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Redistribution, Income cum Investment Subsidy Tax Competition and Capital Flight in Growing Economies

GÜNTHER REHME

BADIA FIESOLANA, SAN DOMENICO (FI)

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European University Institute
Badia Fiesolana
I – 50016 San Domenico (FI)
Italy

Redistribution, Income cum Investment Subsidy Tax Competition and Capital Flight in Growing Economies*

Günther Rehme
European University Institute†
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Abstract

This paper complements Rehme (1995) and reconsiders the trade-off between growth and redistribution in a two-country world with endogenous growth, tax competition, and *capital income cum investment subsidy* tax scheme, perfect capital mobility, extreme investment behaviour, two classes in each country and governments with opposing preferences. It is shown that in a closed economy this tax scheme allows higher growth than a *wealth tax* scheme if the capital owners are sufficiently impatient. Also, a left-wing government's country grows faster than a right-wing government's one. In a two-country world with equal technological efficiency, no redistribution takes place and both countries act as left-wing governments for fear of capital flight. With efficiency differences the efficient country will always get all the capital. The right-wing government cannot use its domestically preferred policy. An efficient left-wing government can redistribute out of its efficiency advantage vis-à-vis a right or left-wing opponent and experience high growth. Efficient right and left-wing governments' countries grow at the *same* rate.

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†*Correspondence*: EUI, Badia Fiesolana, I-50016 San Domenico di Fiesole (FI), Italy. *E-mail*: rehme@datacomm.iue.it.

Contents

1 Introduction

This paper reconsiders the trade-off between growth and redistribution policies in a two-country world with tax competition and perfect capital mobility as presented in Rehme (1995). There it is shown that capital flight forces governments with opposing political preferences ('right vs. left-wing') to pursue growth maximizing ('right-wing') policies if there are no efficiency differences and the two countries use the *source principle* and a *wealth tax* base. So governments that act in the interest of labour ('left-wing') will be threatened to loose their capital stock which provides the basis for redistribution. It is then shown that redistribution and positive growth is only feasible if efficiency differences are present.

This paper complements the results of that paper. Again the set-up follows the analysis presented in Alesina and Rodrik (1991), (1994).[1] The reasons for adopting the source principle are the same as before, namely, that a government in a non-cooperative environment cannot perfectly monitor its residents' income.

First, it will be assumed that the tax base for the government is designed as a *capital income cum investment subsidy* tax scheme. The tax rate on income and investment is assumed to be equal.[2] This appears to be a very special arrangement at first sight, but it may be justified by the following observation. A right-wing government acts in the interests of capital owners ('Capitalists'), consequently it would wish to set the income tax rate equal to zero. Since the presence of a Barro-type production function is assumed where public investment feeds back into production, it would also like to subsidize investment as much as possible. So setting the tax rate on income and investment equal seems to be a rational choice.

Similar reasoning applies for a 'left-wing' government. It would

[1]Bertola (1991), (1993) derives similar results as those obtained by Alesina and Rodrik.

[2]For simplicity and in order to elucidate the effect of that tax we will abstract from wage taxes throughout. Also note that Workers are not assumed to invest, but instead consume all their income, cf. Kaldor (1956) and Bertola (1991).

wish to set a very high tax rate on capital income for redistributive reasons. But this hinders investment, where we recall that in a simple endogenous growth model à la Barro (1990) and Romer (1986) 'Workers' enjoy ever increasing wages along a balanced growth path. Thus, a left-wing government would have to strike a balance between financing investment and redistribution, possibly out of capital income taxes. Hence, setting the tax rate equal again appears to be a rational choice.

Having attempted to justify the uniform tax rate on capital income and investment subsidy the paper simply assumes this uniform tax rate.

Recall that the *source principle* requires that all incomes originating in a country are taxed uniformly, regardless of the place of residence of the income recipients. As before, we will allow for non-uniform taxes.

Then the following results can be obtained:

In a closed economy a *capital income cum investment subsidy tax* scheme allows higher growth than a *wealth tax* scheme if the capital owners are sufficiently impatient. Thus, this paper's tax base appears conducive to high growth given impatience.

In a closed economy a left-wing government's country grows faster than a right-wing government's one. The left-wing government becomes the growth maximizer. Notice that in Alesina and Rodrik (1991) the right-wing government is the growth maximizer.

Extending the analysis to a two country world we will contemplate a simple Tax Competition Game the precise form of which is presented below. The *Nash Equilibria* of this game lead to these results:

In a two-country world with equal technological efficiency across countries, no redistribution takes place and both countries optimally act as left-wing countries for fear of capital flight. You may note that in Rehme (1995) it is shown that both countries act as right-wing governments in the presence of wealth taxes.

Since it is very unlikely ever to find countries almost identical this result provides a benchmark for the case where the countries are different in terms of efficiency.

If the two countries are differently efficient, the efficient country will always get all the capital. The right-wing country will have to abandon its preferred policy towards the Capitalists, that is, it cannot use the tax choice for its preferred growth rate. The reason is that the right-wing government is constrained by not hurting the Capitalists in terms of their utility on the one hand and loosing capital on the other. An efficient left-wing country can redistribute out of its efficiency difference vis-à-vis a right or left-wing opponent *and* experience high growth. It is also shown that efficient right or left-wing governments will grow at the *same* rate.

From this last result one may conclude that given strategic interaction efficiency differences may matter a lot. Given the tax scheme this paper employs there then appears no real trade-off problem between growth and redistribution.

The paper is organized as follows: Section 2 presents the model set-up, derives the equilibrium for a closed economy and compares the optimal tax choices with those obtained by Alesina and Rodrik (1991). Section 3 formulates a dynamic game where governments with possibly opposing political preferences engage in competition for capital by setting tax rates. Two propositions state the main results of this section. Section 4 draws some conclusions. Finally, proofs of the propositions may be found in the appendix.

2 The Model

Consider a Two-Country World with a "domestic" and a "foreign" country. Let us denote variables in the foreign country by a (*). There are two kinds of many identical individuals in each country, those who own capital and no labour and those who own labour, but no capital. Let us call the latter Workers (W) and the former Capitalists (k). The Workers consume domestic consumption goods only and derive utility $U(C_t^W) = \ln C_t^W$. The Capitalists are assumed to consume a mixture of domestic (C_1) and foreign (C_2) consumption goods, which are substitutes. Their overall consumption is $C_t^k = C_{1t}^k + C_{2t}^k$. Their utility is given by $U(C_t^k) = \ln\, C_{1t}^k + \ln C_{2t}^k$.

Hence, both agents derive utility from the consumption of homogeneous, malleable goods that are produced in the two countries. This assumes that foreign and domestic output, Y_t and Y_t^* are perfect substitutes in consumption.

Those who own capital, own shares of two representative firms. A firm is assumed a production unit only. It takes the following important form:

$$Y_t = A\, K_t^{\alpha}\, G_t^{1-\alpha}\, L_t^{1-\alpha}, \quad \text{where} \quad 0 < \alpha < 1 \tag{1}$$

$$K_t = \omega_t k_t + (1 - \omega_t^*) k_t^* \tag{2}$$

where Y_t is output produced in the home country, K_t the overall domestically installed real capital stock, k_t (k_t^*) is the real capital stock owned by domestic (foreign) Capitalists, G_t are public inputs to production and A is an efficiency parameter, which is assumed constant over time. We will set $L_t = 1$, so that labour is supplied inelastically over time. Throughout the analysis we will abstract from problems arising from depreciation and population growth.

Unless stated otherwise it is assumed that $A = A^*$ so that both countries are equally efficient. I will call these economies *similar*. If this does not hold, I will refer to the countries as being *different*.

We will assume that the Capitalists and the Workers are spatially immobile so that they cannot move from one country to the other. The consumption and capital goods in contrast travel freely across countries.

The Capitalists have to decide where they wish to invest. The variable $\omega_t \in [0,1]$ denotes the fraction of real capital at date t owned by domestic Capitalists invested in the home country. The fraction $1 - \omega_t$ is invested abroad by the domestic Capitalists. Similar reasoning applies to the foreign Capitalists.[3]

[3] Note that this formulation allows for the case that all of the domestically owned capital is invested abroad. This serves to bring out the effect of capital flight more clearly. Alternatively we could have assumed that $\omega \in [q, 1]$ where q is a - possibly - small number. The results of the paper would not change in any significant way.

Note that we assume that foreign and domestic capital are substitutes. This abstracts from the possibility that e.g. foreign capital may be a necessary input for domestic production.[4]

From now on the subscript t will be dropped whenever it is clear that the variables in question and the ones derived from them depend on time.

This form of a production function has been introduced by Barro (1990). We may note that in the absence of a government a Closed Economy breaks down and the Workers and the Capitalists starve.

2.1 The Public Sector

The governments in both countries choose to tax capital income and grant an investment tax subsidy. Let θ_1 be the tax rate on real capital income which is held domestically by domestic investors. Thus, θ_1 is levied on ωrk. The government also grants an investment subsidy of $\theta_1 \omega \dot{k}$, i.e. it subsidizes investment undertaken at home at the rate θ_1. Real foreign capital income invested in the home country, i.e. $(1-\omega^*)rk^*$ is taxed at the rate θ_2. This rate also determines the investment subsidy for foreign capital, $(1-\omega^*)\dot{k}^*$.[5] We will assume that there is always some form of taxation and that it is impossible to tax all income. For simplicity we let $\theta_i \in [\nu, 1-\nu]$ where ν is small.

Analogous definitions hold for the foreign government. This way of taxing wealth means that the countries adopt a variant of the *Source Principle* as a tax rule.

The *Source Principle* implies that all types of wealth present in a country are taxed *uniformly*, regardless of the place of residence of the owners of wealth.

[4]As it is the aim of this paper to model competition for capital, assuming complementarity would only exacerbate the competition, but would not change the results of this paper in any fundamental way.

[5]Thus, this paper considers the special case where the tax rates on capital income and the investment subsidy are equal.

If capital is internationally mobile it makes sense to adopt this principle since governments in a non-cooperative environment cannot perfectly monitor their residents' wealth. We still allow for non-uniform tax rates which the principle rules out in order to concentrate on the instruments that are at the governments' disposal.

At this stage let us define τ as the average tax rate levied on the overall capital income cum investment subsidy in the economy. Given the Barro-type production function we can then define the following government budget constraint, which is assumed to be balanced at each point in time:

$$\tau K = G + \lambda \tau K \tag{3}$$

The LHS depicts the tax revenues and the RHS public expenditures. The Workers receive $\lambda \tau k$ as transfers and G is spent on public inputs to production.[6]

Rearranging we consequently contemplate the following budget constraint:

$$G \equiv (1 - \lambda)\tau K \tag{4}$$

Underlying this is our earlier definition of the average tax rate τ, which we have deliberately left unspecified yet. Its explicit specification will be derived below.

2.2 Property Structure and Firms

There are many identical firms in each country which operate in a perfectly competitive environment. A representative firm is assumed to be a profit maximizer. The firms are owned by domestic and foreign capital owners. Foreign and domestic Capitalists rent capital to and demand

[6]Note that $\tau(1 - \lambda) = G/K$ so that $\tau = \tau(K(k, k^*))$. Also, Y is homogeneous of degree 1 in k and k^* so that τ is homogeneous of degree 0 in k and k^*. Thus if K increases by some factor ϕ, τ will remain constant so that r will remain constant as well.

shares of the representative domestic firm. The same holds for the foreign firm. The domestic Capitalists' assets are their shares of the two representative firms. The shares of the two firms are collateralized one-to-one by physical capital. The markets for assets, physical capital and labour are assumed to clear at each point in time so that the representative domestic firm faces a path of a uniform, market clearing rental rate, $\{r_t\}$, of domestically installable capital, K and wage rate, $\{w_t\}$, for labour.

Given perfect competition the firms in the domestic economy rent capital and hire labour in spot market in each period in their country. We assume that foreign and domestic output are perfect substitutes and set the price of Y and Y^* equal to 1. Given constant returns to capital and labour, factor payments exhaust output. Profit maximization then entails that firms pay each factor of production its marginal product

$$r = \partial Y/\partial K = \alpha A[(1-\lambda)\tau]^{1-\alpha} \quad (5)$$

$$w = \partial Y/\partial K \equiv \eta(\tau,\lambda)K = (1-\alpha)A[(1-\lambda)\tau]^{1-\alpha}K, \quad L = 1. \quad (6)$$

Note that (5) implies that there is an intra-country arbitrage at work which makes the return on foreign and domestic capital installed in each firm equal in the domestic country. The same, of course, applies to the foreign country.

We see that the average tax rate has a bearing on the marginal product of capital which is set equal to the rental rate of capital, i.e. the rate of return for the Capitalists, by the firms if the capital market is in equilibrium.

2.3 Capitalists

There are many identical Capitalists in each country, who cannot move, and choose how much of their income they consume or invest. Each individual Capitalist has to take prices such as r as given.

Since they have the opportunity to invest in either country they have to determine where their investment is to take place, ω. Note that we have assumed that the Capitalists consume a mixture of the consumption goods and that this mixture depends on where the the Capitalists invest.

We will assume that it is *costless* to send and install capital abroad so that perfect capital mobility between the countries prevails. This assumption may be justified by the fact that we have assumed that physical capital is entirely collateralized by stocks that are traded. Then perfect capital mobility amounts to a situation where the world capital market is taken to be fully integrated, which for some countries and assets seems to be a reasonable approximation of reality.

A representative Capitalist is assumed to maximize his/her intertemporal utility according to the following programme taking prices and tax rates as given.

$$\max_{C_1^k, C_2^k, \omega} \int_0^\infty \left(\ln C_1^k + \ln C_2^k\right) e^{-\rho t} dt \tag{7}$$

$$s.t. \quad \dot{k} = \omega r k + (1-\omega) r^* k - \frac{C_1^k}{1-\theta_1} - \frac{C_2^k}{1-\theta_2^*} \tag{8}$$

$$0 \leq \omega \leq 1 \tag{9}$$

$$k(0) = \bar{k}, \quad k(\infty) = \text{free.} \tag{10}$$

Equation (8) is the dynamic budget constraint of the representative Capitalist. It consists of two parts. The Capitalists consume C_1^k home consumption goods, where C^k is the Capitalists' overall, that is, foreign and domestic goods consumption at time t. C_1^k equals $(1-\theta_1)\omega[rk - \dot{k}]$ from our earlier assumption that goods are consumed proportionately to where they are produced. Noting that the Capitalists only derive income where they invest and solving for $\dot{k}$, the overall investment, yields (8).

With this budget constraint we also reflect the fact that the representative Capitalist has to take r and r^* as given since we assumed earlier on that the asset and capital markets clear at all times.

The necessary first order conditions for this problem are given by

(8), (9), (10) and the following equations:

$$\frac{1}{C_1^k} - \mu\frac{1}{(1-\theta_1)} = 0 \tag{11a}$$
$$\frac{1}{C_2^k} - \mu\frac{1}{(1-\theta_2^*)} = 0 \tag{11b}$$
$$\mu\,(rk - r^*k) = 0 \tag{11c}$$
$$\dot{\mu} = \mu\rho - \mu[\omega r + (1-\omega)r^*] \tag{11d}$$
$$\lim_{t\to\infty} k\mu e^{-\rho t} = 0 \tag{11e}$$

where μ is a positive co-state variable which can be interpreted as the instantaneous shadow price of one more unit of investment at date t. Equation (11a) and (11b) equate the marginal utility of consumption to the shadow price of more investment, (11d) is the standard *Euler* equation which relates the costs of foregone investment (LHS) to the discounted gain in marginal utility (RHS) and (11e) is the transversality condition for the capital stock which ensures that the capital stock does not grow without bound asymptotically.

Equation (11c) describes the Capitalists' investment decision and its solution takes a "*bang-bang*" form[7]. From this the Capitalists invest in the following way:

$$\omega = \begin{cases} 1 & : \quad r > r^* \\ \in [0,1] & : \quad r = r^* \\ 0 & : \quad r < r^* . \end{cases} \tag{12}$$

Thus, the investors compare marginal gains obtainable in each country. To see this more clearly take the condition for $\omega = 1$. This can be read as[8]

MB of more income at home $>$ MB of more income abroad

Thus, the Capitalists' investment behaviour is *extreme* in that they immediately shift their capital to the country where the net marginal

[7]For a more detailed treatment of this problem cf. eg. Chiang (1992), Kamien and Schwartz (1991).

[8]MB = marginal benefit.

benefit of investment, that is, where the gross rate of return is higher. That replicates the simplifying assumption that capital can costlessly be transferred to other countries. This simple formulation allows one to concentrate on the observation that international return differentials induce capital flows in the direction indicated above.[9]

Then (12) implies that the solution for ω is independent of time. For the moment assume that θ_1, θ_2^* are also independent of time. Taking logarithms and then time derivatives of (11a) and (11b) together with (11d) implies

$$\gamma = \dot{C}^k/C^k = \dot{C}_1^k/C_1^k = \dot{C}_2^k/C_2^k = \dot{k}/k = [\omega r + (1-\omega)r^*] - \rho. \qquad (13)$$

Domestic consumption is given by $C_1^k = [r\omega k - \omega\dot{k}](1-\theta_1)$. Dividing this expression by k yields $C_1^k/k = [\omega r - \omega\gamma](1-\theta_1)$. Substituting for γ and rearranging yields

$$C_1^k = ((1-\omega)(r-r^*) + \rho)\,\omega k(1-\theta_1). \qquad (14)$$

From this and (12) we learn what goods the Capitalists consume, namely

$$\begin{array}{llll} \text{If } r > r^* & \text{then} & C_1^k = \rho k(1-\theta_1), & C_2^k = 0. \\ \text{If } r < r^* & \text{then} & C_1^k = 0, & C_2^k = \rho k(1-\theta_2^*). \\ \text{If } r = r^* & \text{then} & C_1^k = \omega\rho k(1-\theta_1), & C_2^k = (1-\omega)\rho k(1-\theta_2^*). \end{array} \qquad (15)$$

Then, depending on the net benefit in the two countries, we get a *steady state* growth rate of consumption which follows in a standard way from (11d) and (12):

$$\begin{array}{lll} \textbf{Case 1:} & \omega = 0: & \gamma_1 = r^* - \rho \\ \textbf{Case 2:} & \omega \in [0,1]: & \gamma_2 = \omega r + (1-\omega)r^* - \rho \\ \textbf{Case 3:} & \omega = 1: & \gamma_3 = r - \rho \end{array} \qquad (16)$$

It follows that consumption of the Capitalists grows at a rate which depends on the net marginal benefit in the two countries. Note that for

[9] For an example that physical capital may actually be transferred because of return differentials see Ruffin (1984).

Case 1 the growth rate is completely determined by the return in the foreign country and all the domestic capital "bangs" into the foreign country. If $\omega > 0$, however, part of the domestic capital remains in the home country, but this implies that the net marginal benefits in the two countries must be equal. Case 2 is of particular interest below. Note that we have allowed ω to go where it would like if the net benefits are equal. Thus if the latter are equal we may well observe that all the capital of e.g. the home country bangs into the foreign country (Case 1) or entirely remains at home (Case 3). In Case 3 all the growth takes place in the home country, if the net benefit is higher there. This completely describes the behaviour of the Capitalists.

2.4 Workers

The Workers are assumed to derive a utility stream from consuming their wages. They do not invest and they are not taxed by assumption.[10] Thus, their intertemporal utility is given by

$$\int_0^\infty U(C^W)\, e^{-\delta t} dt \quad \text{where} \quad C^W = \eta(\tau, \lambda)K + \lambda \tau K. \tag{17}$$

This assumption is reminiscent of growth models such as Kaldor (1956), where different proportions of profits and wages are saved. In the extreme case Capitalists save and Workers do not, which is the "*Classical Savings Rule*". In Kaldorian models the Capitalists' investment decision is determined by the exogenously given growth rate. Recently, Bertola (1993) has derived the "*Classical Savings Rule*" result from utility maximization, which endogenizes the investment decisions and therefore the growth rate. In that sense our set-up reflects this result. However, Bertola does not use a two class model and there are important differences to post-Keynesian models of growth, the most important of which is probably that the causality in both approaches is running in opposite

[10]Negative values for λ would be tantamount to wage taxes or taxes on human capital. In order to focus on the effects of capital taxation we will abstract from any effects of wage taxes on our economies.

directions. Whereas in Kaldorian models the growth rate determines the factor share incomes, in endogenous growth models the direction is rather from factor shares to the growth rate.

2.5 Taxation

Given the dynamic behaviour of the Capitalists we may now specify the average tax rate τ which we have simply postulated in section 2.1. Recall that the tax revenues are given by $\theta_1\omega(rk-\dot{k})+\theta_2(1-\omega^*)(rk^*-\dot{k}^*)$. But given the optimal behaviour of the Capitalists, equation (15) establishes that the tax revenues are equivalent to $\omega\rho\theta_1 k + (1-\omega^*)\rho^*\theta_2 k^*$.

Thus, the tax arrangement amounts to a tax on consumption.[11] In terms of implementability we will still refer to income taxes cum investment subsidy. The average tax rate τ is then given by

$$\tau = \frac{\omega\rho\theta_1 k + (1-\omega^*)\rho^*\theta_2 k^*}{\omega k + (1-\omega^*)k^*}. \tag{18}$$

One may then verify that for *given* ω, ω^* the effect of changes in policy parameters is given by

$$r_{\theta_1}, \eta_{\theta_1} > 0, \quad r_{\theta_2}, \eta_{\theta_2} > 0, \quad r_\lambda, \eta_\lambda < 0 \tag{19}$$

so that increases in taxes raise and increased distribution lowers the rate of return or wages.

Let $\Delta \equiv \alpha(1-\alpha)A[\cdot]^{-\alpha}(1-\lambda)$. Then we get a rather more ambiguous picture for capital flows

$$\frac{\partial r}{\partial k} = \Delta\left[\frac{(\rho\theta_1 - \rho^*\theta_2)\omega(1-\omega^*)k^*}{K^2}\right] \gtrless 0 \quad \text{if} \quad \rho\theta_1 \gtrless \rho^*\theta_2. \tag{20}$$

Thus the effect of more domestic capital on the interest rate depends on government parameters. Equivalently, for k^* we get

$$\frac{\partial r}{\partial k^*} = \Delta\left[\frac{(\rho^*\theta_2 - \rho\theta_1)\omega(1-\omega^*)k}{K^2}\right] \gtrless 0 \quad \text{if} \quad \rho^*\theta_2 \gtrless \rho\theta_1. \tag{21}$$

[11] Thus, we are in fact contemplating a ***Ramsey Tax Problem***, cf. Atkinson and Stiglitz (1989), chpt. 12.

The equations (20) and (21) capture the fact that the capital that flows into the country should be taxed more heavily ceteris paribus since it provides the basis for more public inputs to production.

2.6 Equilibrium

2.6.1 Closed Economy

In the Closed Economy $\omega = 1, \theta_1 = \theta_2 = \tau, K = k, C_1^k = C^k$. The agents take the parameters and the prices as given.

The overall resource constraint in our economy is:

$$I = \dot{k} = rk + (\eta + \lambda\tau)k - C^k - C^W. \tag{22}$$

Since the Workers' consumption is $C^W = (\eta + \lambda\tau)k, \forall t$ this constraint is binding. This simplifies (22) to

$$\dot{k} = rk - C^k. \tag{23}$$

From (13) we already know that $\gamma_{C^k} = \gamma_k$. The assumption that the tax parameters are independent of time is still assumed to hold. Then we also have that $\gamma_{C^W} = \gamma_k$ from above.

The rental rate, r, is given by (5) and is constant by (18), hence γ_{C^k} is constant. In *steady state* all variables are supposed to grow at the same constant rate. To verify that this is the case consider (1). Use the definition of G, that is, $G = (1 - \lambda)\tau k$, and substitute in (1). Recalling that $L_t = 1$ and taking logarithms and time derivatives yields $\gamma_Y = \gamma_k$.

Hence, in *steady state* we have balanced growth with

$$\gamma_Y = \gamma_k = \gamma_{C^k} = \gamma_{C^W}.$$

This describes the dynamic equilibrium of the Closed Economy.

2.6.2 Two-Country World

In this section we will only make a few observations on the nature of the equilibrium in the presence of arbitrarily given tax rates under the assumption of identical technologies, $A = A^*$. We can have the following situations for the domestic country: $\theta_1 > \theta_2$, $\theta_1 < \theta_2$ or $\theta_1 = \theta_2$. Thus, we would have to go through six domestic vs. foreign tax rate configurations, noting that the levels of the tax rates have been unspecified and using symmetry. If we partition $\omega \in [0,1]$ into $\omega_1 = 0$, $\omega_2 \in (0,1)$, and $\omega_3 = 1$ and similarly ω^* and invoke symmetry we have six possible ω, ω^* configurations.

The determination of ω, ω^* is crucial for the description of the equilibrium of the two-country world. Given the above possibilities one would have to go through 36 possible cases.Since ω depends on $\max(r, r^*)$ in the way given by (12) and the level of the tax rates has been left unspecified it stands to reason that any ω, ω^* can be sustained as a possible equilibrium. This is especially true if there are great differences in the levels. For instance if $\theta_1 - \theta_2 > \theta_1^* - \theta_2^*$ and since r, r^* are increasing in tax rates then $(\omega = 1, \omega^* = 0)$ so that capital flight occurs.

I have tried to argue that almost all ω, ω^* configurations can be sustained given arbitrary levels and combinations of the tax rates and conclude from the above that each ω, ω^* combination can be sustained by multiple tax rate combinations and that these combinations constitute an extremely large, possibly infinite space of possible equilibria.

Economically, this suggests that we cannot say very interesting things about the economies unless we put more restrictions on the way taxes are set, which is the objective of the tax competition game we will contemplate below.

2.7 The Government in a Closed Economy

As in Alesina and Rodrik (1991), (1994) we will now look at a government that cares about the two groups in a closed economy. We will consider the domestic economy. Respecting the right of private property, it has to choose the paths of τ and λ in order to solve the following intertemporal problem, which is taken from the model of Alesina and Rodrik (1991):

$$\max_{\tau,\lambda} (1-\beta) \int_0^\infty \ln C^k \, e^{-\rho t} dt + \beta \int_0^\infty \ln C^W \, e^{-\delta t} dt \tag{24}$$

$$s.t. \qquad C^k = \rho k(1-\tau) \tag{25}$$

$$C^W = \eta(\cdot)k + \lambda\tau k \tag{26}$$

$$\dot{k} = \gamma(\tau, \lambda)k \tag{27}$$

$$\lambda \geq 0 \tag{28}$$

The parameter $\beta \in [0,1]$ represents the welfare weight attached to the two groups in the economy. If $\beta = 1, (0)$, the government cares about the Workers (Capitalists) only. I will refer to the government's choice of β as being a

$\beta = 1, (0)$ - left-wing (right-wing) government

Note that the condition $\lambda \geq 0$ restricts the governments in such a way that even a right-wing government does not tax workers. In that sense even a right-wing government is "nice" to the workers. A negative λ would effectively amount to a tax on wages.

Before presenting the solution of the government's problem we may compare this model with the one put forth in Alesina and Rodrik (1991). There the government chooses to tax *wealth*. Apart from that the model here and theirs are almost identical. In their set-up a right-wing government ($\beta = 0$) solving the related problem above pursues a growth maximizing policy. The growth rate in their model is a concave function of τ and is given by $\gamma = (r - \tau) - \rho$, where $r = \alpha A[(1-\lambda)\tau]^{1-\alpha}$. The growth maximizing tax rate is given by $\tau = \hat{\tau} = [\alpha(1-\alpha)A]^{1/\alpha}$ and $\lambda = 0$.

Let us call their growth rate γ_w and the one used here γ_m. Note that from (5) and (18) $r_m = \alpha A[(1-\lambda)\tau_w\rho]^{1-\alpha}$ with $\tau_m = \rho\tau_w$. Then the following Proposition holds.

Proposition 1: If $\rho \geq 1$ then $\gamma_m > \gamma_w$ for all τ. If $\rho > \alpha^{\frac{1}{1-\alpha}}$ then $\gamma_m > \gamma_w$ at $\tau = \hat{\tau}$.

Proof: Substituting in the growth rate expressions for $\gamma_m > \gamma_w$ leads to $\left[1 - \frac{\tau^\alpha}{\alpha A}\right]^{\frac{1}{1-\alpha}} < \rho$. Then the first part of the proposition holds. Substituting in $\hat{\tau}$ establishes the second part.

So it appears that implementing an income cum investment subsidy tax scheme may lead to higher growth than under wealth taxation if the Capitalists are sufficiently impatient.

The solution of the government's problem establishes

Proposition 2: The growth maximizing tax rate is $\tau = \tau_M = 1 - \nu$. The right-wing government chooses

$$\tau_r = [\alpha(1-\alpha)A]^{1/\alpha} \frac{(1-\tau_r)^{1/\alpha}}{\rho} = \hat{\tau}\frac{(1-\tau_r)^{1/\alpha}}{\rho}. \tag{29}$$

The left-wing government chooses

$$\tau_l = \tau_M = 1 - \nu \quad \text{and} \quad \lambda \geq 0. \tag{30}$$

The left-wing government's country grows faster than the right-wing government's country.

Proof: Cf. Appendix A.2.

It is usually argued that redistribution lowers growth. Given the tax scheme employed in this paper this may not be true. There is room for redistribution under the particular tax scheme considered in this paper. One may envisage situations where a left-wing government chooses $\tau \leq \tau_M$ and so opts for non-maximal growth, but still grows faster than a country whose government solely represents the interest of capital owners. The reason that a right-wing government does not maximize growth is that the tax scheme hurts the Capitalists' consumption stream. This constrains the maximization of the growth rate. The results of Proposition 2 become even stronger if the Capitalists are sufficiently impatient, as has been argued in Proposition 1. So there may be instances where even a right-wing government would wish to implement the tax scheme considered here.

Also note that the left-wing country optimally lets the capital owners just about survive. In the appendix it is shown that a left-wing government will not redistribute if the workers are very patient or if the economy is very efficient (high A). Hence, there are circumstances under which redistribution is possible with high growth.

3 Tax Competition in a Two-Country World with Perfect Capital Mobility

The question we shall pose ourselves in this section is:

> *What happens to the optimal choices of tax rates and redistribution parameters if these choices have to be made in a two-country world with capital mobility and costly capital transfers and countries cannot coordinate their policies?*

This is a relevant question for countries where full tax harmonization may not be possible. There is a possibility then that countries engage in tax competition.[12]

We will look for a Nash Equilibrium of the game described below. The strategies of the two governments are the choices of $\theta_1, \theta_2, \lambda$ and $\theta_1^*, \theta_2^*, \lambda^*$. Only pure strategies choices are considered.[13]

For the formulation of the game we have in mind we will employ the following

[12] For a similar point cf. e.g. Bovenberg (1994).

[13] Cf. e.g. Fudenberg and Tirole (1991).

Assumptions:

1. There is no uncertainty. Perfect knowledge about all the parameters, objective functions, the strategies and the sequence of moves prevails.

2. All agents act non-cooperatively.

3. The governments move simultaneously.

4. The private sector, that is, the Workers and the Capitalists move simultaneously.

5. The governments move before the private sector.

6. At each point in time the agents are confronted with the same problem.

7. Agents remember at t only what they have done at date 0.

8. $k_0 = k_0^*$, i.e. both countries have the same initial capital stock. (Unless stated otherwise.)

9. $A = A^*$, i.e. the countries are equally efficient or *similar*. (Unless stated otherwise.)

10. $\rho = \rho^*$, i.e. the countries' rate of time preference is equal across countries.

Assumption (5.) defines a game whose solution is called a *Ramsey Equilibrium*. This is similar to a *Stackelberg Leadership Solution*, where the governments are the Stackelberg leaders. Assumption (6.) defines a *repeated game* and (7.) means that the information structure is *open-loop*.[14] Also, if the Capitalists can invest in a global environment it makes sense to assume that they have the same rate of time preference.

[14] The justification for assuming this information structure may lie in the fact that democratic governments of either political leaning may constantly be reminded of their pre-election promises so that the outcome of the game in the first stage provides a benchmark for their decisions at time t. If the governments could remember the whole

3.1 The Government's Objective

Denote the domestic and foreign government by Π^i and Π^{i*} where $i =$ left (l), right (r), respectively. We will consider government objectives where each government would like to have as much capital in its country as possible *and* maximize its domestic objective function. It is shown that this is consistent with the objectives as put forth in the set-up of Alesina and Rodrik (1991).

To see this note the following: The governments have to take the $\omega' s$ as *given* from the second stage of the game. For the argument to follow the only thing we need is that the investors take the price paths of r_t, w_t and the taxes as *given* and then choose their optimal $\omega' s$. Then the government goes through a comparative static thought exercise and indirectly chooses optimal $\omega' s$ through its choice of tax parameters.

For what is to follow and to keep matters simple we will define *capital flight* as a situation where one country gets all the capital. For the domestic country this would amount to $\omega = 1$ and $\omega^* = 0$ for instance.

A change in the composition of the overall installed capital stock is given by $dK = \omega\, dk + (1 - \omega^*)\, dk^*$. Noting that $k_0 = k_0^*$ a small change in k or k^* has a positive effect on K and this change depends on ω, ω^*. Hence, for governments that prefer more capital to less policies affecting k or k^* play an important role. Note that we have assumed that domestic and foreign capital are substitutes in production. For this we will contemplate governments that do not prefer domestic over foreign capital.

From our earlier discussion we know that the Capitalists take r, r^* as given and that firms pay each factor its marginal product, also taking prices as given. Thus, in a competitive situation the agents and the

history of the game, time inconsistency issues would emerge. Modelling problems of time inconsistency and assuming appropriate trigger strategies for a *closed loop* information structure is beyond the scope of this paper. Thus it is implicitly assumed that governments commit themselves to their decisions. How this commitment is enforced is outside of this model. References for dynamic games are e.g. Petit (1990) and Basar and Olsder (1982).

firms do not take account of their effect on G. From the fact that the production function is constant returns to scale with respect K and L it follows that *gross* capital income is given by $rK = \alpha Y$ and *gross* wage income by $wL = (1-\alpha)Y$. The effect of more capital, i.e. an increase in k or in k^* on domestic output from the government's viewpoint is given by

$$dY = Y_k\, dk + Y_{k^*}\, dk^* \tag{31}$$

where Y_k and Y_{k^*} are the partial derivatives with respect to k and k^* respectively, evaluated at the second stage equilibrium values of the $\omega' s$.

These derivatives are given by

$$\begin{aligned} Y_k &= [\alpha A K^{\alpha-1} G^{1-\alpha} + (1-\alpha) A K^{\alpha} G^{-\alpha} t_1]\, \omega \geq 0, & \text{(32a)} \\ Y_{k^*} &= [\alpha A K^{\alpha-1} G^{1-\alpha} + (1-\alpha) A K^{\alpha} G^{-\alpha} t_2]\, (1-\omega^*) \geq 0 & \text{(32b)} \end{aligned}$$

and are evaluated at $L = 1$ and the optimal $\omega' s$ from the second stage of the game. It follows that $dY \geq 0$. Thus, an increase in k and in k^* raises domestic output. But it also raises the *gross* income of both types of agents, since

$$d(rK) = \alpha\, dY \geq 0 \quad \text{and} \quad d(wL) = (1-\alpha)\, dY \geq 0. \tag{33}$$

So more capital in the domestic country leads to higher income. This in turn loosens the budget constraints of both Capitalists and Workers as can be seen from (8) and (17).

This means that an increase in k and k^* is in the interest of right-wing and left-wing governments. For consistency with the objective functions as put forth in section 2.7 all we require then are objective functions that are (a) continuous in tax parameters and increasing in (k, k^*) *given* ω and $(1-\omega^*)$.

We know from the theory of optimal taxation that the government's problem can be stated in terms of the indirect utility function.[15]

[15]Note that the welfare function is a function of the government's instruments and that this function need not necessarily coincide with the individual agents' utilities as noted in e.g. Atkinson and Stiglitz (1989), chpt.12 and Diamond and Mirrlees (1971).

Out of this class of objective functions we will consider the following welfare function for the domestic right-wing (r) and left-wing (l) government, Π:

$$V^{\pi} = V(C^k(\cdot), C^W(\cdot)) = V(\beta\lambda, \theta_1, \theta_2, k, k^*)_{|D=\text{given}} \qquad \pi = l, r \quad (34)$$

where $D \equiv \omega + (1 - \omega^*)$, $C^k = C_1^k + C_2^k$ and ω, ω^* are taken as *given* by the government. V^{π} has the following properties $\exists V^{\pi}_{\theta_j}$ for $\theta_j, j = 1, 2$ and

$$V^{\pi}_{k}, V^{\pi}_{k^*} > 0, \quad V^l_{\lambda} \geq 0, \quad V^r_{\theta_i\theta_j} \leq 0 \quad \text{and} \quad V^{\pi}_{D=0} \leq 0, \quad i, j = 1, 2. \, (35)$$

In Appendix A.1 it is shown that (34) satisfies (a) and represents in a concise form the properties of the indirect utility functions of both the agents and the governments.[16] $V^l_{\lambda} \geq 0$ reflects the fact that only left-wing governments ($\beta = 1$) derive utility from redistribution. $V^r_{\theta_i\theta_j} \leq 0$ is assumed for consistency with the closed economy solution where we argued that right-wing governments do not wish to hurt the capital owners too much.

We may note that (34) incorporates an important feature of competition for capital. Having argued that capital is good for right-wing and left-wing governments, the objectives of each government are to get as much capital as possible, i.e. $V^{\pi}_{|D_1} > V^{\pi}_{|D_2}$ if $D_1 > D_2$. Then the ideal situation for e.g. the domestic country would be one where all the capital would be invested at home, $\omega = 1$ and $\omega^* = 0$.

The objective function also makes it possible for each government to pursue its domestically preferred policy, $\tau \in [\tau_r, \tau_l]$. This is captured by the fact that a right-wing government, $\beta = 0$, is only concerned about the Capitalists' welfare. This is tantamount to choosing taxes in a way so as to guarantee high k and k^*.

For the rest of the paper this objective function will be assumed to represent the governments' objectives.

[16]Since a national government usually only represents the interests of its own citizens, the Capitalists' consumption abroad also enters this function. Alternative formulations are possible. For instance, the domestic government could also act in the interest of the foreign capitalists present in the domestic country. An earlier version of this paper used that objective function. Both formulations yield identical results.

3.2 Competition for Capital

In this section we will look for a Nash equilibrium in tax rates and the redistribution parameters λ, λ^*. From the assumptions about the game the following should be noted: Given the timing of moves and the assumption on the information structure the game is reduced to a repeated two-stage game. First the public sector moves and then the private sector. For our game this means that *given* the investment decision of the Capitalists, i.e. ω and $(1-\omega^*)$, the governments decide on the tax rates and redistribution. *Given* the tax rates and λ, λ^* the private sector decides on where to invest.

Let us note that the growth rate of domestically installed capital is given by $\Gamma = \nu\gamma_k + \nu^*\gamma_{k^*}$ where $\nu \equiv \frac{\omega k}{K}$ and $\nu^* \equiv \frac{(1-\omega^*)k^*}{K}$ are the shares of domestic and foreign capital in domestically installed capital.

Solving backwards requires a government to maximize (34) w.r.t. $\theta_1, \theta_2, \lambda$ taking its opponent's choices of $(\theta_1^*, \theta_2^*, \lambda^*)$ as given. The solution to this problem is presented in Appendix A.3 and leads to the following proposition:

Proposition 3: For two *similar* countries there exist nine classes of pure strategy Nash Equilibria. The gross returns are equal, $r = r^*$, and the investors are indifferent where to go, i.e. $\omega \in [0,1]$ and $\omega^* \in [0,1]$ and never pay more than the average tax rates, which are equal across countries and equal the maximum rate, $\tau = \tau^* = \tau_M = 1 - \nu$. No redistribution takes place, i.e. $\lambda, \lambda^* = 0$ regardless of political preferences. Capital flight may occur in two classes of pure strategy equilibria. Both countries grow at the same rate, $\Gamma = \gamma_k = \gamma_{k^*} = \Gamma^*$ if no capital flight occurs.

Therefore, in a situation where both countries are equally efficient both governments optimally act as a *left-wing* government would by setting the growth maximizing tax rates. This is contrast to Rehme (1995) where it shown that *wealth tax competition* optimally involves the countries to act as right-wing governments.

Note also that Proposition 3 predicts that we will see a very unequal distribution of capital over time. Tax competition provides a force that perpetuates this inequality.

This result, of course, is of limited applicability for real life situations since the occurrence of the event of finding two economies that are identical is almost zero. The usefulness of Proposition 3 lies in the fact that it provides a benchmark for the following result that is proved in Appendix A.4.

Proposition 4: If two *different* countries' governments compete for capital the more efficient country, $A > A^*$, always gets all the capital, $\omega = 1, \omega^* = 0$. The inefficient country, $A^* < A$, chooses $\theta_1^* = \theta_2^* = \tau_M^*$ regardless of political preferences, i.e. $\beta^* = 1, (0)$. The efficient country $(A > A^*)$ chooses either

1. if $\beta = 0$ then $\theta_1 = \theta_2 = \tau_r \leq \tau_M^*$ such that $r_r > r_M^*$ and $\lambda = 0$, or
2. if $\beta = 1$ then $\theta_1 = \theta_2 = \tau_l = \tau_M$, where $\lambda \geq 0$ such that $r[(1-\lambda)\theta_M] > r_M^*$.

An efficient right-wing country's government gets the same amount of capital as a redistributing efficient left-wing one, i.e. $\omega_{\text{II}^l}^* = \omega_{\text{II}^r}^* = 0$ and $\omega = 1$. Efficient right or left-wing governments' countries grow at the same rate.

This proposition derives an extreme result that follows from the extreme investment behaviour of the Capitalists coupled with perfect capital mobility. The model would predict that redistribution is possible if a country is more efficient than the other one. Redistribution then depends on the opponent's technology. Also note that an efficient left-wing government will get more capital *and* guarantee a higher after-tax return. Its growth rate will therefore also be higher as shown below. If there is an efficiency difference there is hence a possibility for a left-wing government to pursue a policy which will have higher growth than its opponent and redistribution. The redistributive freedom is limited by the efficiency difference. For an inefficient left-wing government redistribution is always suboptimal.

We will now look at the dynamic equilibrium of the domestic economy under Proposition 4. From (8) and (16) we get $\gamma_C = \gamma_k$. The same holds for the foreign Capitalists. In the two-country world the resource constraint for the domestic country is given by

$$I = \dot{K} = r[\omega k + (1-\omega^*)k^*] - C_1^k - C_2^{k^*}. \tag{36}$$

Now define $C^K = C_1^k + C_2^{k^*}$ where it is important to note $C^K \neq C^k$. Then C^K is the aggregate consumption of the domestic and foreign Capitalists consuming the domestic output and we have used the binding constraint, $C^W = [\eta + \lambda\tau]K$. Given the constancy of the after-tax return, dividing (36) by K, taking logarithms and time derivatives yields $\dot{K}/K = \dot{C}/C$. From the production function we get $\dot{K}/K = \dot{Y}/Y$ by a similar procedure. One may then verify that the aggregate growth rate on a balanced growth path is given by

$$\Gamma \equiv \dot{Y}/Y = \dot{C}/C = \dot{K}/K = \nu\gamma_k + \nu^*\gamma_{k^*}. \tag{37}$$

This completely characterizes the dynamic equilibrium for the efficient economy. The inefficient economy gets no capital, $\omega^* = 0, \omega = 1$, and so does not grow at all. Hence for $A > A^*$ we have $\Gamma > \Gamma^* = 0$.

From this it is clear that an efficient redistributing government pays redistribution by an efficiency difference vis-à-vis its opponent. If this difference is small, redistribution will be small as well. Should one observe redistribution, though, the inequality in the capital distribution will decrease over time. Thus, inequality reducing policies are ultimately made possible by aggregate efficiency differences. The striking feature of Proposition 4 is that redistribution may be coupled with high growth.

Notice that the Workers of the inefficient country inevitably perish and that the Capitalists across countries just survive (ν small) and the Workers of the efficient country get better and better off.

Another interesting implication of this proposition is that any efficient country will always select the tax rate that a left-wing country would prefer and that the growth rate of efficient left or right-wing countries are the same.

Finally, let us note that the equilibria of Propositions 3 and 4 are all Pareto-efficient.[17] To see this note that if we took only a tiny amount of capital away from the capital possessing country it would be worse off which violates the Pareto Principle.

4 Conclusion

Employing the framework of a simple endogenous growth model with distributional conflicts seems to imply that if one taxes wealth, the growth rate is reduced by redistribution. This is the argument presented e.g. in Alesina and Rodrik (1994) and Bertola (1993) and would suggest that redistribution always implies lower growth.

If one extends the growth redistribution trade-off problem to a two-country world with perfect capital mobility, extreme investment behaviour and introduces non-cooperative behaviour, by which governments compete in *wealth tax* rates using the *source principle*, the possibility of capital flight features saliently in the optimal decisions of a government that wishes to redistribute.

It has been shown in Rehme (1995) that when the countries are technologically different, i.e. one country is more efficient than another one, then more capital will locate in the efficient country. If the efficient country wishes to redistribute, it can 'afford' to do so without loosing any capital. The amount of redistribution depends on who the opponent is and in particular on the efficiency gap that distinguishes it from its opponents.

In this paper it is argued that these results are very sensitive to the choice of tax base. First it is shown that in a closed economy a *capital*

[17]This provides an example for a recent result stated in Janeba and Peters (1994) who have shown that in a game where the payoff functions have discontinuities and Nash Equilibria exist, they will be Pareto-efficient.

income cum investment subsidy tax scheme allows higher growth than a *wealth* tax scheme if the capital owners are sufficiently impatient. Second, in a closed economy a left-wing government's country grows faster than a right-wing government's one. The left-wing government becomes the growth-maximizer. Growth is lowered by welfare considerations of a right-wing government.

Thus, a right-wing government may opt for a *capital income cum investment* tax scheme instead of a *wealth* tax scheme if the Capitalists are sufficiently impatient.

Third, in a two-country world with equal efficiency and tax competition no redistribution takes place and both governments act as left-wing governments. This result provides a benchmark for the result to follow since the probability of finding two very similar economies is extremely low.

Fourth, if the countries are differently efficient, the efficient country will always get all the capital. The right-wing government will have to hurt capital owners and cannot use its preferred domestic policy. An efficient left-wing country can redistribute vis-à-vis a right or left-wing opponent and experience high growth. Efficient right or left-wing governments' countries grow at the *same* rate.

This last result is especially interesting if one considers the growth-redistribution problem. Given this paper's tax scheme there appears no real trade-off problem for a redistributing government provided its economy is sufficiently efficient.

These results, however, have to be interpreted cautiously. We have only considered one particular tax base. Other tax base choices such as a tax on wages may change the results in a two-country world considerably.

We have abstracted from questions of time inconsistency. If countries could remember the whole history of the game the outcome might well be different. We have not analyzed the role of tariffs. It is quite likely that a country that experiences capital outflows or capital flight will set up tariffs. It would also be desirable to use a less aggregated set-up when investigating the trade-off problem. In reality workers own capital and some rich capital owners enter employment.

These and other problems provide room for further extensions of this model and for more research on the so-called trade-off between growth and redistribution.

A Appendix

A.1 The indirect utility function

Let f_i denote the derivative of a function f with respect to its i-th element. In steady state the Capitalists' consumption is given by (15). C_1^k and C_2^k are clearly increasing in k. Now substitute for k from (16) to obtain

$$D \equiv C_1^k \dot{k} = \rho\gamma(1-\theta_1). \tag{A1}$$

Maximizing D w.r.t the tax rates yields

$$D_1 = \rho\omega\gamma + (1-\theta_1)\rho\omega\gamma_1 \quad \text{and} \quad D_2 = (1-\theta_1)\rho\omega\gamma_2. \tag{A2}$$

This determines some optimal θ_1, θ_2. Now take the second derivative evaluated at these optimal $\theta's$

$$\begin{aligned} D_{11} &= (1-\theta_1)\rho\omega\gamma_{11}, \qquad & D_{22} &= (1-\theta_1)\rho\omega\gamma_{22}, \\ D_{12} &= -\rho\omega\gamma_2 + (1-\theta_1)\rho\omega\gamma_{12} \quad . \end{aligned} \tag{A3}$$

Note that $\gamma_i, \gamma_{ij} = \rho\omega^2(r_i, r_{ij})$. Define $\alpha(1-\alpha)A\tau^{-\alpha} = \zeta$ and let $\nu = \omega k/K$ and $\nu^* = (1-\omega^*)k^*/K$. Then

$$r_1 = \zeta\nu \geq 0, \qquad \text{and} \qquad r_2\zeta\nu^* \geq 0 \tag{A4}$$

$$r_{11} = -\alpha\zeta\tau^{-1}\nu^2, \quad r_{12} = -\alpha\zeta\tau^{-1}\nu\nu^*, \quad r_{22} = -\alpha\zeta\tau^{-1}\nu^{*2} \leq 0. \tag{A5}$$

Thus the indirect utility function, V^r, is increasing in (k, k^*) and has the property that $V_{\theta_i,\theta_j} \leq 0$ for $i, j = 1, 2$.

The Workers just consume their wage income plus transfers. This is given by (17). Rearranging (4) yields $\tau = \frac{G}{K(1-\lambda)}$. We can then express the Workers' consumption as

$$C^W = (1-\alpha)A\left(\frac{G}{K}\right)^{1-\alpha} K + G\frac{\lambda}{1-\lambda}. \tag{A6}$$

The first expression on the RHS corresponds to the wages and they are given by $\eta K = (1-\alpha)AG^{1-\alpha}K^{\alpha}$. This expression is increasing in k, k^*. As to the second expression. G is clearly increasing in k, k^* as well.

A left-wing government wishes to redistribute. Only the second expression involves λ. Changes of C^W w.r.t. positive changes in λ are given $\frac{G}{(1-\lambda)^2}$, which is positive.

Hence, any utility function, V^l, that is increasing in C^W satisfies (a). Since $\eta(\tau,\lambda)$ and $\gamma(\tau,\lambda)$, the derivatives w.r.t. θ_1, θ_2 exist.

This provides the justification for the restrictions on $V^{\pi}(\cdot)$ as given in (35). Hence, $V^{\pi}(\cdot)$ may capture the properties of the respective indirect utility functions.

A.2 Proof of Proposition 2

The Right-Wing Government

The Hamiltonian for the right-wing government is given by

$$H = \ln(\rho k(1-\tau))e^{-\rho t} + \mu\gamma(\tau,\lambda)k \tag{A7}$$

Maximizing one obtains the following necessary FOC:

$$-\frac{1}{1-\tau}e^{-\rho t} + \mu\gamma_{\tau}k = 0 \tag{A8a}$$

$$-\frac{e^{-\rho t}}{k} - \mu\gamma = \dot{\mu} \tag{A8b}$$

Assume that τ is independent of time, taking time derivatives of (A8a) yields $\rho = -\dot{\mu}/\mu - \dot{k}/k$. Substitution of this in (A8b) and noting that $\gamma = \dot{k}/k$ yields $\rho = \frac{e^{-\rho t}}{\mu k}$. Substituting back into (A8a) one gets $\frac{1}{1-\tau} = \frac{\gamma_\tau}{\rho}$. Multiplying out and rearranging implies

$$\tau_r = [\alpha(1-\alpha)A]^{1/\alpha} \quad \frac{(1-\tau_r)^{1/\alpha}}{\rho} \quad = \quad \hat{\tau} \quad \frac{(1-\tau_r)^{1/\alpha}}{\rho}. \tag{A9}$$

Note that this solution is indeed independent of time. Thus, there exists a time consistent solution justifying our earlier assumption about τ.

The Left-Wing Government

Setting up the Hamiltonian for the left-wing government's problem implies

$$H = ln[\eta(\tau,\lambda)\, k]\, e^{-\delta t} + \mu\, \gamma(\tau,\lambda)\, k. \tag{A10}$$

The necessary FOC involve

$$\frac{1}{C^W}\,(\eta_\tau + \lambda\rho)\, ke^{-\delta t} + \mu\, r_\tau\, k > 0 \tag{A11a}$$

$$\lambda\left[\frac{1}{C^W}\,(\eta_\lambda + \tau\rho)\, ke^{-\delta t} + \mu\, r_\lambda\, k\right] = 0 \tag{A11b}$$

$$-\frac{e^{-\delta t}}{k} - \mu\,(r-\rho) = \dot{\mu} \tag{A11c}$$

The tax rate cannot be greater than $\tau_M = 1-\nu$. Since $0 \leq \tau \leq 1$ in a Closed Economy we know from (A11a) that $C^W \geq 0$, $\eta_\tau > 0$, $r_\tau > 0$ and $\mu > 0$ by assumption. Thus, the expression in (A11a) is positive which would imply that $\tau = 1$. Hence, $\tau_l = \tau_m = 1-\nu$.

Suppose for the moment that the government chooses constant paths of τ, λ. We have just found that a left-wing government will set $\tau = 1-\nu, \forall t$, which may justify this assumption. Suppose τ were set equal to 1. Then we can invoke the following condition[18]

$$\frac{\eta_\lambda + \tau\rho}{r_\lambda} = -1 \tag{A12}$$

[18] For a justification of this condition cf. the appendix in Alesina and Rodrik (1991) and for a detailed derivation Rehme (1994).

Equation (A11b) implies

$$\frac{1}{C^W}\, k\, e^{-\delta t} = -\,\mu\, \frac{r_\lambda}{\eta_\lambda + \tau\rho}\, k \tag{A13a}$$

$$\frac{1}{C^W} e^{-\delta t} = \mu \tag{A13b}$$

From this it follows that: $-\dot{C^W}/C^W - \delta = \dot{\mu}/\mu$. Dividing (A11c) by μ and using the *Balanced Growth Condition* leads to

$$\delta = \frac{e^{-\delta t}}{\mu k} \tag{A14}$$

With $\tau = 1$ and using (A14) for the solution of (A11b) implies

$$(\eta_\lambda + \rho)\,\delta = -r_\lambda\,(\eta + \lambda\rho) \tag{A15}$$

Recalling the definitions of η, η_λ, r_λ entails for the above

$$\begin{aligned}\delta - (1-\alpha)^2 A[(1-\lambda)\rho]^{-\alpha}\delta \; &- \; \alpha(1-\alpha)^2 A^2[(1-\lambda)\rho]^{1-2\alpha} \\ &- \; \alpha(1-\alpha)A[(1-\lambda)\rho]^{\alpha}\lambda\rho = 0 \quad \text{(A16)}\end{aligned}$$

Note that this solution is independent of time, which justifies our earlier assumption. Thus, again we obtain the existence of a time consistent solution.

Let us analyze the effect of changes in λ on our objective function, H, in the neighbourhood of $\lambda = 0$. For this we evaluate $dH/d\lambda$ at $\lambda = 0$. This reduces to the sign of the following expression.

$$\delta - (1-\alpha)^2 A\rho^{-\alpha}\delta - \alpha(1-\alpha)^2 A^2 \rho^{1-2\alpha} \;\gtreqless\; 0 \tag{A17}$$

Since the left-wing government sets $\tau = 1 - \nu$ so that the Capitalists almost starve it makes sense for the government to set $\delta = \rho$ so that we get

$$\delta - (1-\alpha)^2 A\delta^{1-\alpha} - \alpha(1-\alpha)^2 A^2 \delta^{1-2\alpha} \;\gtreqless\; 0 \tag{A18}$$

A left-wing government does not to redistribute if the expression in (A18) is negative, that is, if more redistribution lowers utility if δ is small or if A is large.

A.3 Proof of Proposition 3

In step 1 we look at governments with $\lambda = \lambda^* = 0$. In step 2 we check whether redistribution takes place in equilibrium.

Step 1

This step of the proof involves the same procedure as the one presented in Rehme (1995), Appendix A.2. First one identifies all possible ω, ω^* configurations and checks whether they are candidates of a class of Nash Equilibria. As an exercise the reader may check that all nine possible configurations are indeed possible classes of Nash Equilibria. The next step involves checking whether each class is indeed a class of Nash Equilibria. The argument for proving the existence then runs as follows:

Consider a situation where

$$\theta_1 = \theta_2 = \theta_1^* = \theta_2^* = \tau_M \quad and \quad \omega \in [0,1] \wedge \omega^* \in [0,1] \tag{A19}$$

This concisely captures all nine classes.

Now suppose $\omega \in (0,1) \wedge \omega^* \in (0,1)$ and we cut θ_1 by a some amount ϵ to θ_1'. The resulting changes are denoted by ('). Then $r' < r^*$. So $\omega^* \longrightarrow 1$, where $\longrightarrow$ denotes "goes to".[19] Since $\theta_1' < \theta_2 = \theta_m$ r falls even more so that $r' << r = r^*$. But then $\omega \longrightarrow 0$. So the domestic country is worse off.

Now suppose you raise θ_1 to θ_1'. Then $r' > r = r^*$ and $\omega \longrightarrow 1$ and $r' >> r$ so that $\omega^* \longrightarrow 0$ so that the foreign country is worse off.

Similar reasoning applies to changes in all the other tax rates so that we must have $\theta_1 = \theta_2 = \theta_1^* = \theta_2^*$.

Now suppose $\theta_1 > \theta_1^*$ then $\omega \longrightarrow 1$ and $\omega^* \longrightarrow 0$ so the domestic country is definitely better off. The same holds for the foreign country. Thus, in equilibrium we must have $\theta_1 = \theta_2 = \theta_1^* = \theta_2^* = \tau_M$.

Since $\theta_i \in [\nu, 1-\nu]$ we would have that $\theta_M = 1 - \nu$.

[19] This should not be confused with "converges to".

Analogous reasoning applies to ω configurations of e.g. $(\omega = 1, \omega^* = 1)$, $(\omega = 1, \omega^* \in (0,1))$ or even $(\omega = 1, \omega^* = 0)$.

Step 2

From Step 1 we know that that $\tau = \tau^* = \tau_M$. If $\lambda \geq 0$ then $r < r(\tau_M)$. First suppose the other government is right-wing. Then it can find a θ_1^*, θ_2^* combination so that it gets all the capital. But then from (34) we have $U^l_{||D=0} \leq 0$ so that Π^l is worse off. The opposite holds for the foreign country if it sets $\lambda^* \geq 0$.

Now suppose both countries are left-wing. As the capital may bang from one country to the other lowering λ is good for either government.

If a government sets $\tau \neq \tau_M$ then the other country gets all the capital. Hence, each left-wing government will set $\lambda = \lambda^* = 0$, $\tau_l = \tau_M$ and $\tau^* = \tau_M$.

Finally, from (16) it follows that $\Gamma = \gamma_k = \gamma_{k^*} = \Gamma^*$ except for two classes of possible Nash equilibria, where $(\omega = 1, \omega^* = 0)$ or $(\omega = 0, \omega^* = 1)$. □

A.4 Proof of Proposition 4

Let the home country be more efficient, $A > A^*$. I will now show that the maximum return in the efficient country is higher than in the inefficient one. Assume that $\lambda = 0$. Recall the expression for r.

$$r = \alpha A \tau^{1-\alpha} \tag{A20}$$

Assume that $A = xA^*$, where $x > 1$, then $r > r^*$ for all $\tau = \tau^*$. We will express this fact in a little Lemma.

Lemma 1: If $A > A^*$, then $r > r^*$ for all $\tau = \tau^*$.

After having gone through similar arguments for the choice of $\theta_1, \theta_2, \theta_1^*, \theta_2^*$ as put forth in Appendix A.3, we have to distinguish these cases

1. rr^*: Π^{r*} sets τ_M^* so that r_M^*. But then Π^r chooses τ_r such that $r_r = r(\tau_r) = r^* + \epsilon > r_M^*$, $\epsilon \to 0$ so by $U^r_{\theta_j\theta_j} < 0$ and Lemma 1 $\omega = 1, \omega^* = 0$.

2. rl^*: Similar to (1.).

3. lr^*: Π^l and Π^{r*} choose τ_M. λ is chosen such that $r_l = r[(1-\lambda)\theta_M] = r^* + \epsilon > r_M^*$ with possibly $\lambda > 0$ since $U^l_\lambda \geq 0$ if $D > 0$. But then $\omega = 1, \omega^* = 0$.

4. ll^*: Similar to (3.).

Since $r_M, r_l, r_r > r^*$ we must have $\omega^*_{\Pi^l} = \omega^*_{\Pi^r} = 0$ from the private sector's reaction, equation (12), and $\omega = 1$ for all Π^i.

Finally, since $r_l = r[(1-\lambda)\theta_M] = r^* + \epsilon = r_r = r(\tau_r)$ the efficient countries grow at the same rate. □

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