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The Spillover Effects of Pension Reform with Labour and Capital Mobility

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The spillover effects of pension reform with labour and capital mobility

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Abstract

This paper studies the spillover effects of pension reform in a a two-country two-overlapping-generations model with capital and labour mobility. A stable equilibrium is achieved assuming the presence of an immobile production factor. The long-run effects of pension reform are derived analytically, and the short run dynamics is simulated. It is shown that in general, without international redistribution, benefits and losses caused by a switch from a PAYG to a more funded pension scheme in one country are shared by the neighbouring country. Introducing a central government in the union, which redistributes benefits and losses of the reform both intergenerationally and internationally allows for a globally welfare improving reform if countries a asymmetric, i.e., when the size of the PAYG scheme in one country is larger than in the other.

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1 Introduction

Population ageing will be one of the fundamental factors affecting economic activity in the western world in the upcoming decades. Demographic changes evoke structural changes in economies and emphasize the significance of pension systems. In particular, in countries with unfunded pension schemes rising old-age dependency ratios due to increasing longevity and declining fertility lead to lower pension benefits or a higher tax burden. Therefore, a switch to more funded pension schemes is an often discussed alternative. However, in a globalizing world, such a policy change in one country cannot be analysed separately from the consequences for the rest of the world. As the obstacles for migration and capital flows are being removed, changes in the pension scheme in one country may have serious consequences for other countries that should be taken into account. This holds for instance for the countries of the European Union that constitute a common capital market and where migration is determined by choice of individuals and not by migrational policy of sovereigns.

In this paper we develop a stable two-region model allowing for capital and labour mobility. Young workers are assumed to be perfectly mobile. Financial assets (savings) are also assumed to be perfectly mobile, but (physical) capital stocks may initially be fixed. The model includes an immobile production factor and is used to analyse the spillover effects caused by pension system reform. We show that, in general, benefits and losses caused by a switch from a PAYG to a more funded pension scheme in one country are shared by the neighbouring country. That is, a decrease of the PAYG tax is beggar-thy-neighbour in the short run and beneficial for the neighbouring country in the long run. However, for specific parameter values, pension reform can be locally welfare improving, i.e., beneficial for all generations living in the reforming country, while harming the inhabitants of the other country. This is the case if the inflow of labour largely offsets the decrease in PAYG benefits due to the pension reform. The most important finding of the paper is that in case of asymmetric countries, i.e., if the PAYG tax in one country is higher than in the other, a globally welfare improving reform is possible. The reason for this is that a pension reform that reduces the difference between the PAYG tax rates in both countries improves the efficiency of the international allocation of labour and capital. However, such a reform requires both intergenerational and international redistribution of benefits and losses

The most relevant work in this area is the paper of Adema et al. (2008). This paper studies spillover effects of a shift from unfunded pensions to a more funded scheme. Two countries constitute a common capital market in the model, but there is no migration between the regions. In case the old generation at the time of the reform bears all the costs, the spillover effect of the switch to more funded pensions for the neighbouring country is negative in the short run and positive in the long run. We generalize this result in a more general setting allowing for migration between the countries. Thus, our model implies larger spillovers to the neighbouring country. As a consequence, in contrast to the model of Adema et al. (2008) our model also allows for a welfare improving reform for

one country at the cost of the neighbouring country. There are several papers analyzing the relation between PAYG pensions and migration. Razin and Sadka (1999), for example, show that migration can be beneficial for a small open economy with a PAYG scheme because the resulting increase in labour supply leads to higher pension benefits. These findings where confirmed by Fehr et al. (2003) in a model with 3 regions. However, Fehr et al. argue that these benefits are small and depend on a specific case. Börsch-Supan et al. (2006) develop a large model to study the effects of ageing and pension reform when the pension system is changed from a defined benefit to a defined contribution plan. The regions in this model have a common capital market. Although the model allows for migration, the countries do not constitute a common labour market and migration is given exogenously. The paper suggests that in general a larger capital market implies that fewer cohorts experience losses from the reform, but the losses are higher.

Previous attempts to build a model with unrestricted capital flows and migration met some difficulties. Breyer and Kolmar (2002) used such a type of model to study the need for coordination of pension systems in a union. They show that the absence of coordination leads to an inefficient corner solution, when the total world population and capital moves to one country. Similar types of models allowing for corner solutions are used in by Kolmar (2007) and Poutvaara (2007) to compare the pension systems based on flat benefits and earning related benefits. In our model, we exclude corner solutions by assuming decreasing returns to scale in labour and capital. This is realized by including a third, immobile production factor like land (see for instance Kunce and Schogren, 2007). The presence of land as a production factor causes questions about efficient distribution of other production factors. We show that, for a given capital stock, the interest rate is largest and total wage income in the world is highest when the amount of capital and labour in the countries is proportional to their size in terms of land. Asymmetric pension schemes distort this efficient allocation as a disproportionally large share of the mobile production factors moves to the country with the lowest PAYG tax. It is this inefficiency that allows for a globally welfare improving pension reform: all generations in both countries can gain if , for example, the size of the largest PAYG scheme is reduced to that of the other country[2]. This is possible if the union has a central government that redistributes benefits and losses appropriately over the various generations in both countries.

The paper is organized as follows: the next section presents a simple model allowing for capital and labour mobility between the regions, including the parameter calibration used for the numerical simulation experiments. Section 3 discusses the effects of pension reform, and in particular the international spillover effects. The long-run effects are derived analytically, the short-run effects are illustrated by numerical simulation experiments. Moreover, we show in this section that a pension reform that is beneficial for all generations in the

[2]Or if the PAYG tax in both countries is lowered to a level below that in the country with the smallest PAYG scheme.

home country while harming the neighbouring may be possible. In the fourth section a central government is introduced in the union and a globally welfare improving reform is constructed. Section 5 concludes.

2 The model

Firms

We assume a constant returns to scale Cobb-Douglas production technology with three factors of production: labour L_t, capital K_t, and an immobile production factor A. A may represent land, climate, geographic location and so forth. In general, A may be time-dependent (A_t) and comprise technological growth. We will refer to A as "land". Capital depreciates fully after one period of use. For the home country the production function is:

$$F(K_t, L_t, A) = A^{1-\alpha-\beta} K_t^{\alpha} L_t^{\beta} \tag{1}$$

where $\alpha > 0$, $\beta > 0$ and $\alpha + \beta \leq 1$. As usual, wage rate w is equal to the marginal product of labour:

$$w_t = \beta A^{1-\alpha-\beta} K_t^{\alpha} L_t^{\beta-1} \tag{2}$$

If there are decreasing returns to scale in labour and capital, there will be nonzero returns to land. The introduction of land market is discussed in detail by Köthenbürger and Poutvaara (2006) and is not at the focus of this research. For the sake of simplicity, we will assume that returns to land are redistributed in the form of higher interest rate[3].

$$r_t = (1-\beta) A^{1-\alpha-\beta} K_t^{\alpha-1} L_t^{\beta} \tag{3}$$

Variables referring to the foreign country are denoted by tildes. The foreign country is assumed to be identical, except for possible differences in the size of the PAYG scheme as measured by τ, the share of wages the young contribute to the scheme. Without loss of generality, we will assume $\tilde{\tau} \leq \tau$. Parameters α and β are supposed to be the same in both countries. Moreover, to simplify expressions we assume that the countries have the same land endowment $A_t = \tilde{A}_t$. Capital is

Households

In the first period of life households maximize a logarithmic utility function:

$$U_t = \log C_t^y + \frac{1}{1+\rho} \log C_{t+1}^o \tag{4}$$

[3]This assumption is not restrictive. Exactly the same results can be achieved if all the returns to land go to the young generation in the form of higher wages, or young and old generations receive the returns to land in constant and not necessary equal shares. Moreover, the results will not change if we assume that the land is owned by landlords who are out of the model. Mathematically alternative assumptions lead to a different constant instead of $1 - \beta$.

where C_t^y is consumption when young and C_t^o stands for consumption of the same individual when old. The government runs a PAYG pension scheme with a fixed contribution. During the first period of life agents pay a share τ of their wages, which is redistributed to the old generation. The budget constraints are:

$$C_t^y = w_t(1-\tau) - s_t \tag{5}$$

$$C_{t+1}^o = w_{t+1}\tau(1+n_{t+1}) + s_t(1+r_{t+1}) \tag{6}$$

where s is savings and n_{t+1} denotes the population growth in period $t+1$ in country H. Substituting the budget constraints into the utility function and maximizing it with respect to s_t, we get:

$$s_t = \frac{1}{2+\rho} w_t(1-\tau) - \frac{1+\rho}{2+\rho} \frac{w_{t+1}\tau(1+n_{t+1})}{1+r_{t+1}}. \tag{7}$$

Capital and labour mobility

Labour is assumed to be perfectly mobile. That is, workers migrate at the start of the first period of life to the other country if expected lifetime utility in that country exceeds utility in their country of birth. This implies that expected utilities must be equal in both countries. Workers pay PAYG taxes in the country where they work and accumulate the right to a PAYG benefit in this country when old. There is no migration at later stages of life, i.e., agents spend the period of retirement in the country where they have worked. Note that this implies that, although migration equates expected lifetime utility in both countries, ex post realized lifetime utility in the countries may differ in case of unanticipated shocks. In order to focus on migration we assume that the total population of the two countries is constant and normalized to one, i.e., $L_t + \tilde{L}_t = 1$. Hence, n_t represents a change of working population size as a consequence of migration only.

Financial capital (savings) is assumed to be perfectly mobile. This implies that the anticipated rate of return should be equal in both countries. This does necessarily imply that realized rates of return are equal too. In case of unexpected shocks, the realized rates of return will only be equal if capital is also mobile after investment, i.e., if physical capital is mobile in the short run. Given that a period in the model corresponds to thirty years, it may be considered not very realistic that physical capital is completely immobile in the "short run". On the other hand, fully mobile physical capital may also be considered a strong assumption. Therefore, we allow for both cases when analysing the short-run effects of pension reform. Given that the capital stock in a period is fully determined by savings in the period before, in any case physical capital is perfectly mobile as of the first period after a shock.

Equilibrium

Perfect capital mobility results in the equilibrium interest rates in both countries being equal: $r = \tilde{r}$.[4] Perfect labour mobility implies that utilities must be equal in the countries. Using these two equilibrium conditions we get (see the Appendix for the derivation):

$$\frac{\tilde{L}}{L} = \left(\frac{1+r-\tilde{\tau}r}{1+r-\tau r}\right)^{\frac{1-\alpha}{1-\alpha-\beta}} \tag{8}$$

$$\frac{\tilde{K}}{K} = \left(\frac{1+r-\tilde{\tau}r}{1+r-\tau r}\right)^{\frac{\beta}{1-\alpha-\beta}} \tag{9}$$

Equilibrium capital and labour force rations $\tilde{K}/K$ and $\tilde{L}/L$ are determined by $\tau, \tilde{\tau}$ and r, i.e., the distribution of world population and capital across the countries depends on the generosity of pension systems and the interest rate. As can be seen from equations (8) and (9), changes in size of the PAYG scheme will cause capital and labour flows in the same direction, and in case there are constant returns to scale in labour and capital the magnitude of these migration and capital flows is the same(see equation (14) in the Appendix). That is the main reason why constant returns to scale in labour and capital leads to a corner solution: Any difference in social security tax rates results in all the world labour and capital moving to the country with the lowest tax rate. To get a stable equilibrium we must assume $\alpha + \beta < 1$.

In order to determine the equilibrium we derive two relations between the interest rate r and the capital stock in the home country K. Both relations are presented in Figure 1. The first relation is derived from the fact that the world capital stock is equal to total savings:

$$K = g(r) \tag{10}$$

The functional form and the derivation of this relation are presented in the Appendix. The curve is upward sloping for the most reasonable parameter values, what is consistent with the fact that savings increase in the interest rate.

Combining equations (3) and (8) and recalling assumption $\tau > \tilde{\tau}$ we get a downward slopping relation between K and r:

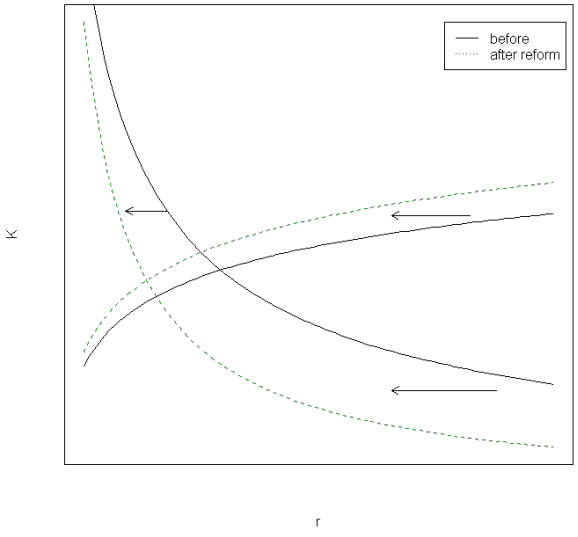
$$K = \left(\frac{(1-\beta)A^{1-\alpha-\beta}}{r\left(1+\left(\frac{1+r-\tilde{\tau}r}{1+r-\tau r}\right)^{\frac{\beta}{1-\alpha-\beta}}\right)^{\beta}}\right)^{1-\alpha} \tag{11}$$

The interpretation of this downward sloping relation is straightforward: An increase in the amount of capital drives interest rate down.

The intersection of both curves is the stable equilibrium. The general result is summarized in the following statement:

[4] L, K, r as well as other variables without time index denote equilibrium values.

Figure 1: Equilibrium



Statement 1. *If $\alpha + \beta < 1$, then an equilibrium exists.*

Proof. First it is noteworthy to see that $\lim_{r\to 0}(1 + r - \tilde{\tau}r)(1 + r - \tau r) = 1$ and $\lim_{r\to\infty}(1 + r - \tilde{\tau}r)(1 + r - \tau r) = (1 - \tilde{\tau})/(1 - \tau)$. Then it is easy to see, that $0 < \lim_{r\to 0} g(r) < \infty$ and $0 < \lim_{r\to\infty} g(r) < \infty$, where $g(r)$ is defined in equation (10) and it's explicit form is presented in appendix. On another hand equation (11) implies, that when $r \to 0$ $K \to \infty$ and when $r \to \infty$ $K \to 0$. From the Bolzano intermediate value theorem it follows that the 2 curves must intersect at least once. Hence, the equilibrium exists. □

As it was mentioned above, the curve (10) is increasing for most of the reasonable parameter values, but in the specific cases the curve may locally fluctuate up and down due to the second order effects. Hence, in general several equilibriums are possible. However, in our simulations with different parameter values we could get one equilibrium only.

Note that this proof does not imply that the equilibrium is stable. However, intuitively it can easily seen that the model will not lead to corner solutions if we rewrite home country wages as:

$$w = \tilde{w}\left(\frac{\tilde{L}}{L}\right)^{\frac{1-\alpha-\beta}{1-\alpha}} \tag{12}$$

Now let's assume the contrary: say, for example, that all the world population (and capital) goes to the foreign country. Then $\tilde{w}_t$ is finite and is given by $\tilde{w}_t =$

$\beta A\mathbf{K}^{\alpha}$. $\mathbf{K}$ denotes the total world capital. But $\tilde{L}_t/L_t$ is increasing to infinity. Hence, equation (12) implies that the wages in the home country increase to infinity. Therefore, the premise that all the world population goes to the foreign country contradicts individual utility maximization. The fact that all the world population cannot move to home country can be shown in a similar way.

The equilibrium interest rate is determined by two factors: total savings, i.e., the total stock of capital in the world, and the international allocation of resources. Equations (8) and (9) describe the long-run allocation of labour and capital respectively. Note that changes in the interest rate do not have a large impact on the allocation of the mobile factors because changes in the nominator and the denominator compensate each other. The effect of the international allocation of resources on the interest rate is given by the following statement:

Statement 2. *Assume that the total stock of labour and capital in the world is exogenous. Capital is mobile. Then the interest rate is largest when labour is evenly spread over both regions:* $\tilde{L} = L$. *Moreover, the interest rate is increasing in* $\tilde{L}/L$ *in the interval* $(0, 1)$ *and decreasing when* $\tilde{L}/L > 1$

Proof. See appendix. □

The statement says that the effect of the relocation of resources on the interest rate may be negative or positive depending on the initial distribution of labour the force, which in turns depends on the initial PAYG taxes in the countries. Taking equation (8) into account, the statement implies that the effect of the relocation of the resources is positive when the tax rates become more equal, and negative if the gap between τ and $\tilde{\tau}$ is widened.

Calibration

The model contains 5 parameters: α, β, ρ, τ and $\tilde{\tau}$. In order to model short-run dynamics we shall assume reasonable parameter values. İmrohoroğlu et al. (1999) estimate a production function where one of the production factors is land. Factor shares are equal 0.690, 0.277 and 0.033 for labour, capital and land respectively. We shall treat these results cautiously. The period in our model is assumed to be larger (35 years instead of 1 year), furthermore our interpretation of "land" is more general and contains all immobile factors. Most of the researchers assume $0.6 \leq \beta \leq 0.7$ independently of the period length. (See Börsch-Supan et al.(2006) and Ambler (2002) for example.) We follow this tradition and assume $\beta = 0.65$. The capital income in our model depends not only on returns to capital but also on returns to land. The rest 35% of income will be split up into $\alpha = 0.3$ (the share of capital) and 0.05 for the returns to A. Remember that all these returns go to the old in the form of interest. Note that assumption on how close the sum $\alpha + \beta$ is to unity has an important effect on the international flows of labour and capital. (see equations (8) and (9)). If the sum is close to 1 the spillover effects of PAYG reform are very high. In an extreme case, when $\alpha + \beta = 1$, any difference between the countries lead to

a corner solution. If the sum of the parameters is less then unity the internal equilibrium is achieved.

The most common choice of annual discount rate is near 1%. For example Broer (2007) assumes a discount rate equal to 0.9%, Börsh-Supan et al. (2006) take $\rho = 1.1\%$. We take an intermediate value of 1%. It corresponds to 41.66% discount rate per 35 years. Hence, $\rho = 0.4166$. The discount factor has a large effect on the level of savings and the world capital stock. The absolute level of capital flows between the countries is affected as well. The qualitative spillover effects, however, remain the same with the different discount rates.

Initial tax rates are set at $\tau = \tilde{\tau} = 0.15$. The choice of initial tax rates τ and $\tilde{\tau}$ does not have any qualitative implications.

3 The spillover effects of pension reform

In this section we analyse the international spillover effects of a pension reform in the foreign country. That is, it is assumed that as of time $t = 0$ the tax rate is unexpectedly and permanently decreased from $\tilde{\tau} = 0.15$ to $\tilde{\tau} = 0.10$ We first analyse the long-run results, then we illustrate the short run dynamics. Finally, the possibility of a locally welfare improving beggar-thy-neighbour reform is shown.

Long-run effects

The long run effect of a decrease in foreign tax $\tilde{\tau}$ can be seen from Figure 1. When $\tilde{\tau}$ is reduced, the curves (11) and (10) presented in the graph move to the left. Hence, the equilibrium interest rate decreases.

According to equations (8) and (9) a reduction of the tax rate $\tilde{\tau}$ evokes labour and capital flows to the foreign country. The equilibrium interest rate is affected in two ways. The first effect on the interest rate is due to international relocation of capital and labour. It follows from statement 2 that, if initially the countries have pension systems of the same size, a decrease of the tax rate in one country reduces interest rate because of the relocations of resources. Second, the lower expected pension benefits in the foreign country lead to larger savings. This increases the world capital stock and lowers the interest rate in the periods $t = 1$ and later.

The effect on the equilibrium value of the capital stock in the home country is not obvious. A reduction of the tax rate increases savings in the foreign country so that the world capital stock grows, which ceteris paribus raises the capital stock in the home country. But migration to the foreign country lowers the capital stock in the home country: migrants "take" a part of the capital stock with them. The overall effect on the home capital stock depends on specific parameter values.

Short-run effects

Figures 2 and 3 present the effects of a tax change on the main macroeconomic indicators. The left hand side of Figure 2 corresponds to country H. The right hand side represents the effects for country F. First, we will discuss the case when (physical) capital is mobile in the short run, then we elaborate on the case that savings are fully mobile in the short run but capital is not.

When capital is mobile in the short run, it immediately follows from statement 2 that, if initially the countries have pension systems of the same size, a decrease in the tax rate in one country reduces the interest rate immediately after the reform has been implemented because of the relocation of resources. Figure 3 b indeed shows a decline in the interest rate in period $t = 0$. This decline is relatively small however, the increase in capital in the next periods causes much larger effects.

As can be seen from panels c and d, pension reform leads to an instantaneous capital flow from country H to country F at the time of reform $t = 0$. There are similar effects on migration (Figure 3 panel a). Relocation of world resources leads to an increase in wages in country H and a decrease in wages in country F. It should be noted that migration is overshooting: when the interest rate decreases further, country H with its more generous pension system becomes more attractive and a part of the population of the foreign country migrates to country H again.

The initial effect of pension reform on savings is presented in (Figure 2 panels a and b). There are several influences affecting savings in the foreign country. First, the agents start to save more because they expect to get lower pension benefits. Second, there is an increase in net wages in the foreign country due to the decreased tax rate, but this is partly offset by the inflow of labour which lowers the gross wage rate (Figure 3 panel a). The overall effect on the net wage is positive however, as migration equates lifetime income in both countries, so the lower PAYG benefit has to be compensated by a higher net wage. Third, because of perfect foresight savings are affected by future migration and changes in the interest rate, but these effects are relatively small and vanish over time. The effect on the home country savings is simpler. The positive effect resulting from the increase in wages caused by the relocation of world resources is rather high, and outbalances the effects of the expected future interest rate decline (Figure 3 panel b) and migration.

Increased savings at time $t = 0$ lead to an increase in the world capital stock at the time $t = 1$. Wages grow in both countries and the interest rate falls. This process continues until the system reaches its new equilibrium.

The effect of pension reform on welfare, when capital is mobile is presented in Figure 4. To illustrate the spill over effects, we also show what would happen with utility if the economies were closed. In general, the utility is the same across the regions because of perfect labour mobility, but the unexpected reform hurts the initial old generations differently. The foreign country reforms its pension system unexpectedly at time $t = 0$. Consequently, the generation born at time $t = -1$ in this country suffers because of reduced pension benefits and lower

Figure 2: Dynamics

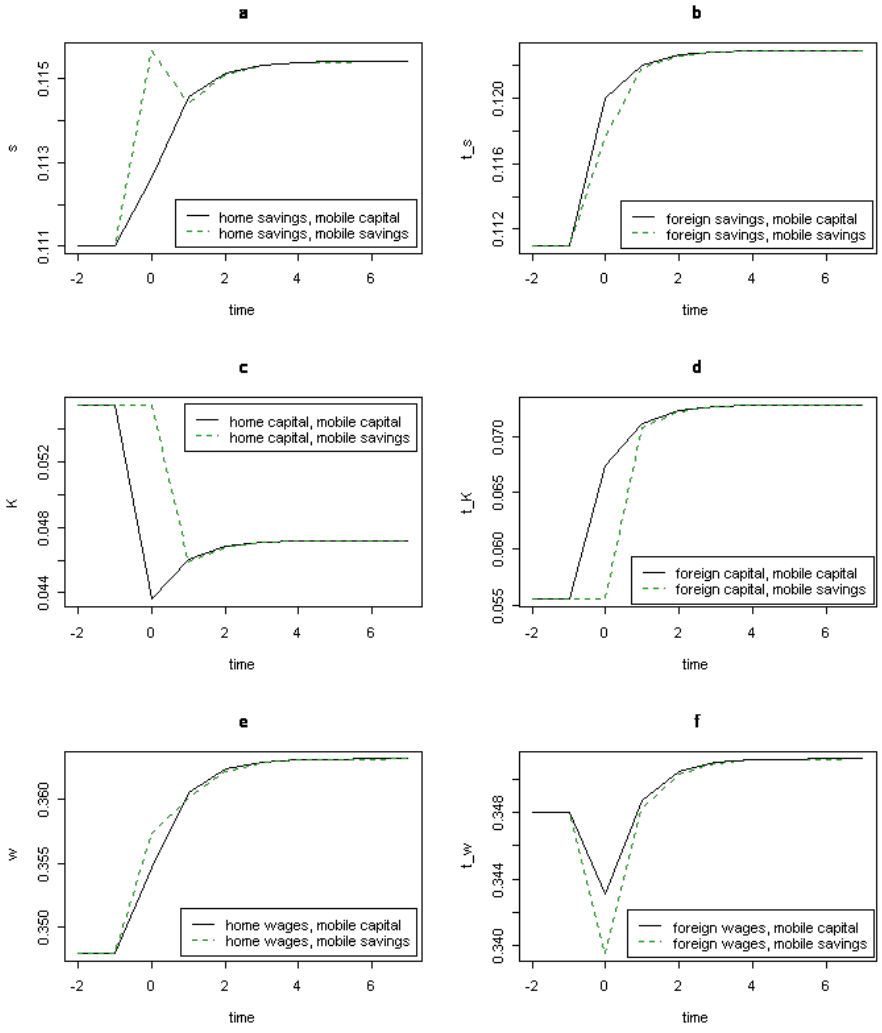
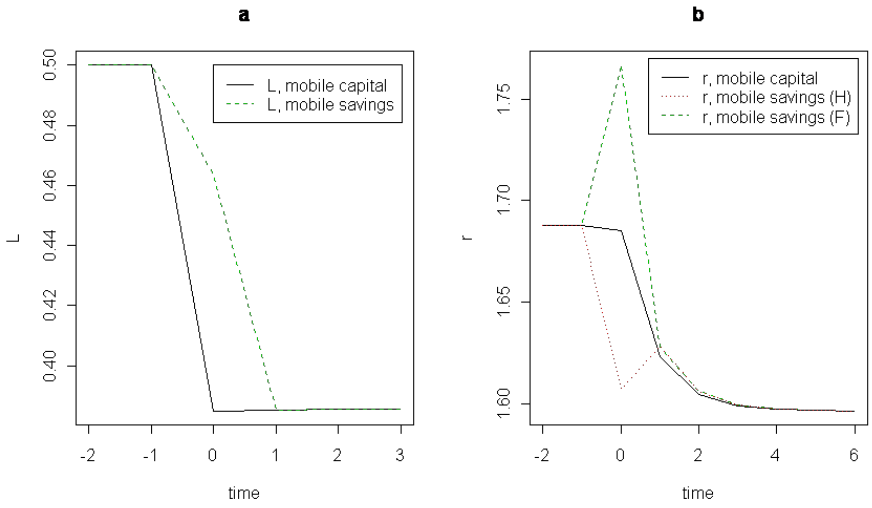


Figure 3: Labour and interest rate

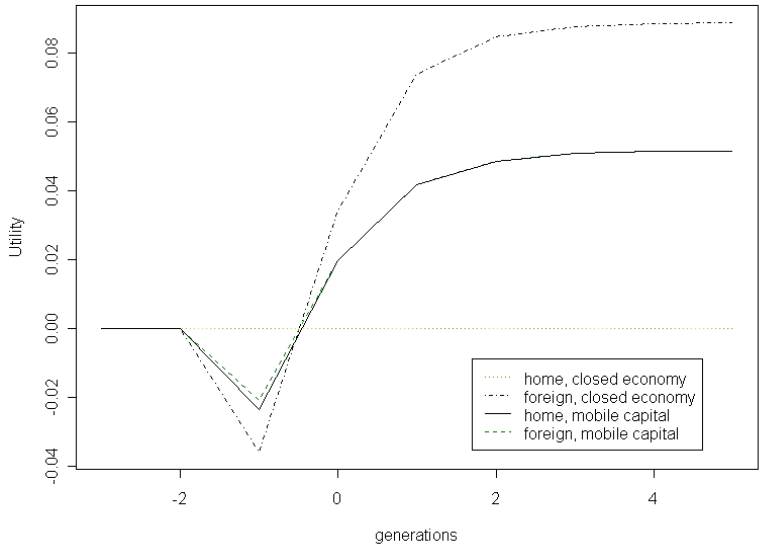


interest rate. Migration from country H to country F mitigates the losses of the old generation in country F and reduces the pension benefits in country H. As shown in the graph, the old generation born at time $t = -1$ in country H suffers even more than the old generation in country F. Therefore, the reform is beggar-thy-neighbour in the short run. On the other hand, the long-run benefits of the reform are shared between the countries as well. That is, the reform leads to negative spillovers for the non-reforming country in the short run, but to positive spillovers in the long run.

Now we will consider what happens when physical capital is not mobile in the short run but savings are. As it can be seen from Figure 3 panel a, migration at the time of reform $t = 0$ is much smaller than in case of mobile capital. Hence, there is no initial overshooting. The reason for the smaller migration flow is that the inflow of labour lowers the wage rate sharply if it is not accompanied by a proportional inflow of capital. After the first period, the capital stock is mobile and the effects are comparable to the case of mobile capital. That is, now a large migration flow to the foreign country takes place at time $t = 1$. As a result there is overshooting also in case capital is immobile in the short run, albeit one period later and to a smaller extent than in the model with perfect capital mobility. As the capital stock in both countries is initially fixed, a difference of interest rates among the countries arises at $t = 0$: the interest rate in the home country falls down, whereas the rate of return in the foreign country goes up. At time $t = 1$ the interest rates are equal again because of the optimal allocation of savings at time $t = 0$ and perfect foresight. Although the migration flow to country F is smaller than with perfect capital mobility, wages

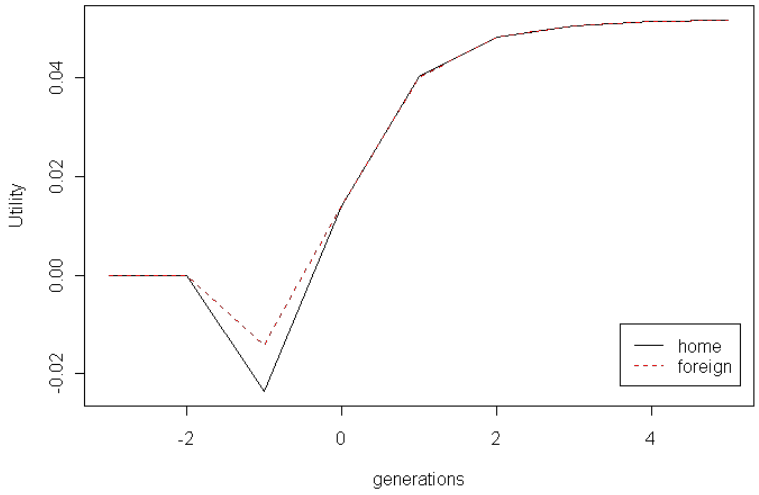
in the home country at time $t = 0$ are larger when no capital flows to the other country. Moreover, at time $t = 0$ the agents expect a large emigration from country H at time $t = 1$ reducing their pension benefits. As a result, they save more, leading to overshooting in savings (Figure 2 panels e and a). Wages and savings in the foreign country are affected in the opposite way (Figure 2 panels f and b). Further dynamics of the variables of interest follow the same path as in case of mobile capital.

Figure 4: Utility change when capital is mobile



The effect of pension reform on utility when savings are mobile is presented on Figure 5. As the initial interest rate in both countries now differs, the effect on utility for the first generation of elderly depends on whether they invested their savings at home or abroad. As both countries are completely identical before the pension reform, savings in each country equals the capital stock in that country and we may assume that workers only invest in their country of birth. Just like with mobile capital, the spillover effect on the initial generation of elderly in the home country is negative. Emigration at time $t = 0$ is not as large as when capital is mobile, but it still outweighs the rise in wages so that PAYG benefits fall. Moreover, the old generation in country H suffers from a decrease in the interest rate. Indeed, for the given parameter values the size of the short-run negative spillover effect is almost the same as with mobile capital. The utility loss of generation $t = -1$ in country F is mitigated by immigration and the higher interest rate in this country. The decrease in utility in the short run is in general a bit smaller rather than in case of mobile capital. On the other

Figure 5: Utility change when savings are mobile



hand, the benefits of the reform for the generations born at time $t = 0$ and 1 are slightly lower in both countries. So, in general, we can conclude that the spillover effects are quantitatively slightly different, but qualitatively the same as with mobile capital.

Reforming at the neighbour's costs

The fact that in a two-country model the initial loss can be shared with another country raises raises the question if it is possible to make a locally welfare improving pension reform at the neighbour's costs, i.e., a pension reform that is Pareto improving when only the utility of all generations in the reforming country is taken into account but lowers utility of some generations in the other country. In a two-country model with mobile capital and immobile labour as analyzed in Adema et al. (2009) such a reform is not possible as (apart form intergenerational transfers) nothing can compensate the initial elderly in the reforming country. In our model with both labour and capital mobility, this may well be possible however. This result is summarized in the next statement.

Statement 3. *Suppose that the capital is mobile. Initially both countries have the same PAYG system* $0 < \tau = \tilde{\tau}$ *and the world economy is in equilibrium state. At time* t *home country performs unexpected pension reform. The new tax rate is* $\tau/2 < \hat{\tau} < \tau$*. Then such a parameter set* $\alpha, \beta > 0$*,* $\alpha + \beta < 1$ *exists, that pension reform is profitable for both generations in country H.*

Proof. First, let's discuss the consumption of the current old. The consumption of the old generation in the absence of pension reform is $C_t^o = w_t\tau + s_{t-1}(1+r_t)$. Assume constant returns to scale: $\alpha + \beta = 1$. Then, pension reform leads to a corner solution, that is, the world labour and capital move to the foreign country. The new consumption of old generation is given by $\hat{C}_t^o = \hat{w}_{t+1}\hat{\tau} * 2 + s_{t-1}(1 + \hat{r}_{t+1})$. Savings s_{t-1} are determined in previous period. The wage rate and interest rate do not change due to constant returns to scale $\hat{r}_t = r_t, \hat{w}_t = w_t$, and decrease in tax rate τ is compensated by increased migration $2 = 1 + n_t$. Hence, the old generation wins if $\hat{\tau} > \tau/2$.

The young generation does not loose either, because wages and interest rate remain constant, and the tax rate decrease.

Given that both consumptions C_t^y and C_t^o are continues functions of parameters α and β, such an open neighborhood of interval $\alpha+\beta = 1$ exists, that both generations are still better off. Hence, such an area of $\alpha > 0, \beta > 0, \alpha + \beta < 1$ exists, that both generations are better off. □

So a locally welfare-improving reform is possible if labour and capital are sufficiently mobile, that is, if the decreasing returns to scale in these factors is relatively weak and the fixed factor is not very important. In that case, the reforming country attracts a lot of labour which allows for an increase in the pension benefit of the elderly. Labour mobility is thus crucial for this result. Only capital mobility is not sufficient to get this result, capital here follows labour.

This proof cannot be generalized to the case of mobile savings. In this case, when $\alpha + \beta$ are close to unity migration to the reforming country at time $t = 0$ will also be large, because agents in the home country expect a large emigration at time $t = 1$ leading to a reduction in their pension benefits. But now the flow of labour to country F at time $t = 0$ is not supported by a capital flow, and hence, it will sharply reduce wages in this country and the generation born at $t = 0$ may be worse off. However, a welfare improving transition to funded pensions for the reforming country is still possible for specific parameters. For example, assuming $\beta = 0.685$ instead of 0.65 results in a locally welfare improving reform. That is, the negative effect of the inflow of labour on wages should not be too strong. On the other hand, however, larger values for β ceteris paribus imply lower values for α that may also affect the possibilities for a locally welfare improving reform. Therefore, further increases in β do not necessarily imply that the reform is welfare improving.

Note that, so far, we have abstracted from the government using debt to compensate the initial generation of elderly in the reforming country. Allowing for this type of intergenerational transfers will increase the possibilities for a locally welfare improving reform. We do not analyse these possibilities in detail. Instead, we turn to the question whether introducing a central government in the union that uses government debt and lump sum taxes to redistribute over generations and countries allows for a globally welfare improving reform.

4 A globally welfare improving pension reform

It is well known that in a closed-economy model where the PAYG scheme does not cause additional distortions (apart from reducing savings) a Pareto improving reform of the pension scheme is not possible (Breyer, 1989). The basic intuition for this result is that the present value of the welfare gains of current young and future generations is not large enough to compensate the welfare loss of the current old by creating government debt and still leave resources for a welfare gain for at least one generation. Adema et al. (2009) generalize this result to a two-country model with mobile capital. In this section we show that in our model, where labour is also mobile and land is introduced as a third, immobile production factor, this result does not hold anymore. That is, we show that if initially the size of the PAYG schemes in both countries differs, a globally welfare improving reform is possible: all generations in both countries can gain if the size of the largest PAYG scheme is reduced.

It should be noted that such a globally welfare improving requires central coordination. That is, we assume the existence of a central government in the union that uses government debt and taxes to redistribute benefits and losses appropriately over the various generations in both countries. Hence, capital market equilibrium now implies:

$$s_{t-1}L_{t-1} + \tilde{s}_{t-1}\tilde{L}_{t-1} = K_t + \tilde{K}_t + b_t + \tilde{b}_t \tag{13}$$

where b_t denotes the government debt of the home country and $\tilde{b}_t$ is the government debt of the foreign country if needed.

The intuition for the result that a globally welfare improving reform is possible is straightforward. From the Statement 2 we know, that interest rate is the largest when labour is equally distributed between the regions. Such an equal distribution of resources leads to a more efficient use of the immobile factor A. If initially the pension systems are different, the allocation of labour will be unequal and thus inefficient. If now the country with the largest tax rate reduces it a welfare gain results that, using the appropriate redistribution policy between the countries and generations, allows for a globally welfare improving reform. The next statement makes the result even more intuitive

Statement 4. *Assume that the total stock of labour and capital in the world is exogenous. Capital is mobile. Then the total world wage earnings* $Lw + \tilde{L}\tilde{w}$ *are largest when labour is evenly spread over both regions:* $\tilde{L} = L$*. Moreover, the total world earnings are increasing in* $\tilde{L}/L$ *in the interval* $(0, 1)$ *and decreasing when* $\tilde{L}/L > 1$

Proof. See appendix. □

The statement says that the total world earnings are optimal when labour is evenly distributed between the countries. Statement 4 thus strengthens the results of Statement 2 and makes the possibility of a globally welfare improving reform more intuitive. However, this is a short-run result because the amount

of capital is assumed to be fixed (given by savings from the previous period). We need to take changes of the capital stock into account to show long run results. This cannot easily be done analytically. However the intuition is simple gain: the economy described by our model is dynamically efficient. [5] Hence, an increase in capital stock leads to further welfare improvement. We construct a numerical simulation example to illustrate the possibility of a welfare improving reform in case capital is mobile in the short run.

To make a Pareto improving reform at time $t = 0$ the PAYG tax in the country with the largest pension scheme is lowered to the level in the other country and the generations born at time $t = -1$ are compensated. That is the central government compensates the elderly at the time of the reform in both countries and borrows the money needed for this on the capital market [6]. In order stabilize the government debt, future elderly are taxed. Given that after the reform the PAYG taxes and benefits are equal in both countries, in order to allocate the world labour force efficiently, the taxes on future old must be the same in both countries. The results of such a reform are presented in Figure 6. We assumed that the tax rate in the home country is equal $\tau = 0.1$ and country F reforms its pension system at time $t = 0$ from $\tilde{\tau} = 15$ to 0.1. In this case the gains of the young generations are approximately 10 times smaller than in the case with no compensation, but now the generation born at time $t = -1$ doesn't suffer anymore.

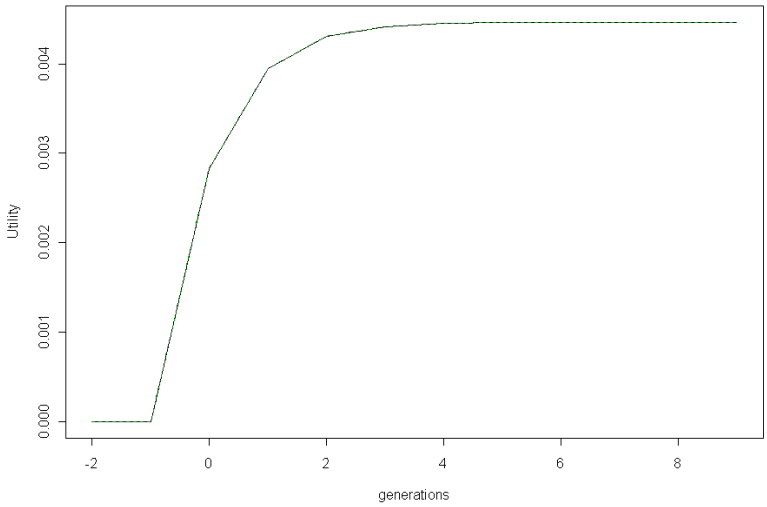
There are three factors that affect welfare of future generations. First, relocation of resources raises the interest rate and thus reduces the compensation needed for the old generation. Therefore, the taxes necessary for stabilizing government debt are lower than in case of a standard welfare neutral reform in a closed economy. Second, optimal location of resources increases total world wage earnings. Third, larger disposable income raises savings and thus the world capital stock, which affects wages and the interest rate. In total, this effect is positive because the economy is dynamically efficient. The generation born at $t = 0$ is affected by the first two factors only, because initially the world capital stock is fixed. The driving force for further welfare improvement of the next generations is the third factor.

The simulation experiment illustrating the possibility of a welfare improving reform assumed that capital is fully mobile in the short run. However, the result does not hinge on this assumption: When capital is immobile in the short run a welfare improving reform is also possible. In this case, even a smaller migration at time $t = 0$ makes the labour distribution more efficient and according to Statements 2 and 4 leads to an increase in total earnings and interest rate.

[5] For more discussion about efficiency in such models see, for example, Kim and Lee (1997) or Homburg (1991).

[6] Or, if the reform is made at neighbour's costs as described in the previous section, it redistributes benefits from benefiting country to the loosing country, and borrows the rest of the money needed for compensation.

Figure 6: Welfare improvement



5 Conclusions

This paper presented a two-country overlapping generations model with a fixed production factor and mobility of capital and labour between the regions to study the effects of pension reform. Labour was assumed to be perfectly mobile, with respect to capital mobility two cases were distinguished: One where capital is fully mobile both in the short run and the long, and one where savings is fully mobile, but the capital stocks are initially fixed. The model can be viewed as a generalization of both Adema et al. (2009) by allowing for labour mobility and Beyer and Kolmar (2002) by introducing a fixed factor of production and thus excluding corner solutions. First, existence of an internal long-run equilibrium was proved. Then the international spillover effects of pension reform were described. Finally, it was shown that introducing a central government in the union allows for a globally welfare improving reform. This is possible if initially the countries have different pension systems leading to an inefficient allocation of mobile resources. Equalizing pension systems then increases efficiency implying the scope for a global welfare improvement. Of course, the analysis in this paper is based on a number of simplifying assumptions. One of these assumptions is that migration is costless. In the reality this is not the case of course. Migration costs consist not only of a ticket price (which is negligible compared to lifetime income), but also the need to study foreign language, adaptation to foreign culture and so forth. If fixed traveling costs for all the agents are assumed, small changes in utility will not provoke migration and migration will occur only when the gain from migration exceeds

migration costs. In this case migration flows would be lower then in our model but the direction of labour flows wouldn't change. Another variant of including the costs of migration is to assume random costs. For example, it is possible to assume that the migration costs are randomly distributed between zero and some maximum value. In this case changes in the PAYG tax generate smaller migration flows than our model predicts. If a difference in utilities between the countries occurs, first people with lowest low migration costs migrate. This migration diminishes the gap between the utilities but does not make it equal to zero. In the next period there will be another young generation with random migration costs. Because it is still better to live in the country with lowest tax rate migration will continue until the system reaches an equilibrium. So introduction of random migrational costs would not change the long run results, but could change the transitional dynamics. For example, overshooting in migration may disappear. The possibility of welfare improving pension reform is rather robust to the assumption of costless migration, because even a small migration from the overcrowded country to the country where the labour is scarce leads to an increase in efficiency. Only if migration costs are so large that pension reform doesn't evoke any migration, a welfare improving reform is not possible.

An important conclusion from our model with mobile labour is that, just like in a model with only capital mobility, the long-run gains of a pension reform spill over to the non-reforming country. Short-run losses in case of an unanticipated reform spill over to the neighbouring country too, introducing the possibility of a locally welfare improving reform at the neighbour's expense. As the country reforming its social security system becomes more attractive to migrants, the inflow of labour counteracts the decrease in PAYG contributions due to the lower tax rate. On the other hand, however, the inflow of labour may lower the wage rate, and thus the PAYG benefit. If capital is perfectly mobile in the short run and migrants 'bring along the capital to work with' this effect is only due to the existence of a fixed factor. Hence, if this factor plays a minor role, a locally welfare improving reform is always possible. If the capital stock in a country is initially fixed, the depressing effect of the inflow of labour on the wage rate is potentially much larger and a locally welfare improving reform may exist only for specific parameter values. Even though pension reform may raise welfare for all generations in the reforming country, the spillover effect on the neighbouring country's old generation is definitely negative, as the outflow of labour reduces pension benefits and possibly also the rate of return on capital.

Adema (2009) concludes that the fact that a pension reform causes negative spillover effects to other countries with a joint capital market, pleas for policy coordination. Our model shows that when not only capital but also labour is mobile, the adverse effects for other countries, and thus the need for policy coordination will be even stronger. If labour mobility is strong enough to allow for a locally welfare improving pension reform at the neighbour's cost, policy coordination will be necessary in order to preserve the existence of PAYG schemes. In this case, policy competition will lead to a race to the bottom, and coordination of pension schemes as proposed by Breyer et al. (2002) is the only way to have positive PAYG transfers in the long run. The most important conclusion from

our analysis is that, if countries optimally coordinate policy, a globally welfare improving pension reform may be possible: if initially the countries have different social security systems it is possible to harmonize the systems and redistribute costs and benefits of this reform in such a way that both countries gain. However, this requires not only redistribution between generations but also between countries. This type of actions may be difficult to realize without central coordination, for example by a central government of the union.

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Appendix 1: Derivation of equations (8) and (9)

Perfect capital mobility condition $r = \tilde{r}$ can be rewritten as

$$\frac{\tilde{K}_t}{K_t} = \left(\frac{\tilde{L}_t}{L_t}\right)^{\frac{\beta}{1-\alpha}} \tag{14}$$

Present value of total agent's income is $w_t(1-\tau)+(1+n_t)w_{t+1}\tau/(1+r_{t+1})$. Using the fact that there is no migration in equilibrium ($n_t = 0$) and the wages are constant ($w_t = w_{t+1}$) present value of total income may be written as $w(1+r-\tau r)/(1+r)$ in equilibrium. Here w and r denote equilibrium wage and interest rate respectively. Migrational equilibrium is equivalent to equality of present values of total incomes:

$$w\frac{1+r-\tau r}{1+r} = \tilde{w}\frac{1+r-\tilde{\tau} r}{1+r} \tag{15}$$

Using (14), the right-hand side of the equation (15) can be rewritten as

$$= w\left(\frac{\tilde{L}}{L}\right)^{-\frac{1-\alpha-\beta}{1-\alpha}} \frac{1+r-\tilde{\tau} r}{1+r} \tag{16}$$

Equation (8) is got expressing $\tilde{L}_t/L_t$ from equation (16) and equation (9) is got inserting (8) to (14).

Appendix 2: Derivation of equation (10)

From equation (9) the world capital may be written as

$$K + \tilde{K} = K\left(1 + \left(\frac{1+r-\tilde{\tau} r}{1+r-\tau r}\right)^{\frac{\beta}{1-\alpha-\beta}}\right) \tag{17}$$

On the other hand the world capital is equal to the total savings in the previous period. Using the expression for savings (7), it's foreign counterpart, wage definition (2) and employing relations (8) and (9) we get:

$$K + \tilde{K} = Ls + \tilde{L}\tilde{s} = \frac{Lw}{2+\rho}\left(\left(1 - \tau\left(1 + \frac{1+\rho}{1+r}\right)\right) + \left(\frac{1+r-\tilde{\tau}r}{1+r-\tau r}\right)^{\frac{\beta}{1-\alpha-\beta}}\left(1 - \tilde{\tau}\left(1 + \frac{1+\rho}{1+r}\right)\right)\right) \tag{18}$$

Equation (19) is got combining equations (17) and (18)

$$K^{1-\alpha} = \frac{\beta A^{1-\alpha-\beta}}{2+\rho}\frac{L(r)}{1 + \left(\frac{1+r-\tilde{\tau}r}{1+r-\tau r}\right)^{\frac{\beta}{1-\alpha-\beta}}}\left(\left(1 - \tau\left(1 + \frac{1+\rho}{1+r}\right)\right) + \left(\frac{1+r-\tilde{\tau}r}{1+r-\tau r}\right)^{\frac{\beta}{1-\alpha-\beta}}\left(1 - \tilde{\tau}\left(1 + \frac{1+\rho}{1+r}\right)\right)\right) \tag{19}$$

Where $L(r)$ is got using equation (8) and normalization $\tilde{L} + L = 1$: $L(r) = \left(1 + ((1+r-\tilde{\tau}r)/(1+r-\tau r))^{\frac{1-\alpha}{1-\alpha-\beta}}\right)^{-1}$. The equation (19) is rather complicated, but it is still possible to analyze. The term $-(1 + (1+\rho)/(1+r))$ and it's foreign counterpart are increasing in r, while the influence of the term $(1+r-\tilde{\tau}r)/(1+r-\tau r)$ is of the second order, unless $\alpha+\beta$ are close to 1, because the change of r in nominator and denominator compensate each other. As the computer simulations have shown, this function is monotonically increasing in r, for $\alpha + \beta < 0.8$. If $\alpha + \beta$ are close to 1 then the relation is downward-sloping, but that doesn't change the results.

Appendix 3: Proof of statement 2

Say, world capital is restricted by savings in the previous period $\kappa = L_{t-1} * s_{t-1} + \tilde{L}_{t-1} * \tilde{s}_{t-1}$. Using equation (9) and denoting $\psi = \tilde{L}_t/L_t$ we get $K = \kappa/(1 + \psi^{\frac{\beta}{1-\alpha}})$. Analogically from (8) $L = 1/(1+\psi)$. Now substituting, this expression to (3) we get

$$r = (1-\beta)A^{1-\alpha-\beta}\left(\frac{\kappa}{1+\psi^{\frac{\beta}{1-\alpha}}}\right)^{\alpha-1}\left(\frac{1}{1+\psi}\right)^{\beta} \tag{20}$$

In order to find a value of ψ, which maximizes r we will take derivative of r with respect to ψ and perform some algebra.

$$\frac{\partial r}{\partial \psi} = A^{1-\alpha-\beta}\frac{(1-\beta)\beta\kappa^{\alpha-1}}{(1+\psi)^{1+\beta}}\left(\frac{\psi^{\frac{\beta}{1-\alpha}}}{1+\psi^{\frac{\beta}{1-\alpha}}}\right)^{\alpha}\left(\psi^{\frac{\beta+\alpha-1}{1-\alpha}}-1\right) \tag{21}$$

It is easy to see that r takes it's maximum when $\psi = 1$. When $0 < \psi < 1$ the slope is positive, and when $\psi > 1$ the slope is negative.

Appendix 4: Proof of statement 4

Using the same expressions as in appendix 3 the total world wages may be expressed as

$$Lw + \tilde{L}\tilde{w} = \beta A^{1-\alpha-\beta}\kappa^{\alpha}\frac{\left(1+\psi^{\frac{\beta}{1-\alpha}}\right)^{1-\alpha}}{(1+\psi)^{\beta}} \tag{22}$$

Differentiating it by ψ we get

$$\frac{\partial Lw + \tilde{L}\tilde{w}}{\partial \psi} = A^{1-\alpha-\beta}\frac{\beta^2\kappa^{\alpha}}{(1+\psi)^{1+\beta}}\frac{1}{\left(1+\psi^{\frac{\beta}{1-\alpha}}\right)^{\alpha}}\left(\psi^{\frac{\beta+\alpha-1}{1-\alpha}}-1\right) \tag{23}$$

The function takes it maximum when $\psi = 1$. gain, the function takes it's maximum when $\psi = 1$. When $0 < \psi < 1$ the slope is positive, and when $\psi > 1$ the slope is negative. When $0 < \psi < 1$ the slope is positive, and when $\psi > 1$ the slope is negative.

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