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The right-wing power of small countries

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Summary
This paper investigates the political implications of tax competition between countries of different sizes. We show that smaller countries competing for internationally mobile capital would set lower tax rates than their larger counterparts when run by similar governments. Moreover, small-country governments are actually politically to the right of those in larger countries, adding a second reason for lower tax rates in the former. Then a higher number of small countries competing for capital with large countries not only decreases the large-country tax rates on capital, but also results in more right-wing governments being elected. Small countries thus have ”right-wing power”.

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Introduction

The enlargement of the European Union in May 2004 was probably the single most significant change in the membership of the European bloc in its history. Ten new countries joined the elite group in what some dubbed the "big bang". They represented new formidable competition for the original EU-15. Apart from their low labour costs, most of the new countries implemented rather low corporate tax rates, in order to attract even more investment in their still transforming economies. The old EU members slowly responded to the new challenge in the tax competition within the EU. The citisens of the old members might themselves have recognised the changed situation and elected governments more capable of reacting to it. Germany, for instance, voted in Angela Merkel instead of Gerhard Schroeder, in a slight shift to the right. Similarly, the French elected Nicolas Sarkozy, a more right-wing successor to Jacques Chirac.

In this paper, we develop a framework based on country size heterogeneity in a capital tax competition environment. It helps explain the right-ward shift in some of the larger EU-15 countries in response to increased competition from the new, smaller members of the Union. We attribute the shift to the "right-wing power" of the mostly small countries of the EU-10 that joined the bloc in 2004. In our model, small countries choose lower tax rates for both economic and political reasons. They would tax capital less than their larger counterparts even if they were run by representative governments from the same part of the political spectrum. They, however, elect more right-wing governments, which, *ceteris paribus*, prefer less taxation in a country of any size. This drives small country tax rates further down relative to those set by their larger competitors. When more such small countries compete for mobile capital, citisens of larger countries do not simply let their governments, which are in power at the time, decrease tax rates. They vote in new governments with more conservative preferences and have even lower taxes implemented. Small countries therefore have right-wing power – their increased presence results in election of more conservative administrations as well as a tax decrease in large countries, as opposed to merely a drop in the large country tax rates.

The economic relationship at the basis of our analysis is clearly substantiated by the data: capital tax rates in the EU countries are positively related to their size (see Charts 1 and 2). Old and new small members have rates as low as 10 per cent, whereas the five largest EU members all tax capital at over 30 per cent. Huizinga and Nicodeme (2005) provide rigorous estimates that support our casual observation when they find a positive impact of a country's GDP on its corporate tax rate.

We thus build a model of tax competition between countries of different sizes that incorporates the economic and political equilibria. Countries compete for internationally mobile capital. Since they are equally productive, capital responds and moves according to the countries' various capital tax rates. The fiscal policies are decided by representative governments elected by heterogeneous populations. Each country is populated by a continuum of agents that differ by their productivity and therefore income as well as preferences for capital taxation. The median agent in each country elects an administration from among the population that will implement his optimal fiscal policy.

First, we show in our environment populated by many large and small countries that when all countries are run by the same type of government, the small countries will set a lower tax rate than large ones. This is because each of the small countries cannot change the world equilibrium much (or at all) through its policy choices. Large countries, on the other hand, realise that when they change their tax rate the world required net return on capital will change as well and therefore the amount of capital present in their economies will not change by as much as it would were the net return to remain constant, as it does for the small countries. With lower perceived elasticity of capital to the tax rate, large countries will choose a higher tax rate.

The second reason in our model why large countries set a higher tax rate than small ones is that their governments are to the left of those elected by their smaller competitors and, *ceteris paribus*, prefer higher taxes. The voters in large countries, just like their governments, understand that their country has an impact on the world equilibrium. Therefore the mechanism proposed by Persson and Tabellini (1992) applies here: before elections in each country and the subsequent non-cooperative tax setting game between them take place, the electorate in the large countries understands that the other countries will respond positively to its own government's actions during the game. After the elections, however, during the Nash game where countries set the tax rates simultaneously, governments take the other countries' fiscal policies as given. Because of this, agents perceive a higher elasticity of capital with respect to the tax rate *ex post*, after the elections, than *ex ante*, before the voting takes place. They thus always prefer a higher tax rate *ex ante*, before the Nash game begins, than *ex post*. The median agent, who effectively chooses the government, understands that a representative with preferences identical to his own will not implement his optimal *ex ante* tax rate once tax competition takes place. To achieve his *ex ante* optimum, he elects a government that desires a higher tax rate than the one he would select at any given point in time. The government will then be to the left of the median of the population.

Once again, though, small countries affect the world equilibrium little or not at all. Therefore in our model of heterogeneous countries a change in the policy of a small country does not cause a shift in other countries' tax rates. But then it follows that the median voter in a small country chooses himself or an agent of the same type to become the policy maker and set the tax rate. The governments in small countries are thus to the right of those in large ones and we have yet another reason why small countries set a lower tax on capital in equilibrium.

Our model then produces its main result: when faced with relatively more small countries in a tax competition, voters in large countries elect more right-wing governments. This occurs for two reasons. First, as we have already mentioned, smaller countries are tougher competitors for scarce capital. They set lower tax rates because they perceive higher elasticity of capital with respect to their fiscal policy and because their governments are to the right of those in large countries. That, in turn, decreases the equilibrium tax rate set by large countries as they are forced to respond to the challenge posed by a larger fraction of small competitors. Smaller absolute tax rates then diminish the difference between large-country voters' desired *ex ante* and *ex post* tax rates. The need to elect a left-wing government decreases. Second, smaller countries respond less (or, in our basic set-up, not at all) to changes in the policy of large countries. This is again due to the higher elasticity of capital they face when they alter their own tax rate. Thus when a large country is competing with relatively more small countries, a more significant proportion of its competitors reacts less to its actions. That, once again, reduces the need for the median agent to elect a representative that is poorer than himself and prefers higher tax rates.

Small countries thus have what we call "right-wing power". Merely increasing their relative proportion in a tax competition environment causes a right-ward move in the type of policy makers elected in large countries. We also show that the same result holds when new small countries are simply added to a group of countries competing for capital. However, the same is not always true for additional large countries joining the tax-setting game. Here, two effects combine. More large countries represent an increased level of competition. Even if they are not as challenging opponents as small countries, a higher number of large competitors in a set-up without small countries would still induce lower equilibrium tax rates and a right-ward move in the type of administration. But these are the countries that respond more significantly to changes in others' fiscal policies. Therefore bringing up their numbers when small countries are present can result in a left-ward shift in large countries' governments and an increase in tax rates, because then proportionately more countries will be responsive in the Nash competition. We demonstrate that the second effect dominates when a minimum mass of small countries is also competing for capital. Thus larger countries do not have the same right-wing power their smaller counterparts possess.

This paper employs the framework of tax competition and coordination in its attempt to explain the political impact of country size heterogeneity in an environment with freely mobile capital. The vast body of work on tax competition is well summarised in Krogstrup (2003) and specifically as it pertains to the European Union in Krogstrup (2002) and Nicodeme (2006). Relative to the size of the literature, few authors have considered the interaction between countries of different size. Under different assumptions - such as quadratic production function - and mostly only for two-country interactions, Kanbur and Keen (1993), Wilson (1991), Bucovetsky (1991) and Peralta and van Ypersele (2005) have all proved that smaller countries set lower tax rates than their larger counterparts. In their models, small countries perceive a higher elasticity of capital with respect to their own tax rate.

However, the literature does not consider the interaction between country size heterogeneity and the political equilibrium. It is this interplay that generates the second reason, for which in our environment large countries set a higher tax rate than small ones - their governments are to the left of those elected by their smaller competitors. Equally importantly, it results in our principal result, the right-wing power of small countries.

The paper proceeds as follows: The next section introduces the model. Section 3 considers *ex post* and *ex ante* tax competition, where we show that smaller countries choose lower tax rates and larger countries elect more left-wing governments. In section 4 we show our main result that a change in the composition of countries, with which a large country is competing, will determine how left-wing its government will be. We also evaluate a minimum tax proposal by some of the EU's policy makers in the framework of our model. Section 5 provides computational solutions for an expanded version of our model. The last section concludes.

The model

The basics

Our model has one period. The world consists of large and small countries. We have n large countries (L), each of which has a mass 1 of agents. We also have a mass s of small countries (S), each of which has an infinitesimally small mass of agents.

There are perfectly competitive firms with access to the same CRS technology in all the countries. Firms produce a single good employing labour and capital, for which they compete in the factor markets and therefore pay them their marginal products.

Throughout our model, we shall assume the Cobb-Douglas production function, so that production is $F(K, L) = K^{\alpha}L^{1-\alpha}$, where K is the capital and L is the total effective labour employed. We can re-write the production function as $f(k) = k^{\alpha}$, where k is capital per unit of effective labour.

Agents are risk-neutral. They are immobile between countries. They each have one unit of labour, which they supply inelastically to the firms. labour market clears, therefore all agents are employed. Some are also endowed with capital, which they rent to firms. Agents' endowment is the only source of capital in the world. Since our model only has one period, no decisions regarding capital accumulation are made.

Agents differ in their labour productivity γ, and capital endowment θ. The mean of each distribution is one. Agents' productivity γ turns the one unit of labour they supply to the market into γ units of effective labour supply. We shall assume that for the median agent $\gamma < 1$.We will make the simplifying assumption that while agents' productivity γ is positive and continuously distributed across all agents, only agents with above-average productivity are also endowed with an amount of capital $\theta > 0$. Moreover, θ is strictly increasing in γ for agents with values of γ above the mean. Therefore the above will imply that the median agent or anyone less productive will not be endowed with any capital.[1] However, since the mean capital endowment of an agent in every country is one, per capita supply of capital will also be one.

Thus the total effective labour employed by firms in any country is equal to the mass of agents in that country. Also, the total amount of capital in the world is simply $K^T = n + s$, in other words, equal to the size of the world population. Throughout the model we will assume that $n \geq 2$ and therefore $K^T \geq 2$. This is because, as we will see later, interesting dynamics in our setup only occur when at least two large countries compete for capital.

Capital is perfectly mobile between the countries and therefore responds to the various tax incentives it faces. Ultimately, thanks to arbitrage, it earns the same endogenously determined net rate of return in all countries.

The government in each country only taxes capital. It collects tax revenue and then redistributes it lump-sum to all the agents in the country, such that they all receive the same payment from the government. Since agents with different productivity earn different labour income, and therefore are affected differently by variations in capital stock caused by the tax rate on capital, the administration can achieve redistribution even under the assumption of uniform lump-sum transfers. We assume that the tax rate on capital is non-negative.[2]

For simplicity, we assume agents have a linear utility function such that each agent's welfare is the sum of his labour and net capital income and the lump-sum transfers from the government. Agent's wage will be $w = \gamma(1-\alpha)k^\alpha$ and his capital income $\theta(1-\tau)\alpha k^{\alpha-1}$, where τ is the tax rate imposed on capital returns. He will receive transfers $\tau.k.\alpha k^{\alpha-1} = \tau\alpha k^\alpha$.Then an agent's welfare will be

$$W(\tau, \gamma, \theta) = \gamma(1-\alpha)k^\alpha + \theta(1-\tau)\alpha k^{\alpha-1} + \tau\alpha k^\alpha.$$

In each country, the agents elect from amongst themselves a government. Whichever of the candidates receives the majority of the votes wins the election. The government then makes policy decisions regarding the capital tax rate τ. It chooses the tax rate, which is optimal for the agent elected, that is, it maximises the welfare of that particular agent with certain parameters γ and θ.

Lastly, the timing in our model is as follows: first, voters in each country simultaneously elect their respective governments. Then, once elected, the various governments simultaneously announce and commit to a capital tax policy. Lastly, capital moves between countries until net return on capital is equalised and then production takes place. At that point, capital is taxed and lump sum payments to agents are made.

[1] Only the more productive agents with a higher labour income own capital. In a richer environment, these would be the agents able to save more and invest their savings, thus resulting in a capital endowment.

[2] In our model, subsidies to capital would be financed by negative transfers to agents. Therefore a negative tax rate on capital would imply imposing a lump-sum tax on the agents.

We thus look for a two-part equilibrium: an economic equilibrium where governments play a non-cooperative Nash game when setting their respective tax rates. In the game, policy makers take the other countries' policy decisions as given. The second part of the solution is a political equilibrium that requires that each government be elected and therefore preferred by a majority of voters in their country. When deciding, voters take foreign countries' election outcomes as given: elections in all countries occur simultaneously and thus voters cannot affect another country's choice of policy maker. However, they realise that the foreign policy makers will set their policies in response to those of their own government. Therefore they certainly do not take the foreign policies as given. Then the voters and policy makers maximise the same welfare function, but subject to different constraints. This, as we will see, will lead to a difference between the optimal policies implemented by the government at the time of the Nash game and those desired by a voter with the same preferences before the elections. Voters therefore strategically delegate at the time of the elections to achieve their optimal policy in the Nash game.

Politics

Let us consider what parameters γ and θ enter the government's maximisation problem, that is, which agent is elected to the government.

We use the single-crossing property of Gans and Smart (1996) to show that the majority of voters always elect the agent preferred by the median voter. In particular, we show that if an agent prefers a higher tax rate to a lower one, than a "poorer" agent will certainly also prefer the higher tax rate, and vice versa (see Appendix 1). Then the agents' preferences satisfy the single crossing property in each country and we can use the result of Gans and Smart that a Condorcet winner exists and he represents the optimum for the median voter.

To ensure that the Condorcet winner is elected, we will make one additional assumption regarding the political process: let us assume that the election is never a single pairwise competition of candidates equally preferred by the median voter. In such a case he would be indifferent between the two candidates and they would both stand the same chance of winning. We would have an equilibrium with a random election outcome.

Rather, we have pairwise competitions between candidates, one of whom is always preferred by the median voter. Then the Condorcet winner beats any opponent. The candidate preferred by the median agent wins the election with certainty.

Small country

An infinitesimally small country on its own has no effect on the world economy. While a mass of such small countries may together affect the world equilibrium, any individual small country will necessarily take as exogenous the world net return on capital, which is equalised between the countries and actually determined endogenously within the model.

Due to international arbitrage, the net return on capital present in the economy must equal the world net return on capital, r^*, taken as given by the small country. Therefore $(1-\tau_S)\alpha k_S^{\alpha-1} = r^*$, and the amount of capital in a small country $k_S = \left(\frac{(1-\tau_S)\alpha}{r^*}\right)^{\frac{1}{1-\alpha}}$, where τ_S stands for the small-country tax rate. We will only consider symmetric equilibria, where identical countries also behave identically and therefore all small countries select the same tax rate.

A small country government maximises the total labour and capital income of and transfers received by the agent it represents; that is,

$$\max_{\tau_S} \gamma(1-\alpha)\left(\frac{(1-\tau_S)\alpha}{r^*}\right)^{\frac{\alpha}{1-\alpha}} + \tau_S\alpha\left(\frac{(1-\tau_S)\alpha}{r^*}\right)^{\frac{\alpha}{1-\alpha}} + \theta r^*.$$

Note that capital income in the case of the small country does not depend on the government's policy, because net capital return is perceived to be constant and $\theta(1-\tau)\alpha k^{\alpha-1} = \theta r^*$.

The maximisation problem yields $\tau_S = (1-\alpha)(1-\gamma)$. Since we have assumed taxes to be non-negative, the government will choose the corner solution of zero taxation whenever it cares about an agent with an above-average labour productivity.

Large country

A large country realises that its choice of capital tax rate will have an impact on the world net capital return. For example, if it decreases its capital tax rate, capital will f low into the country, but as that also implies that, given the fixed total amount of capital in the world, there will be capital outf low elsewhere, the net return on capital will also rise. Therefore it will perceive a lower elasticity of capital with respect to its tax rate than a small country, which believes the only effect of its actions to be the f low of capital (and no change in the net return on capital).

Let us for now assume that the median voter in a large country will prefer either himself or someone poorer than himself, that is, an agent with a lower value of γ, to be the policy maker. This is to simplify our subsequent optimisation problems by setting $\theta = 0$. We will later see that the median voter will indeed prefer to elect an agent with the same or smaller labour productivity.

Because the net return on capital must be equal between countries, if our large country's capital stock is k'_L and tax rate τ'_L (we will denote with primes the variables for that particular large country, for which we are performing a given calculation at the time), every other large country's capital stock can be obtained from $\alpha(1-\tau'_L)k_L'^{\alpha-1} = \alpha(1-\tau_L)k_L^{\alpha-1}$. Thus we have $k_L = k'_L\left(\frac{1-\tau_L}{1-\tau'_L}\right)^{\frac{1}{1-\alpha}}$. For small countries we already know that $k_S = \left(\frac{(1-\tau_S)\alpha}{r^*}\right)^{\frac{1}{1-\alpha}}$ and we can again express the net world return as $r^* = \alpha(1-\tau'_L)k_L'^{\alpha-1}$, therefore obtaining $k_S = k'_L\left(\frac{1-\tau_S}{1-\tau'_L}\right)^{\frac{1}{1-\alpha}}$.

Then, since the total world capital is $K^T = n + s$, we will have

$$k = \frac{K^T}{A'}, \text{ where } A' \equiv 1 + (n-1)\left(\frac{1-\tau_L}{1-\tau'_L}\right)^{\frac{1}{1-\alpha}} + s\left(\frac{1-\tau_S}{1-\tau'_L}\right)^{\frac{1}{1-\alpha}}. \tag{1}$$

Then the government maximisation problem becomes

$$\max_{\tau'_L} [\gamma(1-\alpha) + \tau'_L\alpha]\left(\frac{K^T}{A'}\right)^{\alpha},$$

which yields the first order condition

$$-\frac{A'-1}{(1-\tau'_L)(1-\alpha)}[\gamma(1-\alpha) + \tau'_L\alpha] + A' = 0. \tag{2}$$

The optimal tax rate is the solution to (2).

Note that there is a one-to-one correspondence between the type γ and the tax rate τ'_L chosen by that type, since, as we show in the Appendix, preferences of agents in large countries as a function of τ'_L are quasi-concave and have a unique maximum on the interval $(0,1)$. When we hold τ'_L constant, differentiating the LHS of (2) we have

$$\frac{\partial W}{\partial \tau'_L \partial \gamma} = -\frac{A' - 1}{(1 - \tau'_L)} < 0.$$

The desired policy τ'_L is then a decreasing function of the type γ or, in other words, more productive agents prefer less redistribution and lower tax rates.

Tax competition

Nash competition

We can now show that for two governments representing their median agent, a government in a large country will set a higher tax rate than a government in a small country. This is simply due to the fact that the small country government perceives a higher elasticity of capital with respect to the tax rate it selects than the same type of government in a large country.

Let us assume, by contradiction, that the large countries select the same tax rate as the small countries and therefore in equilibrium all states choose the tax rate $\tau = (1-\gamma)(1-\alpha)$. Then let us show that the expression on the left-hand side in (2), that is, the derivative of welfare with respect to the tax rate in large countries, is positive, and thus the optimal tax rate is higher than that in small ones. The left-hand side of (2) becomes

$$-\frac{K^T - 1}{[1-(1-\gamma)(1-\alpha)](1-\alpha)}\left[\gamma(1-\alpha) + (1-\gamma)(1-\alpha)\alpha\right] + K^T = 1,$$

which is always positive.

Since the preferences of the median agent are quasi-concave (see Appendix 2), the tax rate in the large countries is higher than in small countries if they are all run by median agents.

Elections

We are now ready to show that a large country elects a government to the left of the median agent, because the voters at the time of the elections and the government, when it sets its fiscal policy, perceive the international tax competition differently. Whereas *ex post* the government takes other countries' tax rates as given when choosing its tax policy, *ex ante* the voters realise that other countries' tax rates will respond to their own country's policy changes. Since the tax policies of the various countries are strategic complements, each agent will perceive a lower elasticity of capital with respect to the tax rate before the election than if he is in the government, deciding on the optimal fiscal policy.

We have already shown that it is the median agent who chooses the policy maker. However, in this case, he will not find it optimal to elect himself or an agent with the same preferences, since he realises that he himself would not actually implement his desired *ex ante* tax policy. Since, as we have seen above, the tax rate that is implemented in the Nash equilibrium is decreasing in the type of policy maker γ, the median agent will strategically delegate someone poorer than himself, that is, with a lower γ, if he desires a higher tax rate *ex ante* than he himself would choose in the Nash competition, and vice versa.

Therefore, since there is a one-to-one correspondence between agent type γ and his optimal *ex post* tax rate τ, we can think of the median agent wanting a certain ideal tax rate at the time of the election as him choosing the optimal policy maker to run the government. He therefore maximises his welfare with respect to the parameter γ_p' of the policy maker, where γ is his own productivity. For now, we shall assume that he will elect a poorer agent, so that we can disregard election candidates with positive holdings of capital. We then have

$$\frac{\partial W}{\partial \gamma_p'} = \frac{\partial W}{\partial \tau_L'} . \frac{d\tau_L'}{d\gamma_p'} + \frac{\partial W}{\partial \tau_L} . \frac{d\tau_L}{d\gamma_p'} = 0, \tag{3}$$

since the tax rate chosen by other large countries, τ_L, will also depend on the type of the policy maker γ_p'. That policy maker is the competitor for the other large countries and therefore influences their own policy. Remember that small countries have a constant fiscal policy.

From (3) we can then obtain

$$\frac{\partial W}{\partial \tau_L'} + \frac{\partial W}{\partial \tau_L} . \frac{d\tau_L}{d\tau_L'} = 0,$$

which is our *ex ante* first-order condition. We can also interpret it as simply the derivative of the welfare function with respect to τ_L', where the median agent realises *ex ante* (as opposed to *ex post*) that other countries' tax rates, that is, τ_L, will respond to changes in his own tax policy. The agent, once again, does not actually choose and implement the tax rate τ_L'. He views the problem before the elections and therefore takes only the types of the foreign governments (rather than their policies) as given. Then he knows what his ideal tax rate is: the tax rate τ_L' that maximises his welfare when the other countries' fiscal policies are functions of τ_L' that arise from the Nash game optimal responses. He then elects the agent, who will implement his desired τ_L'.

The *ex ante* first order condition of a large country's median agent becomes

$$\left(\frac{1-\tau_L}{1-\tau_L'}\right)^{\frac{1}{1-\alpha}} \frac{(n-1)d\tau_L/d\tau_L'}{(1-\tau_L)(1-\alpha)} \left[\gamma(1-\alpha) + \tau_L'\alpha\right] - \frac{A'-1}{(1-\tau_L')(1-\alpha)} \left[\gamma(1-\alpha) + \tau_L'\alpha\right] + A' = 0. \tag{4}$$

Here, $d\tau_L/d\tau_L'$ is, once again, the response of any other large country's policy to a change in the tax rate of that large country, for which (4) holds. Since the response occurs when the Nash policy game is played, we can obtain $d\tau_L/d\tau_L'$ from (2), since that condition holds for any large country.

To determine $d\tau_L/d\tau_L'$ that holds for all $n-1$ large countries responding to a change in $d\tau_L'$ we first need to calculate the response of a particular large country from that group. Let us say that that particular large country responding to changes in τ_L' sets a tax rate τ_L'' and has a policy maker γ_p''. The rest of the world is populated by the remaining $n-2$ large countries, which set a tax rate τ_L, and a mass s of small countries which choose their policy rate τ_S.We can re-write the left-hand side of (2) for the particular large country that sets τ_L'' with a policy maker γ_p'',facing both the large country that sets τ_L', for which (4) is written, and the other $n-2$ large countries, which set a tax rate τ_L. We then have

$$\begin{aligned} F \;\; \equiv \;\; & -\left[1 + (n-2)\left(\frac{1-\tau_L}{1-\tau_L''}\right)^{\frac{1}{1-\alpha}} + \left(\frac{1-\tau_L'}{1-\tau_L''}\right)^{\frac{1}{1-\alpha}} + s\left(\frac{1-\tau_S}{1-\tau_L''}\right)^{\frac{1}{1-\alpha}}\right] . \\ & .\left[(\gamma - \Delta\gamma)(1-\alpha) + \tau_L''\alpha - (1-\tau_L'')(1-\alpha)\right] + (\gamma - \Delta\gamma)(1-\alpha) + \tau_L''\alpha, \end{aligned} \tag{5}$$

where $\Delta\gamma \equiv \gamma - \gamma_p''$ is the left-ward shift of the government with preferences γ_p''

Of course, the $n-2$ large countries that set τ_L will also respond to a change in τ_L'.Since all large countries are identical, their response will be identical. The median agent in the country selecting τ_L' who is solving (4) realises that τ_L and τ_L'' are chosen by identical large countries and therefore $\tau_L = \tau_L''$ as well as response in τ_L is identical to the response in τ_L'', that is, $d\tau_L/d\tau_L' = d\tau_L''/d\tau_L'$.

Then we have

$$0 = dF/d\tau_L' = \partial F/\partial\tau_L' + \partial F/\partial\tau_L.d\tau_L/d\tau_L' + \partial F/\partial\tau_L''.d\tau_L''/d\tau_L',$$

which implies

$$d\tau_L/d\tau_L' = d\tau_L''/d\tau_L' = -\frac{\partial F/\partial\tau_L'}{\partial F/\partial\tau_L + \partial F/\partial\tau_L''}. \tag{6}$$

This leads to, when we incorporate the fact that $\tau_L = \tau_L''$,

$$\frac{d\tau_L}{d\tau_L'} = \left(\frac{1-\tau_L'}{1-\tau_L}\right)^{\frac{1}{1-\alpha}} \left[(A+1-n)\left(\frac{1-\tau_L'}{1-\tau_L}\right) + \frac{(1-\tau_L')(A-\alpha)}{\left[\gamma_p + \frac{\tau_L\alpha}{1-\alpha} - (1-\tau_L)\right]}\right]^{-1},$$

where

$$A = n-1+\left(\frac{1-\tau_L'}{1-\tau_L}\right)^{\frac{1}{1-\alpha}} + s\left(\frac{1-\tau_S}{1-\tau_L}\right)^{\frac{1}{1-\alpha}}.$$

A here is evaluated from the point of view of the country choosing τ_L'. From (2) we also have

$$\gamma_p + \frac{\tau_L\alpha}{1-\alpha} = \frac{A(1-\tau_L)}{(A-1)},$$

which we can substitute into the former to obtain

$$d\tau_L/d\tau_L' = \left(\frac{1-\tau_L'}{1-\tau_L}\right)^{\frac{1}{1-\alpha}-1} \left[(A+1-\alpha)(A-1)-(n-2)\right]^{-1}. \tag{7}$$

We can see that, since $A \geq n-1$, we will have $d\tau_L/d\tau_L' > 0$. The tax rates are strategic complements.

Then for any tax rate that satisfies (2), the expression in left-hand side of (4) will be positive, which, since preferences are quasi-concave, implies that the *ex ante* optimal tax rate will be higher than the *ex post* optimal tax rate. The median voter will therefore indeed want to elect an agent to the left of himself, that is, with a smaller parameter γ, in order to achieve his *ex ante* desired tax policy.

Thus large countries will have higher tax rates than their smaller competitors for two reasons: the economic equilibrium implies that even if they have governments with identical preferences, the one in the large country will select a higher tax rate. Moreover, since individual small countries do not affect the world equilibrium and therefore do not induce any fiscal response by changing their own policies (that is, $d\tau_L/d\tau_S = 0$), the above mechanism does not apply to them and they elect median types to run the government. But then the large countries will have governments to the left of those in the small countries. Such more left-wing governments would set higher taxes even in small countries. Therefore in each large country the economic and political reasons combine to produce taxes above small-country levels.

Composition of competitors and political shifts

Small countries and the shift to the right

We now show that if a large country faces competition from a relatively larger number of small countries, its government will be more right-wing. We proceed by performing a comparative static exercise where we increase the total size of small countries (their total mass) s and decrease the number of large countries n so as to keep $K^T = n + s$ constant. The size of the world is held constant so that we can determine the political impact of competing with relatively more small countries, as separate from the effect of simply competing with a higher number of countries. A competition between more countries alone, small or large, can cause a right-ward shift in the governments of large countries, therefore we want to demonstrate our result net of this impact. We will be comparing symmetric equilibria, therefore, once again, all large countries' tax rates will be equal to each other.

Remember that $\Delta\gamma$ is the difference in productivity between the median agent and the agent elected to the government in a large country, so that large country governments maximise for an agent with parameter $\gamma_p = \gamma - \Delta\gamma$. In equilibrium, γ_p will be the same for all large countries. We want to show that the equilibrium value of $\Delta\gamma$ decreases as s increases.

We begin by showing that the equilibrium tax rate in large countries decreases when the mass of small countries increases (once again, the tax rate in small countries remains unchanged). First, we can rewrite (4) in a symmetric equilibrium as $0 = G(\tau_L, s)$, where

$$\begin{aligned} G(\tau_L, s) \;\equiv\; & \frac{(n-1)\left[\gamma(1-\alpha)+\tau_L\alpha\right]}{(1-\tau_L)(1-\alpha)\left[(A+1-\alpha)(A-1)-(n-2)\right]} + \\ & + A\left(1-\frac{\gamma(1-\alpha)+\tau_L\alpha}{(1-\tau_L)(1-\alpha)}\right)+\frac{\gamma(1-\alpha)+\tau_L\alpha}{(1-\tau_L)(1-\alpha)}. \end{aligned} \tag{8}$$

$G(\tau_L, s)$ is simply the *ex ante* derivative of the welfare function with respect to the country's own tax rate τ_L', evaluated at the point $\tau_L' = \tau_L$.

By implicit function theorem, we have

$$\frac{\partial \tau_L}{\partial s} = -\frac{\partial G(\tau_L, s)/\partial s}{\partial G(\tau_L, s)/\partial \tau_L}.$$

We show in Appendix 3 that $\partial G(\tau_L, s)/\partial s < 0$ and $\partial G(\tau_L, s)/\partial \tau_L < 0$, therefore $\partial \tau_L/\partial s < 0$: The equilibrium large-country tax decreases when s increases.

When we write (2) for γ_p, we obtain

$$\Delta\gamma = \gamma + \frac{\tau_L\alpha}{1-\alpha} - \frac{A(1-\tau_L)}{(A-1)}. \tag{9}$$

Differentiating with respect to s, realising that both τ_L and A are functions of s, gives

$$\partial\Delta\gamma/\partial s = \frac{\alpha(\partial\tau_L/\partial s)}{1-\alpha} - \frac{\left[(\partial A/\partial s)(1-\tau_L) - A(\partial\tau_L/\partial s)\right](A-1) - (\partial A/\partial s)A(1-\tau_L)}{(A-1)^2}$$

Let us proceed by contradiction: we want to show that $\partial\Delta\gamma/\partial s < 0$, therefore we will assume that $\partial\Delta\gamma/\partial s > 0$, that is,

$$(\partial\tau_L/\partial s)\left(\frac{\alpha}{1-\alpha}+\frac{A}{A-1}\right) + (\partial A/\partial s)\frac{1-\tau_L}{A-1} > 0. \tag{10}$$

Since $\partial\tau_L/\partial s < 0$, (10) can only possibly hold if $\partial A/\partial s > 0$ holds.

However, combining (2) and (4), we have

$$\Delta\gamma = \frac{(n-1)\left[\gamma(1-\alpha)+\tau_L\alpha\right]}{(A-1)(1-\alpha)\left[(A+1-\alpha)(A-1)-n+2\right]}$$

Here,

$$\begin{aligned}\frac{\partial\Delta\gamma}{\partial s} &= -\frac{\left[\gamma(1-\alpha)+\tau_L\alpha\right]-(\partial\tau_L/\partial s)(n-1)\alpha}{(1-\alpha)(A-1)\left[(A+1-\alpha)(A-1)-n+2\right]} - \\ &\quad -\frac{(n-1)\left[\gamma(1-\alpha)+\tau_L\alpha\right]\left[A-1+(\partial A/\partial s)\left[(3A+1-2\alpha)(A-1)-n+2\right]\right]}{\left[(A-1)\left[(A+1-\alpha)(A-1)-n+2\right]\right]^2} \qquad (11)\end{aligned}$$

If, as we concluded above, $\partial A/\partial s > 0$, then we necessarily arrive at $\partial\Delta\gamma/\partial s < 0$, which is a contradiction. Therefore we have shown that in fact $\partial\Delta\gamma/\partial s < 0$.

Therefore as s increases, power in large countries will be strategically delegated to an agent closer to the median agent's type, that is, we will not need as low a value of γ to satisfy (2) at the optimal tax rate from (4). Large countries will elect more right-wing governments (even though still to the left of the median and of the governments of the small countries) when they face proportionally more competition from small countries than otherwise.

More competitors: small countries

In practice we can rarely compare two instances of tax competition where in one of the cases we replace large countries with small countries. Rather, we can observe additional small countries joining the competition. We have already noted that increased competition alone can drive governments to the right. Here, that effect combines with the one we described in the previous section. Therefore our preceding result suggests that additional small countries in the tax competition will also shift the large country policy maker type to the right. We want to nevertheless verify formally that this change occurs when s increases and we keep n constant.

As in the previous section, we show in Appendix 3 that $\partial G(\tau_L, s)/\partial s < 0$, therefore $\partial\tau_L/\partial s < 0$. Therefore simply increasing the mass of small countries also decreases the equilibrium tax rate in the large countries.

We still need $\partial A/\partial s > 0$ for (10) to hold. Since (11) becomes

$$\begin{aligned}\frac{\partial\Delta\gamma}{\partial s} &= \frac{(\partial\tau_L/\partial s)(n-1)\alpha}{(1-\alpha)(A-1)\left[(A+1-\alpha)(A-1)-n+2\right]} - \\ &\quad -\frac{(n-1)\left[\gamma(1-\alpha)+\tau_L\alpha\right](\partial A/\partial s)\left[(3A+1-2\alpha)(A-1)-n+2\right]}{\left[(A-1)\left[(A+1-\alpha)(A-1)-n+2\right]\right]^2}\end{aligned}$$

there is once again a contradiction, because the above implies that $\partial\Delta\gamma/\partial s < 0$ when $\partial A/\partial s > 0$.

Therefore our result from the previous section holds: governments in large countries shift to the right when additional small countries join the tax competition.

More competitors: large countries

A similar condition does not hold in general when we increase the number of large countries competing for capital. We already know that when we simply increase the proportion of large countries in the tax competition, while keeping the size of the world constant, their governments will actually move to the left of the political spectrum. This is a corollary of our result that decreasing the proportion of small countries moves the governments to the left. Clearly, when the size of the world is constant, a smaller proportion of small countries necessarily means a higher proportion of large ones and vice versa. Now we consider the implication of simply adding new large countries into the game, keeping s constant.

While the algebra of the model does not permit us to find an explicit solution to the problem, we can show that when no small countries are present, increasing the number of large countries will shift the large-country governments to the right. Only the economic effect of increased tax competition is present and the subsequent lower equilibrium taxes are going to cause a right-ward shift in governments.

However, in general the effect of increasing n is ambiguous and depends on s. When small countries are present, large countries joining the competition have a political effect as well: they will respond to the policy changes of other large countries in the Nash game. In our model, this is the reason why large countries elect governments to the left of the median. Additional large countries when small countries are present then imply a higher proportion of a large country's competitors being "responsive". This effect then causes the median voters to strategically delegate further to the left of themselves. There is a minimum mass of small countries in the competition (a mass comparable in size to the total size of large countries involved), for which the political effect dominates and additional large countries will cause a move to the left. Therefore the effect of more large countries involved in a tax competition depends on the composition of existing competitors and can actually be opposite to that of an increase in the mass of small countries competing for capital.

Let us begin by considering the case when $s = 0$ to demonstrate that when no small countries are competing for capital with large ones, additional large countries will always cause a shift to the right in the policy maker elected. In equilibrium (4) becomes

$$H \equiv \frac{(n-1)\left[\gamma(1-\alpha)+\tau_L\alpha\right]}{(1-\tau_L)(1-\alpha)\left[(n+1-\alpha)(n-1)-(n-2)\right]} + n - (n-1)\frac{\gamma(1-\alpha)+\tau_L\alpha}{(1-\tau_L)(1-\alpha)} = 0. \quad (12)$$

Here, we can express τ_L explicitly, namely it is

$$\tau_L = \frac{n(1-\alpha)[(n+1-\alpha)(n-1)-(n-2)] - (n-1)^2(n-\alpha)(1-\alpha)\gamma}{n(1-\alpha)[(n+1-\alpha)(n-1)-(n-2)] + \alpha^2(n-1)^2(n-\alpha)}.$$

We can substitute the above into (9) and then differentiate it with respect to n to obtain an explicit expression for $\frac{\partial\Delta\gamma}{\partial n}$. We then find that $\frac{\partial\Delta\gamma}{\partial n} < 0$ for all $n > \frac{1+\sqrt{1+8\alpha}}{4}$. The latter expression attains a maximum value of 1 as a function of $\alpha \in (0,1\rangle$ (the possible values of parameter α), which means that $\frac{\partial\Delta\gamma}{\partial n} < 0$ for all $n > 1$.

Therefore when no small countries are participating in the tax competition, additional large countries will cause a shift in the governments of the original competitors to the right - as well as decrease the tax rate in each of those countries. There is no political effect present here: for a given large country, when it is competing solely with other large countries, more competitors do not represent an increase in the proportion of countries that respond to its policy changes in the Nash game.

However, when $s > 0$, the situation changes. G defined in (8) is now a function of τ_L and n. We still have that $\partial G(\tau_L, n)/\partial\tau_L < 0$, therefore $\partial\tau_L/\partial n > 0$ whenever $\partial G(\tau_L, n)/\partial n > 0$. We can obtain that, holding the equilibrium tax rate constant,

$$\partial G(\tau_L, n)/\partial n > 0 \Leftrightarrow A^2 - \alpha A - 2An - 2A + 2\alpha + \alpha n + 2 + \left[\frac{\gamma(1-\alpha) + \tau_L\alpha}{(1-\tau_L)(1-\alpha)} - 1\right] > 0. \quad (13)$$

Since we know from (4) that $-1 < \frac{\gamma(1-\alpha)+\tau_L\alpha}{(1-\tau_L)(1-\alpha)} - 1 < 0$, (13) will hold whenever

$$-n^2 + \overline{s}^2 - 2n - (2+\alpha)\overline{s} + 2\alpha + 1 > 0,$$

where $\overline{s} \equiv s\left(\frac{1-\tau_S}{1-\tau_L}\right)^{\frac{1}{1-\alpha}}$. The only non-negative solution to the corresponding quadratic equation for $\overline{s}$ is

$$\overline{s} = \frac{2 + \alpha + \sqrt{4n^2 + 8n - 4\alpha + \alpha^2}}{2}.$$

This value is of the same order of magnitude as n (given that $n \geq 2$). Moreover, as n increases, $\overline{s}$ approaches $n + 2 + \alpha/2$.

Therefore $\partial G(\tau_L, n)/\partial n > 0$, and thus equilibrium large-country tax rate increases when n rises, for all $\overline{s} \in \left(\frac{2+\alpha+\sqrt{4n^2+8n-4\alpha+\alpha^2}}{2}, \infty\right)$. The actual mass of small countries s is in fact always smaller than $\overline{s}$, since $\left(\frac{1-\tau_S}{1-\tau_L}\right)^{\frac{1}{1-\alpha}} > 1$, because, as we have already shown, $\tau_S < \tau_L$.

Therefore for any number of large countries n, when there is a sufficiently large mass of small countries competing with them, additional large countries in the competition will increase the equilibrium tax rate adopted by large countries. That mass of small countries is comparable to the total mass of large countries.

Then differentiating (9) with respect to n, realising that τ_L is a function of n, gives us

$$\frac{\partial \Delta\gamma}{\partial n} = (\partial\tau_L/\partial n)\left(\frac{\alpha}{1-\alpha} + \frac{A}{A-1}\right) + \left(1 + s\left(\frac{1-\tau_S}{1-\tau_L}\right)^{\frac{1}{1-\alpha}} \frac{(\partial\tau_L/\partial n)}{(1-\alpha)(1-\tau_L)}\right)\frac{(1-\tau_L)}{(A-1)^2}.$$

Then we have that $\frac{\partial\Delta\gamma}{\partial n} > 0$ certainly holds whenever $\partial\tau_L/\partial n > 0$. Thus by showing that when a minimum number of small countries is present in the competition, additional large countries will increase the equilibrium large-country tax rate means we have also shown that the large-country governments will shift to the left. It is important to note that the tax rate increasing is a sufficient, not a necessary condition for the left-ward shift of elected policy maker. Therefore there is yet another reason (apart from the fact that $\overline{s} > s$), for which we may observe that additional large countries do not cause a right-ward shift in governments of large countries even for values of $s < \frac{2+\alpha+\sqrt{4n^2+8n-4\alpha+\alpha^2}}{2}$.

A higher number of large countries competing for capital will therefore not necessarily have the same effect as a larger mass of small countries: the large countries only have the "right-wing power" as long as no or relatively few small countries are present. Otherwise, the political effect of additional large countries takes over: a significantly higher fraction of a large country's competitors becomes responsive to its policy changes, so that the country's median voter will elect a more left-wing government. More competition in the form of more large countries will then cause a leftward rather than a rightward shift in the governments of large countries.

A policy example: tax cooperation and minimum tax

As a policy exercise in the context of our model, it is interesting to consider proposals for tax harmonisation and, in particular, a minimum tax rate rule in the European Union. Immediately upon the enlargement of the Union in 2004, the German Chancellor Schroeder and subsequently the French finance minister Sarkozy criticised the low corporate tax rates in the new countries as tax dumping. They in fact accused the new entrants of intentions to finance parts of their budgets through EU transfers from the old and richer members, rather than through tax revenue. The politicians suggested that while some level of tax competition was desirable, the new members of the bloc were simply lowering their corporate tax rates too far and therefore a minimum tax rate rule should be imposed in the Union. While these suggestions did not translate into actual policy actions, ongoing work towards a fiscal compact within the eurozone and the wider EU may also lead to renewed calls for tax harmonisation.

In this section, we demonstrate that in our model such a change would always improve the welfare for the median agents in the large countries. More interestingly, we also show that provided that the total mass of small countries is not too small, median agents in those countries would also benefit from a minimum tax rule - even though they themselves would individually oppose it.

The literature on tax cooperation and tax harmonisation is almost as rich as the literature on tax competition itself. The research thus far has not arrived at any conclusive results. Rather, depending on the assumptions made, cooperation may be harmful or beneficial. In a set-up such as ours, but with homogeneous countries, tax harmonisation would clearly increase welfare of the median agents.[3]

However, if we redefined government as maximising public spending rather than welfare of a particular agent, tax competition can limit wasteful spending through limiting the amount of revenue the government can collect. Edwards and Keen (1996) provide a treatment of the issue and consider intermediate types of government. Also, Kehoe (1989) demonstrates that coordination is undesirable when tax competition helps solve governments' credibility problems. More recently, Brueckner (2001) shows that for a particular type of tax cooperation taxes may actually decrease and therefore welfare can fall relative to free tax competition.

Moreover, while some level of cooperation may indeed be desirable, it can be difficult to implement. In particular, one would need either institutions powerful enough to prevent individual governments from deviating in their policy from the cooperative equilibrium levels, or incentives that would render such deviations undesirable. Also, full tax cooperation may be problematic, especially when tax competition occurrs between a larger number of countries, due to the complexity of the decision process that is the real-world equivalent of maximising the weighted sum of welfares of the respective countries.

For both of the above reasons, here we shall simply evaluate, in the context of our model, a particular and easily implementable form of tax cooperation[4] that has been suggested in direct relation to the subject discussed above - namely the one proposed by the German and French policy makers.

[3] If the competing countries were identical, they would all set the same tax rate in equilibrium and they would all have the same amount of capital per capita in the economy. Therefore with full tax harmonisation, they would retain the same amount of capital, but would be able to set a much higher tax rate. In fact, since supply of capital would be inelastic, all countries would tax away all capital income. This would increase lump-sum transfers to median agents and thus their welfare, since they do not own any capital.

[4] Here we suggest that the mechanism for tax cooperation is easily implementable once approved. Of course, under the current EU rules, dissent by a single member of the Union would preclude such an approval – and later in this section we show that small countries would indeed dissent.

The large (and rich) countries would select a minimum corporate tax rate for all the members of the Union. It would be the tax rate that the large countries would set in a tax competition, however, it would be binding on the small countries, which, in a purely competitive environment, would choose lower rates. Therefore no implementation mechanism would be necessary for the large countries. The small countries, on the other hand, would require an incentive not to deviate and decrease their corporate tax rates. Given that for the forseeable future these countries are mostly net recipients of transfers from the EU budget, that is, indirectly mostly from the large, wealthy countries, making the transfers conditional upon sufficiently high a tax rate could provide such an incentive. While requiring independent countries to render any payments whenever they amend their tax policy in a certain manner may be unenforceable, simply reducing the size of payments they are due in the first place certainly is very implementable.

We now want to investigate the welfare impact of such a minimum tax in the large and small countries. Of course, the impact on the welfare of entire countries would depend on the weights we would place on the various agents and on the distribution of productivities and endowments among these agents. Therefore for simplicity we shall only consider the welfare of the median agents.

Median agents in the large countries would be unequivocally better off under a minimum tax rate rule. First, since we start from a point, where $\tau_L > \tau_S$, we also have $k_L < k_S$. There is less capital per capita in the large countries. Once all countries tax capital at the same rate, $k_L = k_S = 1$, that is, capital moves from small countries to the large ones. From (4) we know that when τ_S increases and thus A decreases for any given tax rate in the large countries, the derivative of the welfare function becomes positive. Since preferences of the median agent are quasi-concave, this implies that τ_L will be higher in all large countries in the new equilibrium. Therefore the minimum tax rate the large countries will want to establish will be in fact higher than their own prevailing tax rate under an unconstrained tax competition that includes a positive mass of small countries.

More importantly, though, it means that the minimum tax rule will bring both a higher tax rate and more capital per capita in the large countries, thus increasing wages and transfers, thereby resulting in a higher level of welfare for the median agents. The median voters in those countries will therefore always support a minimum tax rate rule of the form described above.

The impact on the median agents in the small countries is slightly more complicated. Clearly, the only reason for small countries in our model to select a lower tax rate is that they, each on their own, do not affect the world equilibrium net return on capital. This effect works directly and indirectly - through the small countries electing governments to the right of those in large countries. However, a mass s of small countries does impact the world equilibrium and therefore a social planner maximising median-agent welfare for all small countries can improve on that welfare by taking this into account. Let us therefore compare the tax rate this planner would choose with the tax rate large countries would like to impose on the small countries. Given the quasi-concavity of preferences, once we show that the planner would select a tax rate higher than the minimum tax rate required by the large countries, we will know that the median agents in the small countries would be better off under a minimum tax rate rule than when left to compete for capital freely.[5]

When $s = 0$, this social planner would perform the same maximisation as individual small-

[5]This is simply because the social planner's tax rate is the unique maximum of the small country median agents' utility function. If the minimum tax rate is lower than the social planner's tax rate, then the former is associated with a point on the increasing portion of the utility fuction. Since the minimum tax rate is higher than the small-country tax rate that arises in a country-competitive environment, the utility associated with the latter tax rate is also on the increasing portion of the utility function but below the utility associated with the minimum tax rate.

country governments. Therefore at zero total mass of small countries, those countries are necessarily worse off at a higher tax rate imposed by the large countries.

When $s > 0$, we can write the planner's first-order condition similarly to (4), that is,

$$\left[\left(\frac{1-\tau_L}{1-\tau_S}\right)^{\frac{1}{1-\alpha}} \frac{n(\partial\tau_L/\partial\tau_S)}{(1-\tau_L)(1-\alpha)} - \frac{A_S - s}{(1-\tau_S)(1-\alpha)}\right][\gamma(1-\alpha)+\tau_S\alpha] + A_S = 0, \tag{14}$$

where

$$A_S \equiv n\left(\frac{1-\tau_L}{1-\tau_S}\right)^{\frac{1}{1-\alpha}} + s.$$

The response of large countries to a cooperative mass of small countries in the above is a modified version of (7), that is,

$$\partial\tau_L/\partial\tau_S = s\left[(A_L + 1 - \alpha)(A_L - 1) - (n-1)\right]^{-1},$$

where A_L is analogous to the one defined in (1).

The FOC of large countries depends on how they perceive the minimum tax rule. Since we want to show that a planner for the small countries prefers a higher tax than that imposed on the small countries by their large counterparts, let us consider the more "constraining" option that results in a higher tax rate selected by the large countries: we shall assume that any particular large country believes that a response by other large countries to its own policy will induce the same change in the minimum tax rule and therefore an equal increase or decrease in the small country tax rate. Mathematically, this implies that the modified FOC for the large countries is

$$\begin{aligned} 0 = & \left[\left(\frac{1-\tau_S}{1-\tau'_L}\right)^{\frac{1}{1-\alpha}} \frac{s(\partial\tau_S/\partial\tau'_L)}{(1-\tau_S)(1-\alpha)} + \left(\frac{1-\tau_L}{1-\tau'_L}\right)^{\frac{1}{1-\alpha}} \frac{(n-1)(\partial\tau_L/\partial\tau'_L)}{(1-\tau_L)(1-\alpha)} - \frac{A_L - 1}{(1-\tau'_L)(1-\alpha)}\right] \cdot \\ & [\gamma(1-\alpha)+\tau'_L\alpha] + A_L, \end{aligned} \tag{15}$$

where we have not only $\tau_S = \tau_L$, but also

$$\partial\tau_S/\partial\tau'_L = \partial\tau_L/\partial\tau'_L = \left[(A_L + 1 - \alpha)(A_L - 1) - (n-2) - s\right]^{-1}.$$

We can see that $\partial\tau_L/\partial\tau'_L < \partial\tau_L/\partial\tau_S$ whenever

$$(s-1)\left[(A_L + 1 - \alpha)(A_L - 1) - (n-1) - s\right] > 0.$$

This always holds as long as $s > 1$.

Let us see what the sign is of the derivative of the welfare function for the planner for small countries when countries are in an equilibrium where $\tau_S = \tau_L$ is imposed upon the small countries. (15) holds and therefore (14) simplifies to

$$\partial W/\partial\tau_S = (s-1)(1 - \partial\tau_L/\partial\tau'_L) + n(\partial\tau_L/\partial\tau_S - \partial\tau_L/\partial\tau'_L).$$

Since $\partial\tau_L/\partial\tau'_L < \partial\tau_L/\partial\tau_S$ and $\partial\tau_L/\partial\tau'_L < 1$ for $s > 1$, for total masses of small countries greater than one we will have $\partial W/\partial\tau_S > 0$.

Therefore, since his preferences are quasi-concave, the planner for the mass of small countries will ideally desire a tax rate higher than that imposed upon the small countries by the large ones under our minimum-tax rule. Then he will prefer the minimum tax to the tax chosen by the individual small countries in a free tax competition, since the latter is lower than the former.

Thus small countries are also better off under the minimum-tax regime we have described, provided their total mass is equal or greater than that of a single large country. Since no planner exists that would force them to adopt a higher tax rate that would maximise their total welfare (that is, there is no mechanism to induce a cooperation between the small countries in the face of competition from their large counterparts), they will certainly not want to voluntarily join such a regime and will voice their opposition to it - just as the real-world new entrants to the EU have in 2004 and since then. However, the regime would improve the welfare of all parties concerned (or, at the very least, of the median agent in each country). Our model then suggests that since the potential enforcement mechanism - the transfers to poorer members, who also happen to be small - already exists, the Union might want to try setting a minimum corporate tax rate for its members despite disagreement from some of them, as difficult as that might be under the current voting rules of the EU.

Extensions

Small countries with positive size

Our assumption of infinitesimally small countries competing with large countries may not seem particularly realistic, however, it yields a very plausible premise in our model - that small countries do not consider their impact on the world (or, specifically, on the group of countries, with which they most directly compete for capital). The new small entrants to the EU almost certainly do not take into account any effect on the EU equilibrium at all when making their individual tax-rate decisions. This results in the small countries in our model always electing the median agent to represent them, rather than a government to the left of the median as is the case in large countries.

However, in conjunction with the standard (and algebraically manageable) Cobb-Douglas function, the assumption of infinitesimal size of small countries results in a constant tax rate implemented by them. That is, they do not react to changes in the competition-area equilibrium by modifying their tax policies. This in turn implies that the difference between the *ex ante* and *ex post* tax rate for the large countries will be smaller than in a more general case where small-country tax rate depends on the equilibrium net return on capital. In a Cobb-Douglas production function environment, only other large countries respond to a change in the tax policy of a particular large country with an increase or decrease of their own corporate tax rates. Small countries do not respond at all.

To verify that our results hold in a more general setting whose assumptions do not imply the above simplifications, we want to modify our model so that each individual small country will have a positive size. First, these countries will understand that modifying their own tax rate will alter the world net return on capital. Therefore they will perceive a lower elasticity of capital with respect to their tax rate than infinitesimally small countries. Still, though, since they are smaller than their large competitors, their impact on the world equilibrium is not as significant, the elasticity of capital is therefore larger and thus also their tax rates are smaller than those implemented by the large countries. Similarly, because their tax policy modifications induce a smaller response in other countries, small and large, than a policy change by large countries, they will have a smaller disparity between the median agent's *ex ante* and *ex post* optimal tax rates. This in turn will spell a government to the right of those elected in large countries.

Second, when large countries compete with proportionately more small countries (or additional small countries enter the tax competition), their governments will still shift to the right. The small countries' lower tax rates will induce a decrease in the rates of the large countries, which will in turn reduce the difference between the desired *ex ante* and *ex post* tax rates by the median agents in those countries.

All of the above is difficult to show algebraically, therefore we will rely on a computational solution for a selected calibration of the model in order to verify that our results hold. First, we have to modify the two first-order conditions that define our symmetric equilibrium. The median agents in the small countries will *ex ante* desire the tax rate that satisfies

$$0 = G_S \equiv \left[\left(\frac{1-\tau_S}{1-\tau'_S}\right)^{\frac{1}{1-\alpha}} \frac{(s-\sigma)(\partial\tau_S/\partial\tau'_S)}{(1-\tau_S)(1-\alpha)} + \left(\frac{1-\tau_L}{1-\tau'_S}\right)^{\frac{1}{1-\alpha}} \frac{n(\partial\tau_L/\partial\tau'_S)}{(1-\tau_L)(1-\alpha)} - \frac{A_S-1}{(1-\tau'_S)(1-\alpha)}\right] \cdot [\gamma(1-\alpha)+\tau'_S\alpha] + A_S, \tag{16}$$

where

$$A_S \equiv \sigma + n\left(\frac{1-\tau_L}{1-\tau'_S}\right)^{\frac{1}{1-\alpha}} + (s-\sigma)\left(\frac{1-\tau_S}{1-\tau'_S}\right)^{\frac{1}{1-\alpha}},$$

s is still the total mass of small countries and $\sigma < 1$ is the size of each individual small country. In the large countries it will be

$$0 = G_L \equiv \left[\left(\frac{1-\tau_S}{1-\tau'_L}\right)^{\frac{1}{1-\alpha}} \frac{s(\partial\tau_S/\partial\tau'_L)}{(1-\tau_S)(1-\alpha)} + \left(\frac{1-\tau_L}{1-\tau'_L}\right)^{\frac{1}{1-\alpha}} \frac{(n-1)(\partial\tau_L/\partial\tau'_{:L})}{(1-\tau_L)(1-\alpha)} - \frac{A_L-1}{(1-\tau'_L)(1-\alpha)}\right] \cdot [\gamma(1-\alpha)+\tau'_L\alpha] + A_L, \tag{17}$$

where A_L is analogous to the one defined in (1). The derivative pairs $\partial\tau_S/\partial\tau'_S$ and $\partial\tau_L/\partial\tau'_S$, as well as $\partial\tau_S/\partial\tau'_L$ and $\partial\tau_L/\partial\tau'_{:L}$ will now each be solutions to systems of two linear equations.

As before, we note that while $\partial\tau_S/\partial\tau'_L$ and $\partial\tau_L/\partial\tau'_{:L}$ will be all small and large countries', respectively, response to a change in a particular large country's tax rate $\tau'_{:L}$ in a symmetric equilibrium, to determine the derivatives, which represent individual countries' responses, we must focus on the reaction of a particular large country with tax rate $\tau''_{:L}$ and a particular small country with tax rate $\tau''_{:S}$. We therefore rewrite the large and small country *ex post* FOCs for such a particular large country with tax τ''_L and such a particular small country with tax τ''_S, separating in both FOCs the large country with tax τ'_L from the remaining large countries. Then we obtain, similarly to (5),

$$0 = F_L \equiv -\left[1+(n-2)\left(\frac{1-\tau_L}{1-\tau''_L}\right)^{\frac{1}{1-\alpha}} + \left(\frac{1-\tau'_L}{1-\tau''_L}\right)^{\frac{1}{1-\alpha}} + s\left(\frac{1-\tau_S}{1-\tau''_L}\right)^{\frac{1}{1-\alpha}}\right] \cdot [(\gamma-\Delta\gamma_L)(1-\alpha)+\tau''_L\alpha-(1-\tau''_L)(1-\alpha)] + (\gamma-\Delta\gamma_L)(1-\alpha)+\tau''_L\alpha,$$

and

$$0 = F_S \equiv -\left[\sigma+(n-1)\left(\frac{1-\tau_L}{1-\tau''_S}\right)^{\frac{1}{1-\alpha}} + \left(\frac{1-\tau'_L}{1-\tau''_S}\right)^{\frac{1}{1-\alpha}} + (s-\sigma)\left(\frac{1-\tau_S}{1-\tau''_S}\right)^{\frac{1}{1-\alpha}}\right] \cdot [(\gamma-\Delta\gamma_S)(1-\alpha)+\tau''_S\alpha-(1-\tau''_S)(1-\alpha)] + (\gamma-\Delta\gamma_S)(1-\alpha)+\tau''_S\alpha.$$

Here we realise that both large and small country governments will be to the left of the median agent, however, not by the same amount. Therefore we call the difference in the productivity parameter between the median agent and the government he elects $\Delta\gamma_L$ in a large country and $\Delta\gamma_S$ in a small country. Once again, this is assuming a symmetric equilibrium where all countries of the same size have the same government.

The left-ward shift in a small country is the solution to the equation

$$\begin{aligned}\Delta\gamma_S &= \left[\left(\frac{1-\tau_S}{1-\tau'_S}\right)^{\frac{1}{1-\alpha}}\frac{(s-\sigma)(\partial\tau_S/\partial\tau'_S)}{(1-\tau_S)(1-\alpha)}+\left(\frac{1-\tau_L}{1-\tau'_S}\right)^{\frac{1}{1-\alpha}}\frac{n(\partial\tau_L/\partial\tau'_S)}{(1-\tau_L)(1-\alpha)}\right]. \\ &\quad .\left[\gamma(1-\alpha)+\tau'_S\alpha\right](1-\tau'_S)(A_S-1)^{-1}, \qquad (18)\end{aligned}$$

whereas in a large country it is

$$\begin{aligned}\Delta\gamma_L &= \left[\left(\frac{1-\tau_S}{1-\tau'_L}\right)^{\frac{1}{1-\alpha}}\frac{s(\partial\tau_S/\partial\tau'_L)}{(1-\tau_S)(1-\alpha)}+\left(\frac{1-\tau_L}{1-\tau'_L}\right)^{\frac{1}{1-\alpha}}\frac{(n-1)(\partial\tau_L/\partial\tau'_{:L})}{(1-\tau_L)(1-\alpha)}\right]. \\ &\quad \left[\gamma(1-\alpha)+\tau'_L\alpha\right](1-\tau'_L)(A_L-1)^{-1}, \qquad (19)\end{aligned}$$

Then, as in (6), we have

$$d\tau_L/d\tau'_L = -\frac{\partial F_L/\partial\tau'_L+\partial F_L/\partial\tau_S.d\tau_S/d\tau'_L}{\partial F_L/\partial\tau_L+\partial F_L/\partial\tau''_L}$$

and

$$d\tau_S/d\tau'_L = -\frac{\partial F_S/\partial\tau'_L+\partial F_S/\partial\tau_L.d\tau_L/d\tau'_L}{\partial F_S/\partial\tau_S+\partial F_S/\partial\tau''_S}.$$

Solving this system of equations, we obtain

$$d\tau_L/d\tau'_L = \frac{(\partial F_L/\partial\tau'_L)(\partial F_S/\partial\tau_S+\partial F_S/\partial\tau''_S)-(\partial F_S/\partial\tau'_L)(\partial F_L/\partial\tau_S)}{(\partial F_S/\partial\tau_L)(\partial F_L/\partial\tau_S)-(\partial F_L/\partial\tau''_L+\partial F_L/\partial\tau_L)(\partial F_S/\partial\tau_S+\partial F_S/\partial\tau''_S)}$$

and

$$d\tau_S/d\tau'_L = \frac{(\partial F_S/\partial\tau'_L)(\partial F_L/\partial\tau_L+\partial F_L/\partial\tau''_L)-(\partial F_S/\partial\tau_L)(\partial F_L/\partial\tau'_L)}{(\partial F_S/\partial\tau_L)(\partial F_L/\partial\tau_S)-(\partial F_L/\partial\tau''_L+\partial F_L/\partial\tau''_L)(\partial F_S/\partial\tau_S+\partial F_S/\partial\tau''_S)}.$$

Rewriting F_L and F_S so that we separate the small country with tax τ'_S from the remaining small countries and include the large country with tax τ'_L with the other large countries (with tax rate τ_L), we can similarly obtain the expressions for the partial derivatives in (16), $\partial\tau_L/\partial\tau'_S$ and $\partial\tau_S/\partial\tau'_S$.

Calibration

Now we can solve the system of two equations with two unknowns, (16) and (17), having substituted in for the leftward shift parameters $\Delta\gamma_S$ and $\Delta\gamma_L$ from (18) and (19), respectively. To do so, we calibrate the model: we set $\gamma = 3/4$, implying that the wages of the median agents will be at 75 per cent of the average level in each economy. Further, we choose the standard share of capital in the production function, $\alpha = 1/3$. We compute the equilibrium values of $\tau_L, \tau_S, \Delta\gamma_L$ and $\Delta\gamma_S$ for the baseline model of small countries with infinitesimal populations as well as for small countries with size $\sigma = 1/10$ and $\sigma = 1/4$ (remember, the large countries have size one).

We perform our computations in three series. First, we keep the size of the world constant, so that as we increase n, there is a compensating decrease in s. Second, we set $n = 3$ and vary the value of s, and finally, we anchor the total mass of small countries at $s = 3$ and vary the number of large countries. When small countries have infinitesimal populations, interesting interactions only occur for at least two large countries, therefore we vary n so that $n \geq 2$. We consider values of $s \geq 0$.

Computational results

The results of the computations are presented in Figures 3-8. We can see that introducing positive size for our small countries does not significantly alter the results of the model. As expected, the large country tax rates are higher when each small country has a mass for any combination of n and s because the large countries are facing less of a tough competitor: The small countries themselves have higher taxes than in our base case because they realise they affect, albeit not too significantly, the world equilibrium net return on capital. Also, their governments are slightly to the left of the median, even if much less so than in large countries.

As expected, the tax rate in the large countries decreases and their governments shift to the right as a function of higher proportion or number of small countries, not only in the baseline case of infinitesimal small countries, but also when the mass of each of those countries is positive. The large-country governments only become more right-wing when additional large countries enter the competition when n is sufficiently large relative to s, again, even when small countries have positive mass. As we mentioned in our theoretical discussion, an increase in the tax rate is not necessary to have a left-ward shift as a consequence of more large countries joining the competition: indeed, as n increases, keeping s constant, the equilibrium tax rate in large countries drops, and yet the large-country governments first shift slightly to the left and then to the right. This further shows that large countries do not have the "right-wing power" that their smaller counterparts possess.

Capital ownership by median agents

Throughout our analysis, we assumed that median agents (and those less productive than they are) do not hold any capital. While it is certainly plausible that if those agents are less productive than the average agent in the population, they possess even less in terms of relative capital endowment, we might still want to consider a case where they do own capital stock.

We shall make two alternative simple assumptions regarding capital ownership in the economy. First, we assume that all agents with below-average productivity hold γ units of capital, where γ is the productivity of the median agent. Thus all agents are endowed with capital, but that endowment does not vary among agents with median or lower productivity. This will mean that, relative to our results thus far, the median agents in the large countries will desire a lower tax rate, both *ex post* and *ex ante*, because their welfare is decreasing in tax beyond the drop in wage experienced by agents with no capital endowment: Their net income from capital holdings will also decrease as a function of corporate tax implemented by their own country. Since both *ex post* and *ex ante* tax rates will be lower, so will the difference between them, and the median voter will elect a more right-wing government than in the case when he and those poorer than him own no capital.

On the other hand, we can instead assume that both labour productivity and capital endowment follow the same distribution in every economy, that is, capital endowment equals productivity of an agent γ, which varies continuously across agents. Then electing someone with a lower productivity will also mean choosing a representative with a lower capital endowment - both reasons for desiring a higher *ex post* tax rate in our model. Choosing a poorer representative will be more "effective" at having the median voter's ideal *ex ante* tax rate implemented. A poorer agent closer in type to the median voter will, when elected, select that tax rate. The median agent, when agents to the left of him vary in their capital endowments, will not need to elect as left-wing a government to achieve his desired *ex ante* tax policy. The elected policy maker will be more to the right than in the previous case.

Mathematically, the solution for small countries is exactly as before. Since small countries consider the net return on capital to their agents as exogenous, capital ownership does not enter the solution for their optimal tax rate. In the case of the large countries, we can modify the first-order condition in (4) to obtain

$$\begin{aligned} 0 &= \left(\frac{1-\tau_L}{1-\tau'_L}\right)^{\frac{1}{1-\alpha}} \frac{(n-1)\partial\tau_L/\partial\tau'_L}{(1-\tau_L)(1-\alpha)} \left[K^T\left[\gamma(1-\alpha)+\tau'_L\alpha\right] - A'\gamma(1-\alpha)(1-\tau'_L)\right] \\ &\quad - \frac{A'-1}{(1-\tau'_L)(1-\alpha)}\left[\gamma(1-\alpha)+\tau'_L\alpha\right] + A'(K^T-\gamma). \end{aligned}$$

Let us call β a parameter that depends on the distribution of capital for agents below median productivity: if all those agents hold the same amount of capital as the median agent, let $\beta = 0$. If, on the other hand, capital endowment distribution is the same as the distribution of labour productivity, let $\beta = 1$. Then the difference between the productivity of the agent in the government and the median agent is defined by

$$\begin{aligned} \Delta\gamma &= \left[\frac{(A'-1)K^T}{1-\tau'_L} + \beta A'\right]^{-1} \left(\frac{1-\tau_L}{1-\tau'_L}\right)^{\frac{1}{1-\alpha}} \frac{(n-1)\partial\tau_L/\partial\tau'_L}{(1-\tau_L)(1-\alpha)}. \\ &\quad . \left[K^T\left[\gamma(1-\alpha)+\tau'_L\alpha\right] - A'\gamma(1-\alpha)(1-\tau'_L)\right]. \end{aligned}$$

It is rather complicated to show all of our results algebraically when the median agents in the large countries hold capital. Therefore, again, we choose to computationally solve for the equilibrium in a calibrated version of our model. The calibration and values for n and s are the same as before.

Computational results

We present the results in Figures 9-14. As in the case of positive mass of individual small countries, capital ownership by the median agents in the various countries does not qualitatively affect our results.

However, as mentioned before, two effects are present: when median agents own capital, they desire and subsequently implement lower tax rates. Moreover, with lower taxes, the magnitude of difference between the median agent's *ex post* and *ex ante* optimal tax rates drops - since both of those rates decrease. Then he does not need to elect an agent as different from himself to implement his desired *ex ante* tax rate. Therefore, governments are going to be more right-wing for all values of n and s when median agents in the various countries own capital.

The second effect is present when $\beta = 1$, that is, when capital ownership distribution is identical to labour productivity distribution in the population. The distribution in capital ownership among agents poorer than the median, that is, among those he considers electing, renders choosing a different policy maker than oneself more powerful: for any difference between types, the policies chosen by them *ex post* will be more unlike each other. Therefore while assuming $\beta = 1$ instead of $\beta = 0$, *ceteris paribus*, does not change the equilibrium tax rates, it will shift the large-country governments further to the right and closer to the median agent.

Conclusion

In this paper we have first showed that smaller countries present a challenge to their larger counterparts in a tax competition setting. Because of their size, their fiscal policy affects little or not at all the world equilibrium net return on capital. Therefore they perceive a higher elasticity of capital with respect to their corporate tax and choose a lower tax on capital than larger countries, with which they compete. Moreover, countries with larger populations that realise the impact of their policy decisions on those of other countries elect more left-wing governments than small countries, leading to an even larger difference between their tax rates.

Then we captured the political impact of country-size heterogeneity in a tax competition setting. Namely, we have shown that small countries have a right-wing power: proportionately more small countries in a group of countries attempting to attract capital will lead to a right-ward shift in the governments that implement policy in the large countries, as will the addition of more small countries to the group. In both cases, voters in large countries elect more conservative governments that lower taxes further than administrations in place at the time of the small country expansion would. Additional large countries, on the other hand, do not clearly lead to a similar shift to the right.

Through this mechanism large countries are able to better respond to the tougher competition for capital resources they face when interacting with small countries. However, even when they elect a fiscally more conservative government and thus further decrease their taxes, they still lose some of their capital to their small competitors. Therefore, they have a further incentive to search for a welfare-improving partial tax cooperation or harmonisation solution.

In the case of the 2004 EU enlargement, when mostly small countries entered the bloc, a possibly easily implementable solution has presented itself – a minimum tax rate requirement backed by the threat of reduced transfers from the Union to the budgets of countries that do not comply. We therefore explored this proposal in our framework and found that it would be beneficial to all parties concerned as long as a sufficiently large number of small countries is present in the competition - which, by now, is almost certainly the case in the European Union.

Overall, there is a multitude of factors that help determine the type of government that voters choose to elect in any particular country. Those factors are not only economic, but also social, cultural and others. Moreover, capital taxation is merely one of many fiscal policy tools at the disposal of any given government. However, we have shown here that, *ceteris paribus*, the composition of countries involved in tax competition will help determine who voters elect to represent them.

Appendix

Appendix 1: single-crossing property

The single-crossing property of Gans and Smart (1996) is satisfied when $\tau > \tau'$, $\gamma < \gamma'$ and $\theta \le \theta'$ or if $\tau < \tau'$, $\gamma > \gamma'$ and $\theta \ge \theta'$, then $W(\tau, \gamma, \theta) \ge W(\tau', \gamma, \theta)$ implies $W(\tau, \gamma', \theta') \ge W(\tau', \gamma', \theta')$.

We note that both in a small and in a large country, less capital enters the economy when the tax rate is higher. Also, in a large country, the net return on capital will be lower when the tax rate is increased: capital leaves the country, which increases the gross return on capital. But taxation results in a lower net rate of return: the leaving capital enters other economies and when their tax rates remain the same, their gross returns and thus also net returns on capital decrease. Therefore by arbitrage the domestic net return on capital must decrease.

Then we have $W(\tau, \gamma, \theta) = \gamma(1-\alpha)k^{\alpha} + \theta(1-\tau)\alpha k^{\alpha-1} + \tau\alpha k^{\alpha} \ge W(\tau', \gamma, \theta) = \gamma(1-\alpha)k'^{\alpha} + \theta(1-\tau')\alpha k'^{\alpha-1} + \tau'\alpha k'^{\alpha}$ and when $\tau < \tau'$ also $k^{\alpha} < k'^{\alpha}$, $(1-\tau)\alpha k^{\alpha-1} \le (1-\tau')\alpha k'^{\alpha-1}$ (the latter with equality in the case of a small country). Thus this implies $\gamma(1-\alpha)(k'^{\alpha} - k^{\alpha}) + \theta[(1-\tau')\alpha k'^{\alpha-1} - (1-\tau)\alpha k^{\alpha-1}] \le \tau\alpha k^{\alpha} - \tau'\alpha k'^{\alpha}$ and since $k'^{\alpha} - k^{\alpha} > 0$ and $(1-\tau')\alpha k'^{\alpha-1} - (1-\tau)\alpha k^{\alpha-1} > 0$, when $\gamma < \gamma'$ and $\theta \le \theta'$ we necessarily also have $\gamma'(1-\alpha)(k'^{\alpha} - k^{\alpha}) + \theta'[(1-\tau')\alpha k'^{\alpha-1} - (1-\tau)\alpha k^{\alpha-1}] \le \tau\alpha k^{\alpha} - \tau'\alpha k'^{\alpha}$ and therefore $W(\tau, \gamma', \theta') \ge W(\tau', \gamma', \theta')$. Similarly, we could show the implication for $\tau < \tau'$, $\gamma > \gamma'$ and $\theta \ge \theta'$.

Since the agents' preferences satisfy the single crossing property in each country, a Condorcet winner exists and he represents the optimum for the median voter.

Appendix 2: quasi-concave preferences

We want to show that the *ex ante* as well as *ex post* preferences of the median agent in the large country and anyone poorer than him (that is, with a lower value of the productivity parameter γ) are quasi-concave as a function of their own country's tax rate. Since none of these agents own any capital, we can set $\theta = 0$ in our analysis.

We shall proceed as follows. First, we show that at any point where the first-order condition is satisfied, the second order condition will be negative, meaning that the local extremum is in fact a local maximum. Second, we verify that at the lowest possible value of the country's tax rate, $\tau'_L = 0$, the slope of the welfare function is positive. Last, we show that welfare is zero at the highest possible value of the tax rate, $\tau'_L = 1$. Since welfare is positive at $\tau'_L = 0$, then we will have ascertained that the welfare function is quasi-concave for $\tau'_L \in [0, 1]$ and attains a maximum on that interval at a point $\tau'_L \in (0, 1)$.

For the *ex ante* welfare function, we begin by substituting for $\partial\tau_L/\partial\tau'_L$ into the first-order condition, (4), obtaining

$$0 = \frac{(n-1)\left[\gamma(1-\alpha) + \tau'_L\alpha\right]}{(1-\tau'_L)(1-\alpha)\left[(A+1-\alpha)(A-1)-(n-2)\right]} - \frac{A'-1}{(1-\tau'_L)(1-\alpha)}\left[\gamma(1-\alpha) + \tau'_L\alpha\right] + A'. \tag{20}$$

Then the second derivative of the *ex ante* welfare function is

$$\frac{\partial^2 W}{\partial \tau_L'^2} = \frac{1}{1-\tau_L'}\left[\frac{n-1}{1-\alpha}\left[\frac{\gamma(1-\alpha)+\tau_L'\alpha+\alpha(1-\tau_L')}{(1-\tau_L')\left[(A+1-\alpha)(A-1)-(n-2)\right]}-\right.\right.$$
$$\left.-\frac{\left[\gamma(1-\alpha)+\tau_L'\alpha\right](2A-\alpha)}{(1-\tau_L')(1-\alpha)\left[(A+1-\alpha)(A-1)-(n-2)\right]^2}\left(\frac{1-\tau_L'}{1-\tau_L}\right)^{\frac{1}{1-\alpha}}\right]+$$
$$\left.+A'-1-\frac{(A'-1)\left[\gamma(1-\alpha)+\tau_L'\alpha\right]}{1-\tau_L'}\left[\frac{1}{1-\alpha}+\frac{1}{(1-\alpha)^2}\right]\right].$$

After substituting in from (20), we can simplify the above to

$$\frac{\partial^2 W}{\partial \tau_L'^2} = \left[\left(\frac{1-\tau_L'}{1-\tau_L}\right)^{\frac{1}{1-\alpha}}\frac{(2A-\alpha)}{(1-\alpha)\left[(A+1-\alpha)(A-1)-(n-2)\right]}\left[\frac{(A'-1)\left[\gamma(1-\alpha)+\tau_L'\alpha\right]}{(1-\alpha)(1-\tau_L')}-A'\right]\right.$$
$$\left.+\frac{\alpha(n-1)}{(1-\alpha)\left[(A+1-\alpha)(A-1)-(n-2)\right]}-1-\frac{(A'-1)\left[\gamma(1-\alpha)+\tau_L'\alpha\right]}{(1-\alpha)^2(1-\tau_L')}\right]\cdot\frac{1}{1-\tau_L'}.$$

Remember, we want to demonstrate that $\frac{\partial^2 W}{\partial \tau_L'^2}<0$. We can first show that

$$\left(\frac{1-\tau_L'}{1-\tau_L}\right)^{\frac{1}{1-\alpha}}\frac{(2A-\alpha)}{\left[(A+1-\alpha)(A-1)-(n-2)\right]}<1$$

is satisfied whenever

$$n^2-n(3+\alpha)+2(1+\alpha)+2(n-1)s\left(\frac{1-\tau_S}{1-\tau_L}\right)^{\frac{1}{1-\alpha}}+s^2\left(\frac{1-\tau_S}{1-\tau_L}\right)^{\frac{2}{1-\alpha}}>0.$$

But this surely holds for all $n\geq 2$. Therefore we can simplify our problem to showing that

$$\frac{-\left(\frac{1-\tau_L'}{1-\tau_L}\right)^{\frac{1}{1-\alpha}}(2A-\alpha)A'+\alpha(n-1)}{(1-\alpha)\left[(A+1-\alpha)(A-1)-(n-2)\right]}-1<0.$$

This is equivalent to

$$-(2A-\alpha)A+\alpha(n-1)-(1-\alpha)\left[(A+1-\alpha)(A-1)-(n-2)\right]<0,$$

which, realising that $A\geq n-1$ with certainty, holds whenever

$$-\left[2(n-1)-\alpha\right](n-1)+\alpha(n-1)<0.$$

This once again surely holds for all $n\geq 2$.

We have thus shown that $\frac{\partial^2 W}{\partial \tau_L'^2}<0$ at any local extremum and therefore also that any local extrema of the welfare function are necessarily local maxima.

Now we can also see that at $\tau_L'=0$,

$$\frac{\partial W}{\partial \tau_L'}=\frac{(n-1)\gamma}{(A+1-\alpha)(A-1)-(n-2)}-(A'-1)\gamma+A',$$

which is clearly positive for the median agent (for whom $\gamma < 1$) or for anyone with a lower-than-median productivity.

At $\tau = 1$, no capital is present in the country, because the net marginal return on capital is zero even when there is no capital in the economy. Then the marginal product of labour and thus wages, as well as tax revenues are zero.

Therefore we have determined that the *ex ante* welfare function is quasi-concave on the interval $\tau'_L \in [0, 1]$ for $\gamma < 1$, and attains its maximum on that interval for a tax rate $\tau'_L \in (0, 1)$ Welfare first increases as a function of the tax rate, reaches its maximum, and then subsequently drops to zero when all capital income is (or, rather, would be) taxed away.

We can easily obtain the same result for the *ex post* welfare, simply realising that we need to consider the first order condition in (2). The second derivative here is

$$\frac{\partial^2 W}{\partial \tau_L'^2} = \frac{1}{1-\tau'_L}\left[A' - 1 - \frac{(A'-1)\left[\gamma(1-\alpha)+\tau'_L\alpha\right]}{1-\tau'_L}\left[\frac{1}{1-\alpha} + \frac{1}{(1-\alpha)^2}\right]\right].$$

Once again, we substitute in from (2) to obtain the simplified expression

$$\frac{\partial^2 W}{\partial \tau_L'^2} = -1 - \frac{A'}{1-\alpha}.$$

This will always be negative. The derivative of the welfare function at $\tau'_L = 0$ is

$$\frac{\partial W}{\partial \tau'_L} = -(A'-1)\gamma + A'$$

and therefore remains positive for the median or poorer agent. Our conclusion for the *ex ante* welfare function thus holds for the *ex post* function as well. Both are quasi-concave.

Appendix 3: impact of small countries

We first show that $\partial G(\tau_L, s)/\partial \tau_L < 0$ when evaluated at $G(\tau_L, s) = 0$. We have

$$\begin{aligned}\frac{\partial G(\tau_L, s)}{\partial \tau_L} \quad = \quad & \frac{1}{1-\tau_L}\left[\frac{n-1}{1-\alpha}\left[\frac{\gamma(1-\alpha)+\alpha}{(1-\tau_L)\left[(A+1-\alpha)(A-1)-(n-2)\right]} - \right.\right.\\ & \left. - \frac{\left[\gamma(1-\alpha)+\tau_L\alpha\right](2A-\alpha)(A-1)}{(1-\tau_L)(1-\alpha)\left[(A+1-\alpha)(A-1)-(n-2)\right]^2}\right] + A - 1 - \\ & \left. - \frac{(A-1)\left[\gamma(1-\alpha)+\tau_L\alpha\right]}{1-\tau_L}\left[\frac{1}{1-\alpha}+\frac{1}{(1-\alpha)^2}\right]\right].\end{aligned}$$

After substituting in from $G(\tau_L, s) = 0$, we can simplify the above to

$$\begin{aligned}\frac{\partial G(\tau_L, s)}{\partial \tau_L} \quad = \quad & \frac{1}{1-\tau_L}\left[-\frac{(n-1)\left[\gamma(1-\alpha)+\tau_L\alpha\right](2A-\alpha)(A-1)}{(1-\tau_L)(1-\alpha)^2\left[(A+1-\alpha)(A-1)-(n-2)\right]^2}\right.\\ & \left. -1 - \frac{\alpha A(1-\tau_L)}{\gamma(1-\alpha)+\tau_L\alpha} - \frac{(A-1)}{1-\alpha}\left[\frac{\gamma(1-\alpha)+\tau_L\alpha}{(1-\tau_L)(1-\alpha)} - \alpha\right]\right].\end{aligned}$$

Since for $G(\tau_L, s) = 0$ to hold, we must have

$$\frac{\gamma(1-\alpha)+\tau_L\alpha}{(1-\tau_L)(1-\alpha)} > 1, \tag{21}$$

we have shown that $\partial G(\tau_L, s)/\partial \tau_L < 0$.

Now, for the case when the size of the world, that is, $K^T = n + s$, is constant, we show that $\partial G(\tau_L, s)/\partial s < 0$. We have

$$\begin{aligned}
\frac{\partial G(\tau_L, s)}{\partial s} &= -\frac{[\gamma(1-\alpha)+\tau_L\alpha]}{(1-\tau_L)(1-\alpha)\left[(A+1-\alpha)(A-1)-(n-2)\right]}\cdot \\
&\quad \cdot\left[1+\frac{(n-1)}{[(A+1-\alpha)(A-1)-n+2]}\left[(2A-\alpha)\left(\left(\frac{1-\tau_S}{1-\tau_L}\right)^{\frac{1}{1-\alpha}}-1\right)+1\right]\right]+ \\
&\quad +\left(\left(\frac{1-\tau_S}{1-\tau_L}\right)^{\frac{1}{1-\alpha}}-1\right)\left(1-\frac{\gamma(1-\alpha)+\tau_L\alpha}{(1-\tau_L)(1-\alpha)}\right) \qquad (22)
\end{aligned}$$

We see that indeed $\partial G(\tau_L, s)/\partial s < 0$, because (21) still holds.

Similarly, when we hold n constant (and let the size of the world vary as we change s), we obtain

$$\begin{aligned}
\frac{\partial G(\tau_L, s)}{\partial s} &= -(n-1)\left[\gamma(1-\alpha)+\tau_L\alpha\right](1-\tau_L)(1-\alpha)\left[(2A-\alpha)\left(\frac{1-\tau_S}{1-\tau_L}\right)^{\frac{1}{1-\alpha}}+1\right]\cdot \\
&\quad \cdot\left[(1-\tau_L)(1-\alpha)\left[(A+1-\alpha)(A-1)-(n-2)\right]\right]^{-2}+ \\
&\quad +\left(\frac{1-\tau_S}{1-\tau_L}\right)^{\frac{1}{1-\alpha}}\left(1-\frac{\gamma(1-\alpha)+\tau_L\alpha}{(1-\tau_L)(1-\alpha)}\right),
\end{aligned}$$

which is still negative.

Appendix 4: charts

European Union corporate taxes as a function of country size

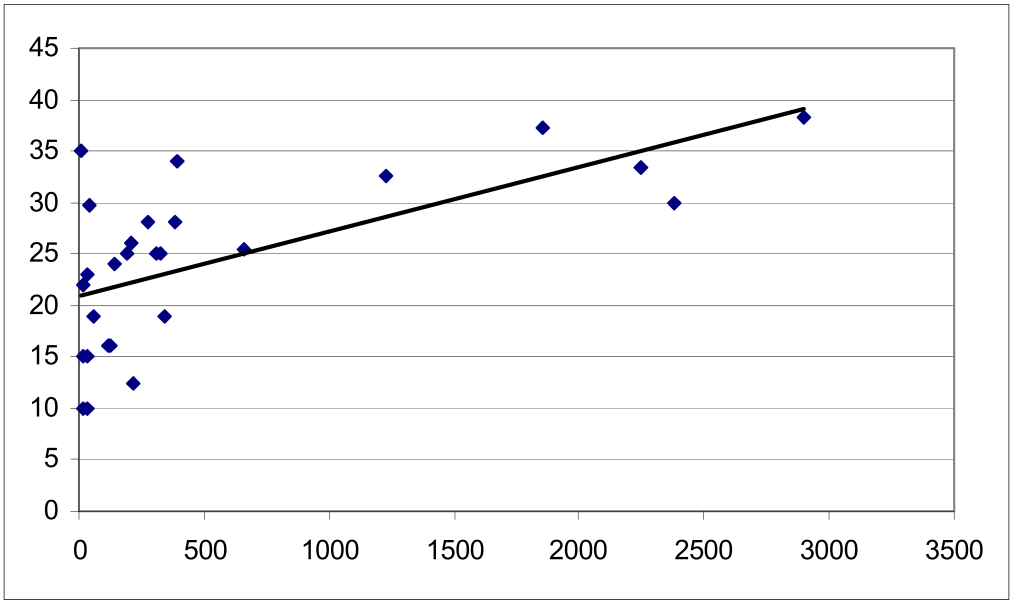

Chart 1: 2007 corporate taxes in EU 27 vs. GDP (in bil. USD)

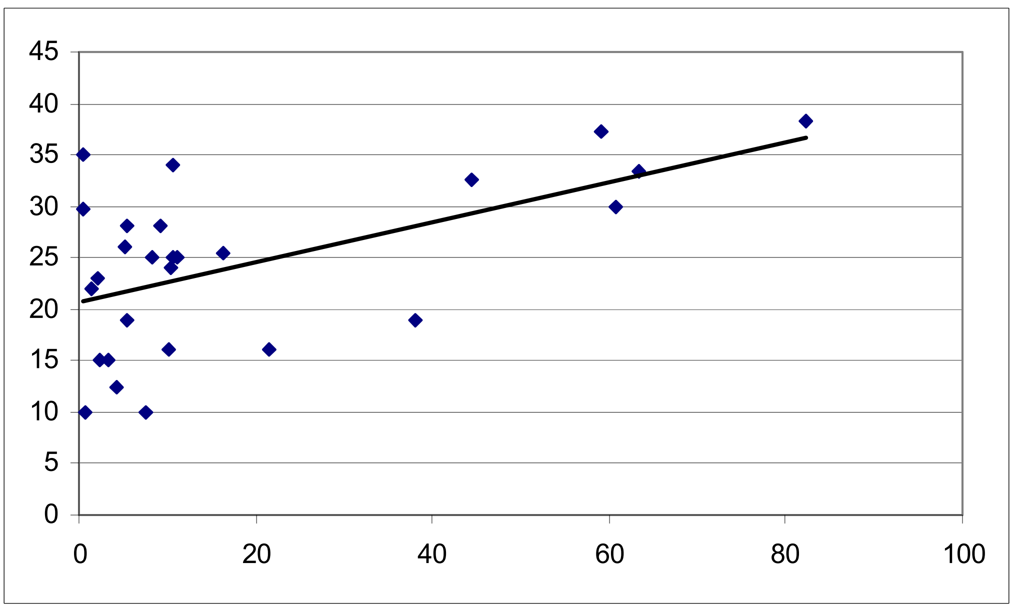

Chart 2: 2007 corporate taxes in EU 27 vs. population (mil.)

Computations for small countries with positive size

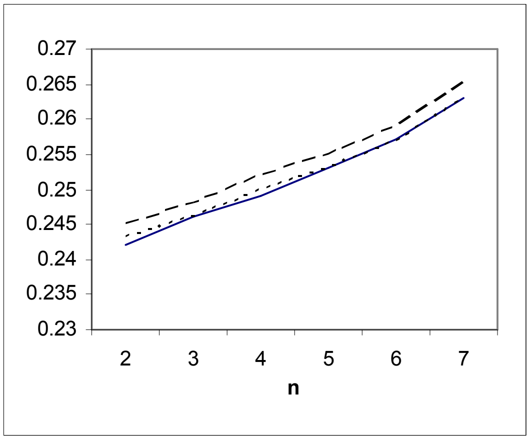

Chart 3: τ_L when $n + s = 7$

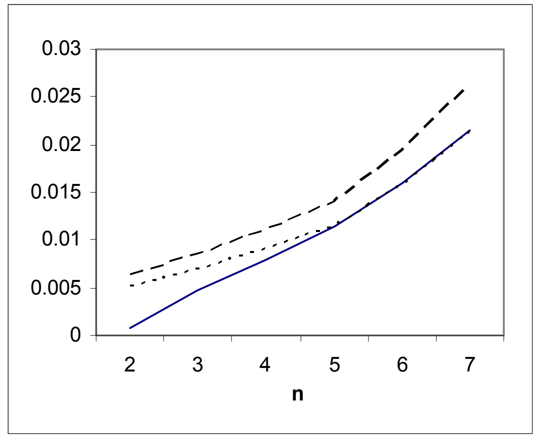

Chart 4: $\Delta\gamma_L$ when $n + s = 7$

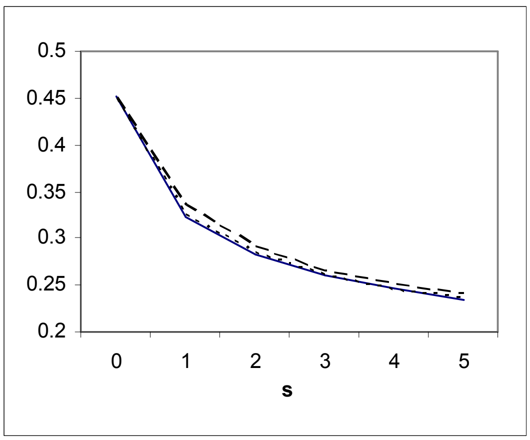

Chart 5: τ_L when $n = 3$

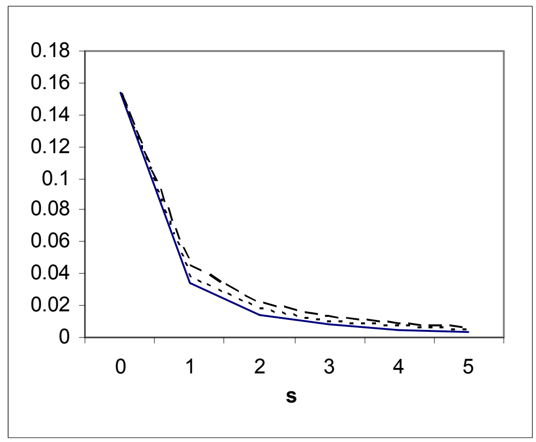

Chart 6: $\Delta\gamma_L$ when $n = 3$

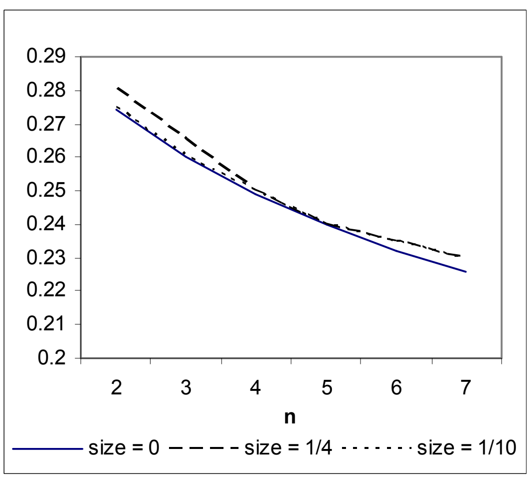

Chart 7: τ_L when $s = 3$

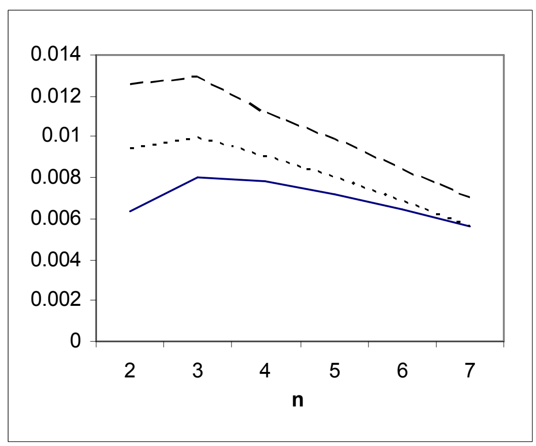

Chart 8: $\Delta\gamma_L$ when $s = 3$

Computations for median agents with capital holdings

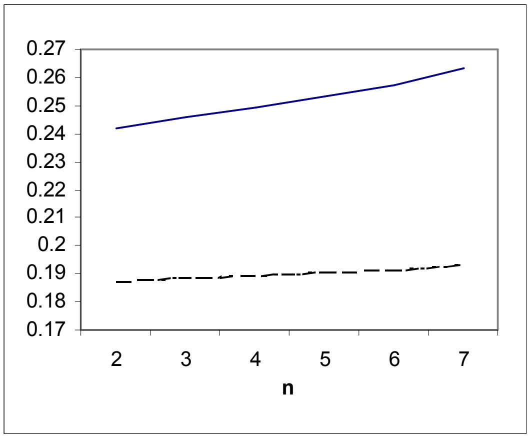

Chart 9: τ_L when $n + s = 7$

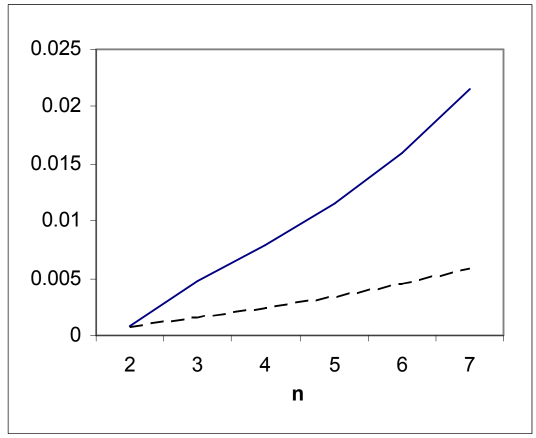

Chart 10: $\Delta\gamma_L$ when $n + s = 7$

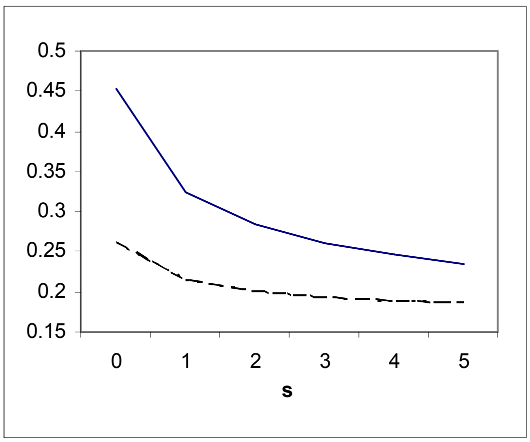

Chart 11: τ_L when $n = 3$

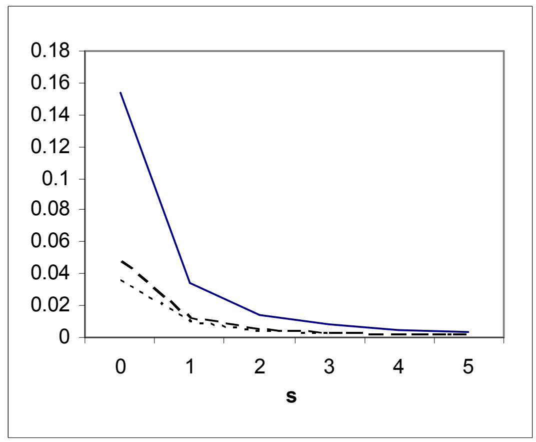

Chart 12: $\Delta\gamma_L$ when $n = 3$

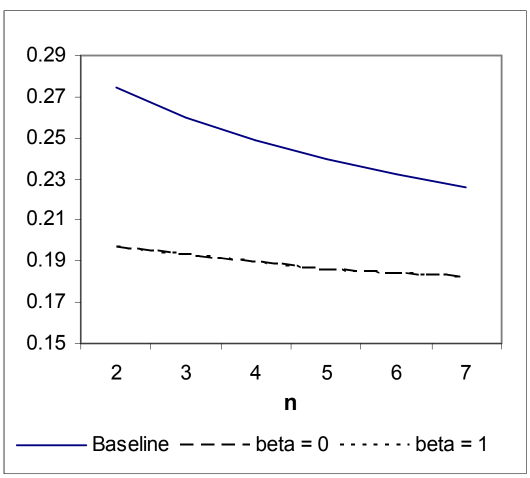

Chart 13: τ_L when $s = 3$

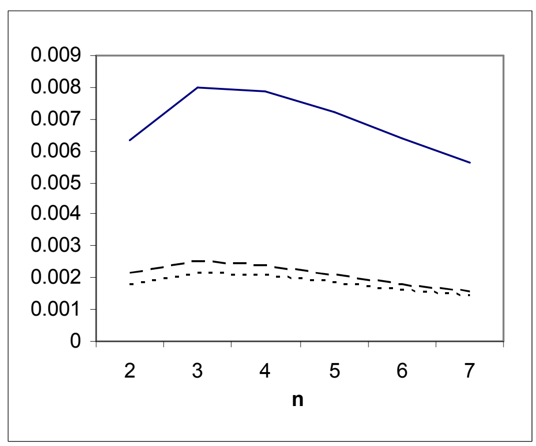

Chart 14: $\Delta\gamma_L$ when $s = 3$

Bibliography

[1] A. Alesina and G. Tabellini (1990), "A positive theory of fiscal deficits and government debt," *Review of Economic Studies* 57: 403-414.

[2] M. Brueckner (2001), " Strategic delegation and international capital taxation," Working paper no. B22, Center for European Integration Studies, Bonn.

[3] S. Bucovetsky (1991), "Asymmetric tax competition," *Journal of Urban Economics* 30: 167-181.

[4] J. Edwards and M. Keen (1996), "Tax competition and Leviathan," *European Economic Review* 40: 113-134.

[5] J. S. Gans and M. Smart (1996), "Majority voting with single-crossing preferences," *Journal of Public Economics* 59: 219-237.

[6] H. Huizinga and G. Nicodeme (2006), "Foreign ownership and corporate income taxation: An empirical evaluation," *European Economic Review* 50: 1223-1244.

[7] R. Kanbur and M. Keen (1993), "Jeux sans frontières: Tax competition and tax coordination when countries differ in size," *The American Economic Review* 83: 877-892.

[8] P. Kehoe (1989), "Policy cooperation among benevolent governments may be undesirable," *Review of Economic Studies* 56: 289-296.

[9] S. Krogstrup (2002), "What do theories of tax competition predict for capital taxes in EU countries?" Working paper no. 05/2002, The Graduate Institute of International Studies, Geneva.

[10] S. Krogstrup (2004), "A Synthesis of recent developments in the theory of capital tax competition," Working paper no. 2004-02, Economic Policy Research Unit, Copenhagen.

[11] G. Nicodeme (2006), "Corporate tax competition and coordination in the European Union: What do we know? Where do we stand?" *European Economy* 250.

[12] S. Peralta and T. van Ypersele (2005), "Factor endowments and welfare levels in an asymmetric tax competition game," *Journal of Urban Economics* 57: 258-274.

[13] T. Persson and G. Tabellini (1992), "The politics of 1992: Fiscal policy and European integration," *The Review of Economic Studies* 59: 689-701.

[14] T. Persson and G. Tabellini (1994), "Representative democracy and capital taxation," *Journal of Public Economics* 55: 53-70.

[15] J. D. Wilson (1991), "Tax competition with interregional differences in factor endowments," *Regional Science and Urban Economics* 21: 423-451.