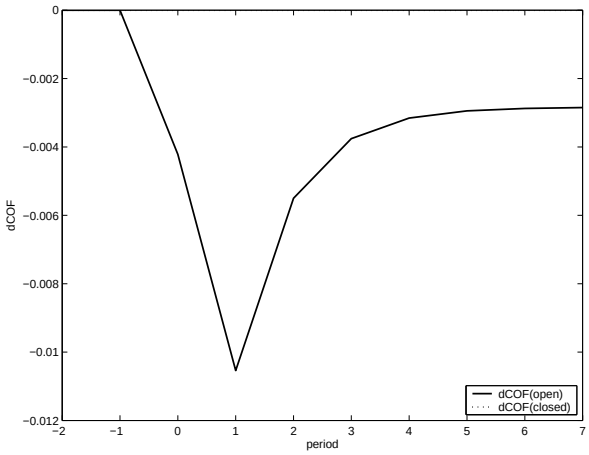


Figure 7: Change in $c_t^{o,F}$



C.2 Reform with compensation

Figure 8: Change in k_t

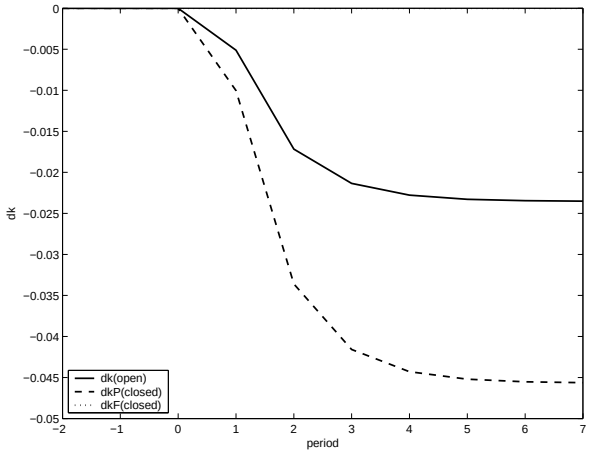


Figure 9: Change in U_t^P

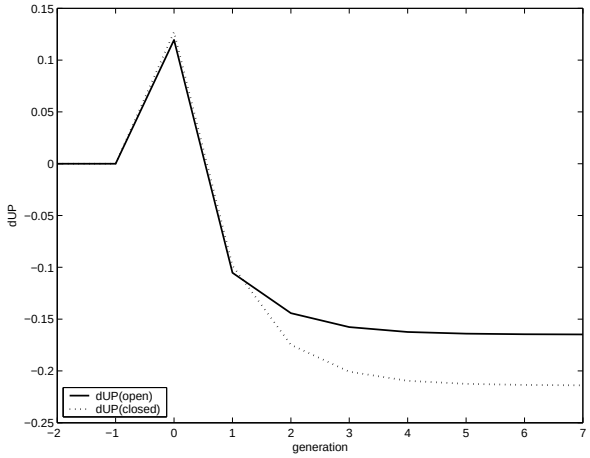


Figure 10: Change in U_t^F

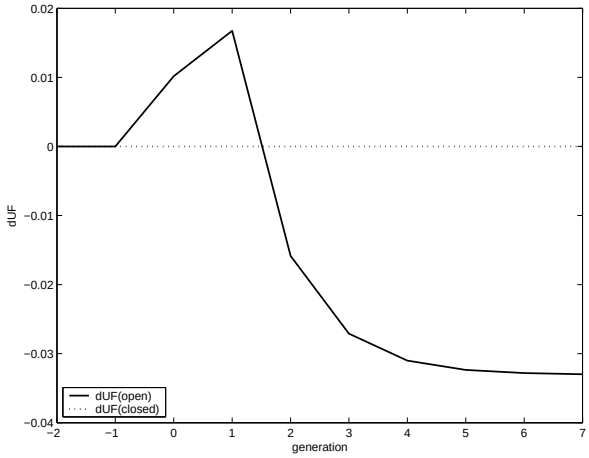


Figure 11: Change in $c_t^{y,P}$

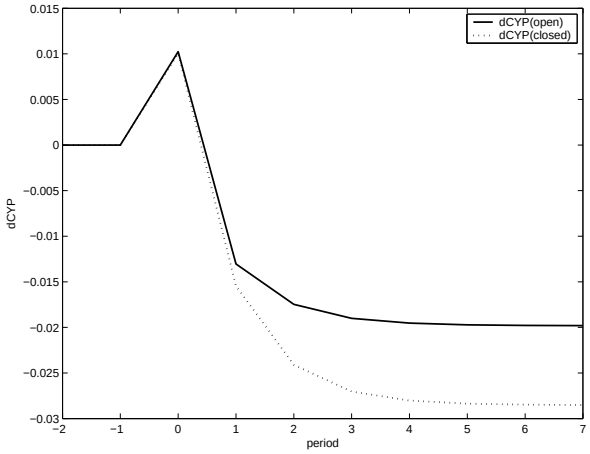


Figure 12: Change in $c_t^{o,P}$

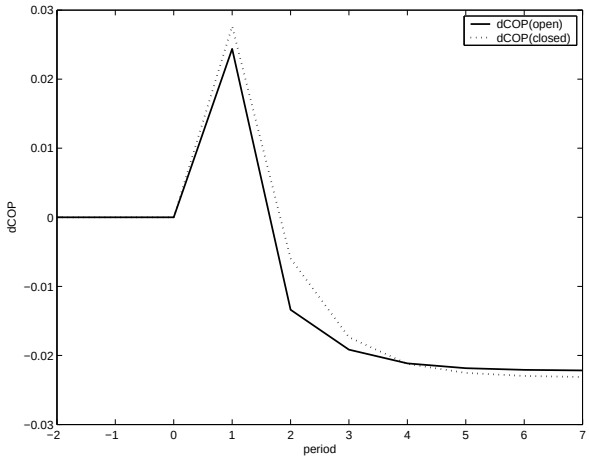


Figure 13: Change in $c_t^{y,F}$

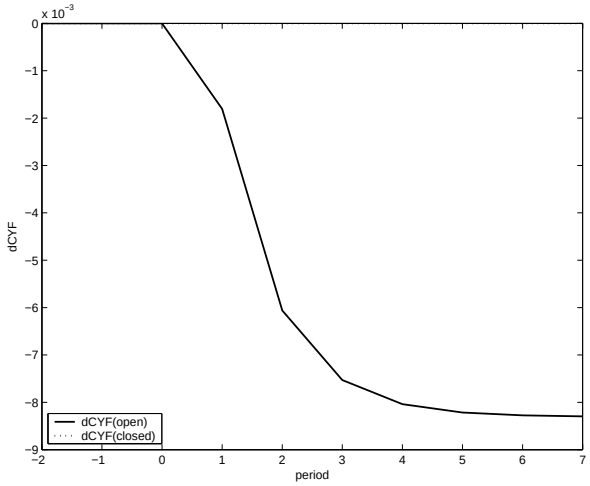
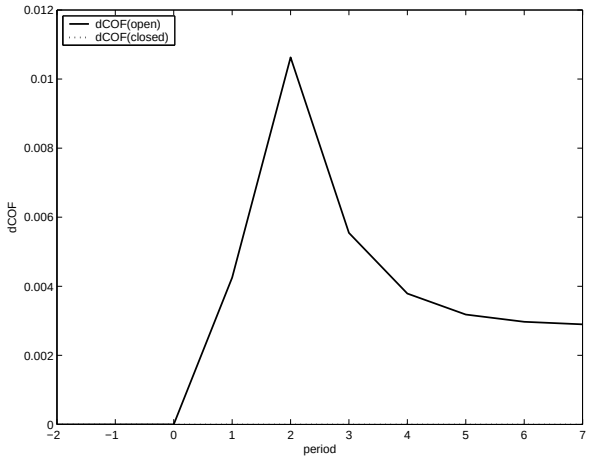


Figure 14: Change in $c_t^{o,F}$



C.3 Pareto-improving pension reform

Figure 15: Change in k_t

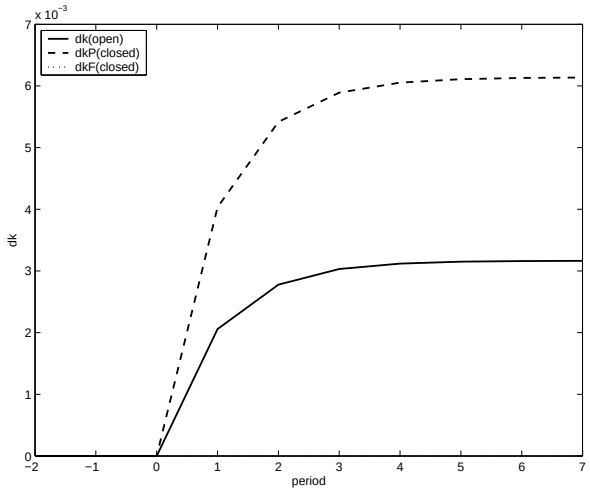


Figure 16: Change in U_t^P

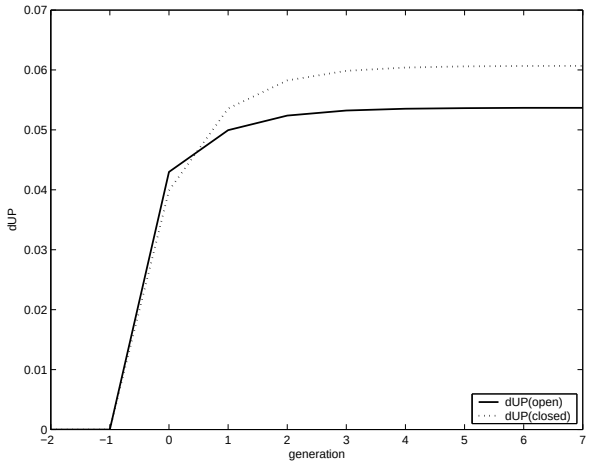


Figure 17: Change in U_t^F

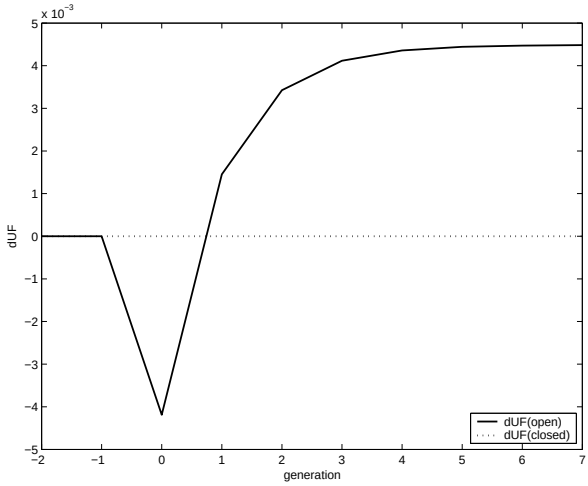


Figure 18: Change in $c_t^{y,P}$

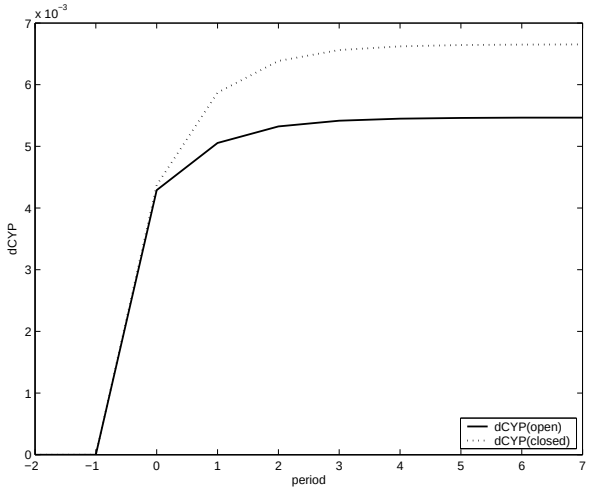


Figure 19: Change in $c_t^{o,P}$

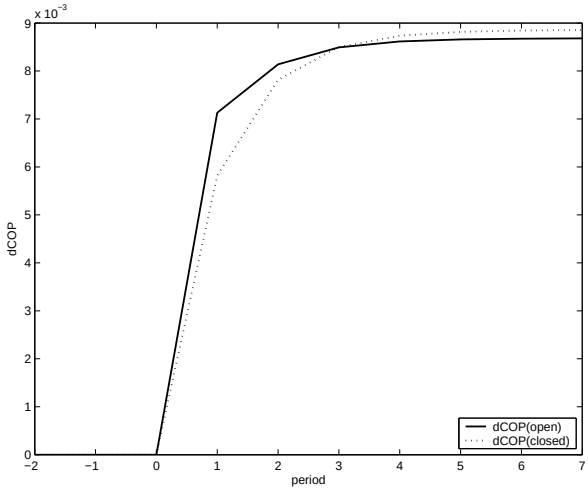


Figure 20: Change in $c_t^{y,F}$

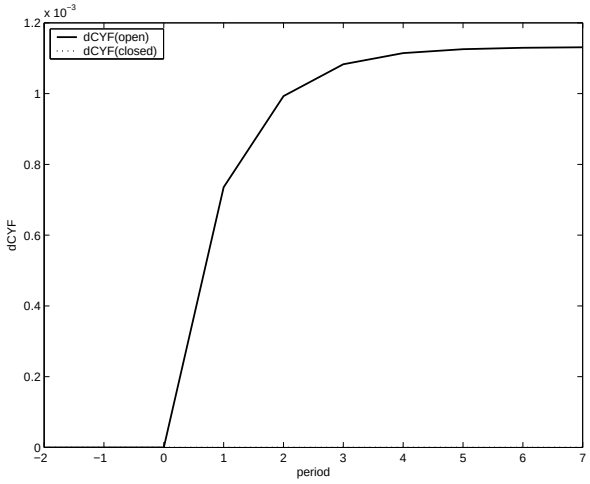
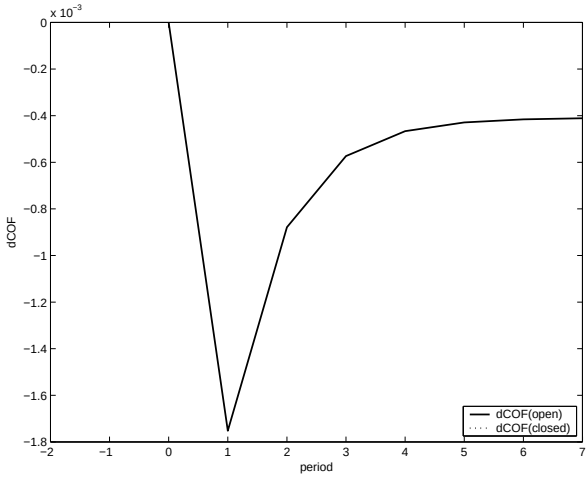


Figure 21: Change in $c_t^{o,F}$



Acknowledgements

We are grateful for useful comments from Lans Bovenberg, Marko Köthenbürger and Sweder van Wijnbergen. Furthermore we would like to thank all the participants of the CEBR/CESifo conference on Pension Reform in Copenhagen, Denmark, June 2005, and the Economics lunch seminar, Tilburg, The Netherlands, May 2005, for valuable comments and discussions.

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