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Ben Lockwood and Miltiadis Makris

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Tax Competition and Politics: Double-Edged Incentives Revisited*

Ben Lockwood† and Miltiadis Makris‡

†Department of Economics and CSGR,

University of Warwick, UK

‡Department of Economics, University of Exeter,

CMPO, University of Bristol, UK

and IMOP, Athens University of Economics and Business

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Abstract

We re-examine, from a political economy perspective, the standard view that higher capital mobility results in lower capital taxes - a view, in fact, that is not confirmed by the available empirical evidence. We show that when a small economy is opened to capital mobility, the change of incidence of a tax on capital - from capital owners to owners of the immobile factor - may interact in such a way with political decision-making so as to cause a *rise* in the equilibrium tax. This can happen whether or not the fixed factor (labour) can be taxed.

Keywords: Tax Competition.

JEL Classification Numbers: H25, H77

Correspondence: Dr. Miltiadis Makris, Department of Economics, University of Exeter, Streatham Court, Rennes Drive, Exeter EX45BA, EMAIL: M.Makris@exeter.ac.uk.

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1 Introduction

In spite of the now large literature on capital tax competition, there have been relatively few systematic analyses of the interaction between the level of tax competition and the political process by which taxes are chosen. An early and important exception[1] is Persson and Tabellini(1992), who stress that with tax competition, voters in a country generally vote strategically by choosing a candidate who, once in office, will tax capital more than the median voter would - in their model, such a candidate has less than the median endowment of capital i.e. is poorer. By this means, the voters precommit to a higher tax rate, thus counteracting the ex post incentive of the policy-maker, once in office, to under-tax capital. So, intensification of tax competition, due to increased capital mobility (capital market integration, CMI), will also induce a change in the choice of candidate from a richer to a poorer one. Generally, this model exhibits what Persson and Tabellini elsewhere call *double-edged incentives*: that is, *"incentives in the domestic policy process spill over into the international arena, and international strategic considerations partly shape domestic policy"* (Persson and Tabellini(1995)). The effect of increased capital mobility changes each of these incentives: it sharpens the incentive to cut taxes due to international strategic considerations, but also increases the incentive to change to a more tax-friendly political representative.

Here, we focus on two aspects of this important paper. First, note that in Persson and Tabellini (1992), the political precommitment effect requires representative democracy. That is, in their model, with direct democracy i.e. majority voting over the tax rate, there would be no political effect of increased CMI, and thus no double-edged incentives, in the sense that (i) the policy-maker's identity is fixed,[2] whatever the level of capital mobility, *and* (ii) his choice of tax rate only responds to increased CMI via the increase in the marginal cost of public funds. Second[3], the economic effect is dominant: that is, increased capital mobility can never lead to a rise in the equilibrium tax rate, only a smaller fall than would occur in the absence of the political effect.

This raises two questions: first, is representative, rather than direct democracy, a necessary condition for double-edged incentives to arise? And, second,[4] in a model with double-edged incentives,

[1]Other, more recent contributions are discussed in Section 6.

[2]In this case the median voter is always the individual with the median level of endowment of the good in the first period.

[3]This is certainly the case for the symmetric equilibrium in the symmetric model: Persson and Tabellini(1992) do not discuss asymmetric equilibria, and the analysis of their model in the asymmetric case would be very difficult: one would have to solve for asymmetric Nash equilibrium in taxes, given any configuration of government types in the two countries, derive equilibrium types and then calculate the consequences for equilibrium taxes. In any case, it seems very unlikely that one would find that the equilibrium tax would rise in all (i.e. both) countries, as we do here.

[4]We should stress that there are already a number of papers which show that equilibrium taxes may rise in some or all countries following CMI (for instance, DePater and Myers (1994), Wilson (1987), Huizinga and Nielsen (1997), Noiset(1995) and Wooders, Zissimos and Dhillon(2001)). However, none of these models exhibit double-edged incentives,

can the political effect of CMI ever dominate the economic effect? These are both interesting questions, we would argue, for different reasons. They are both of some theoretical interest, but the second is also of practical interest, as there is a growing body of empirical evidence that CMI has not clearly led to cuts in corporate tax rates, at least for OECD countries. Specifically, recent studies by Hallerberg and Basinger (1998), (2001), Devereux, Lockwood, and Redoano(2002), Garrett(1998), Quinn(1997) Rodrik(1997), Swank and Steinmo(2002)) find rather mixed effects[5] of relaxation of exchange controls on the capital account on corporate tax rates.

In this paper, we present a simple model of tax competition, where as in Persson and Tabellini(1992, 1995, 2000 Ch 12.4), citizens within a country differ in wealth. Unlike Persson and Tabellini (PT hereafter), democracy is direct, rather than representative. In our model, there are double-edged incentives in the sense made precise above. We show that the (symmetric) equilibrium tax can *rise* in all countries following CMI.

The key feature of our model is that, unlike PT, there are two factors of production in every country, one internationally immobile (labour) and one possibly internationally mobile (capital), and the before-tax prices of factors are not fixed. So, in this model, following capital market integration, the incidence of the capital tax changes: part of the burden of the tax shifts from owners of capital to owners of labour. Now, suppose that agents within a given country are heterogenous, in the sense that different agents in that country own different shares of the total capital stock and the total stock of labour, and also decisions over tax rates are made by majority voting. Then the change in the incidence of the capital tax, following CMI, will be reflected in the way majority voting aggregates policy preferences into domestic policies.

For simplicity, we assume that labour and savings are inelastically supplied in each country, and that each country is "small" i.e. takes the world interest rate as given. In this environment, the change in the incidence of the capital tax is dramatic. Without capital mobility, owners of capital bear the entire burden of the tax, as the after-tax price of capital decreases and the wage is fixed by the level of inelastically supplied savings. With capital mobility, instead, the entire burden of the tax is shifted to owners of the immobile factor of production (labour), as each country takes the world interest rate as

in that the effect does not occur due to a spillover from the domestic political process: rather, the rise is taxes is generated by some modification of the economic environment relative to the standard tax competition model. These contributions are all discussed in more detail in Section 6.

[5] In particular, Devereux, Lockwood, and Redoano(2002) is probably the most comprehensive, as it allows for four different measures of exchange controls, and studies not only statutory rates of corporate tax, but also effective marginal and average rates, for almost all OECD countries, and allows for strategic interaction in corporate tax setting between countries. It finds that depending on the choice of measure of capital controls and corporate tax rates, a unilateral or multilateral liberalisation of controls may lower *or* raise corporate taxes. This is broadly consistent with the findings of Quinn(1997) and Rodrik(1997): Garrett(1998) and Swank and Steinmo(2002) who simply find that capital controls have no significant effect.

given, and the wage depends on the net flow of capital. Then, by the tax incidence effect, the median voter in the closed economy case is the *owner of the median share of the capital endowment*, whereas the median voter in the open economy case is the *owner of the median share of the labour endowment*.[6] Moreover, in either case, the higher the relevant median voter's share of the relevant endowment, the greater the share of the cost of the public good paid by that median voter. So, other things equal, if the median voter's share of the capital endowment is high, and his share of the labour endowment is low, the median voter's demand for the public good (and therefore the tax) will be low in the closed economy, and high in the open economy. We call this the *tax incidence* effect of capital market integration.

Of course, following capital market integration, other things are not equal: from the point of view of the median voter in a given country, the elasticity of supply of capital, formerly zero, is now positive, and so the marginal cost of public funds rises from unity to a value greater than unity, causing the policy-maker to choose a lower tax. Call this latter effect the *tax competition* effect. Of course, this effect is also present in the PT model. However - and this is the main result of our paper - in our model, it is perfectly possible for the incidence effect to outweigh the tax competition effect, so that equilibrium tax rates *rise*, following capital market integration. Indeed, under some conditions (basically, when the marginal cost of public funds is close to unity in the open economy) the difference in the median shares does not have to be large to result in a rise in capital taxes.[7]

This main result is first derived for the case where labour income is not taxed. One reason for doing this is that in this case, our model effectively reduces to an extension of the classic Zodrow-Mieskowski model, extended to allow for agents who have different capital and labour endowments. Our results therefore also extend in various ways (fully explained in Section 6) the many papers that use this model. Also, we note that the results are qualitatively similar (but easier to derive and interpret) to the ones when labour and capital are taxed at a common uniform rate.

The same basic effect will also be at work if both labour and capital can be taxed at different rates. There are complications, however: in particular, as the policy space is then multi-dimensional, some restrictions on the joint distribution of capital and labour endowments are required to ensure a well-defined median voter and thus a Condorcet Winner. Our main finding is that when the median voter has a relatively larger capital than labour endowment, he will choose a capital subsidy in the closed economy, but the capital tax in the open economy is zero. So, our counter-intuitive finding is

[6]Note that these may in fact be different agents, so we may have a *shifting median voter*. However, as argued below, the shifting median voter per se does not drive our results.

[7]Of course, the logic of the above argument is that a necessary condition for this to occur is that the endowments of the fixed factor are more unequally distributed than those of the mobile factor. Given that the fixed factor is labour, this is empirically rather implausible, see for instance Goodman et. al. (1997). However, one can reconcile our result with the stylized fact that labour income is more equally distributed than income from capital by introducing preference heterogeneity for the public good (see Section 5.1 below).

robust to the taxation of labour.

Our result that CMI affects political incentives, i.e. the policy preferences of voters, and that this in turn may lead to higher capital taxation is also related to the recent work of Kessler, Lulfesmann and Myers (2002). In that model, agents differ only with respect to their capital endowment, and capital taxes fund a lump-sum transfer to all residents. Moreover, capital is perfectly mobile, and labour is imperfectly mobile (there are migration costs). Their main result is that in this setting, a reduction in migration costs (further integration of the *labour* market) leads to an increase in the capital tax when countries are symmetric. The intuition is the following: "*The integration of labour markets reduces the incentives for voters to attract foreign capital through lowering national tax rates because it at the same time causes an inflow of labour, which is detrimental to a majority*" (Kessler, Lulfesmann and Myers(2002)). So, both the result and the reasoning behind it are rather different to our paper. More broadly, however, both their paper and this one indicate that the under-taxation results of the classic Zodrow-Mieskowski model are not robust to apparently quite minor changes.

The organisation of the paper is the following: Section 2 describes the model. Section 3 characterizes the equilibria with and without capital mobility when labour taxes are constrained to be zero. Section 4 does the same in the general case. In Section 5 we discuss possible extensions. Section 6 discusses related literature in some depth and finally, Section 7 concludes the paper.

2 The Model

There are a large number $j = 1,..m$ of identical countries. Each country is populated by a number of agents $i \in N = \{1,..n\}$, where n is odd. There are two periods. In the first period, agent i in any country decides how much to save out of her initial endowment of the consumption good, e_i. In the second period, the saved endowment of this agent, k_i, can be sold to firms as an input (the capital input). Each agent also has an endowment of labour time, l_i, which can also be sold to firms as an input. There is a number of identical firms in each country, which transform the two inputs into the consumption good using a constant-returns technology. The labour input is internationally immobile, but the capital input may be internationally mobile(CMI) or not. The government in any country provides a public good by taxing the income generated by the use of capital and labour inputs. Capital income is taxed on a source basis. We now turn to discuss each component of the model in more detail.

The timing of events is as follows.[8] First, the taxes τ_w, τ_r are determined by majority voting at the beginning of period 1. Then, given taxes, the saving decision is made at the end of period 1. Then, at the beginning of period 2, firms choose their capital and labour inputs, and the prices of the factors

[8]This timing follows Persson and Tabellini(1992). However, due to the special form of first-period preferences, savings are perfectly inelastic in our model, and so there is no "capital levy" problem. So, the outcome would be the same if voting on taxes took place after the savings decision were made.

are determined. Finally, production and second-period consumption take place.

Now we turn to the consumption, savings, and labour supply decisions of agent $i \in N$ in a typical country.[9] The present value of utility of such an agent is assumed to be of the form

$$u_i = \alpha \min\{c_i, \hat{c}\} + d_i + v(g) \tag{1}$$

where c_i, d_i are consumption levels in periods 1,2, g is a level of public good provision in period 2, and $\hat{c}$ is a satiation level of consumption in period 1. Also, $v(.)$ is assumed to have the standard properties that $v'(.) > 0$ and $v''(.) < 0$ for all non-negative g. Note that the agent does not value leisure so that labour time l_i will always be inelastically supplied.

First and second-period personal budget constraints are

$$c_i = e_i - k_i \tag{2}$$

$$d_i = rk_i + (w - \tau_w)l_i \tag{3}$$

where r and w are prices of the capital and labour inputs respectively, r is understood to be the price net of tax, and τ_w is the tax labour income. Substituting the personal budget constraints (2),(3) into (1), we get:

$$u_i = \alpha \min\{e_i - k_i, \hat{c}\} + rk_i + (w - \tau_w)l_i + v(g) \tag{4}$$

We assume α is large enough[10] so that i wants to consume up to $\hat{c}$ in period 1. In this case, optimal savings choice is simply $k_i = e_i - \hat{c}$, and is thus independent of factor prices. We assume for convenience that $\sum_{i \in N} l_i = \sum_{i \in N} k_i = 1$, so that k_i, l_i measure not only the absolute endowment of the two factors of agent i, but also agent $i's$ share of the aggregate endowment of each of these factors in his country of residence.

Now consider the behaviour of firms. These are assumed competitive, i.e. they take factor prices as given. Due to the assumed constant returns to scale, we can assume without loss of generality that there is only one firm in each country, with a production function in intensive form of $F(\tilde{k})$, where $\tilde{k}$ is the amount of capital employed by the firm in a typical country per unit of labour. $F(.)$ has the standard properties, $F(0) = 0$, $F'(.) > 0, F''(.) < 0$. In the closed economy case, the price of the capital input adjusts to the point where it is optimal for the firm to use one unit of capital i.e.

$$F'(1) = r_c + \tau_r \tag{5}$$

where τ_r is the tax on capital income. In the open economy case, the demand for capital by the firm is implicitly given by

$$F'(\tilde{k}) = r_o + \tau_r \tag{6}$$

[9]For convenince, we do not introduce country sub- or superscripts at this stage.

[10]This requires that $\alpha > r$. In the case where $\tau_w = 0$, as discussed below, $r \leq F'(1)$. In the general case, $r \leq F(1)$. So, in general, we assume $\alpha > \max\{F'(1), F(1)\}$.

Finally, the wage adjusts to the point where it is optimal for the firm to employ one unit of labour, so the wage is

$$w(\tilde{k}) = F(\tilde{k}) - \tilde{k}F'(\tilde{k}) \tag{7}$$

noting that if the economy is closed, $\tilde{k} = 1$.

Turing now to determination of the taxes, the government budget constraint is $g = \tau_r\tilde{k}+\tau_w$ where $\tilde{k} = 1$ in the closed economy case. So, substituting the government budget constraint and (5) into (4), the overall payoff to i in the second period is

$$u_i = \begin{cases} (F'(1) - \tau_r)k_i + (w(1) - \tau_w)l_i \ + v(\tau_r + \tau_w) & \text{(closed)} \\ r_o k_i + (w(\tilde{k}) - \tau_w)l_i \ + v(\tau_r\tilde{k} + \tau_w) & \text{(open)} \end{cases}. \tag{8}$$

Then, (τ_w, τ_r) are determined simultaneously in each country by majority voting as described in the following sections. In particular, in the open-economy case, the voters in each country are assumed to take r_o as given[11] (i.e. each country is assumed small relative to the international market for the capital input), in which case they rationally anticipate that the capital employed in that country will be determined by (6), given tax τ_r. Also, taxes must be feasible in the sense that they generate non-negative revenue (as $g \geq 0$) and also imply non-negative post-tax prices for labour and capital.

As these feasibility constraints play an important role in what follows, it is helpful to state them formally. Non-negative revenue requires that $\tau_w + \tilde{k}\tau_r \geq 0$. From (7), a non-negative wage requires $\tau_w \leq w(\tilde{k})$. From (5), in the closed economy, a non-negative price of capital $r_c \geq 0$ requires $\tau_r \leq F'(1)$. In the open economy case, as r_o is exogenous, there is no upper bound on τ_r. So, in the closed economy case, recalling $\tilde{k} = 1$, the feasible set of taxes is

$$S_c = \{(\tau_w, \tau_r)\,|\tau_w + \tau_r \geq 0,\ \tau_w \leq w(1),\ \tau_r \leq F'(1)\}$$

In the open-economy case, taking r_o as given, and recalling $\tilde{k} = k(r_o + \tau_r)$, the feasible set of taxes is

$$S_o = \{(\tau_w, \tau_r)\,|\tau_w + k(r_o + \tau_r)\tau_r \geq 0,\ \tau_w \leq w(k(r_o + \tau_r))\}$$

Note that we have allowed the taxes to be individually negative i.e. we allow for a wage or capital subsidy. The reason for doing so is discussed in Section 4 below.

We can now comment on how this model relates to the literature. First, if $\tau_w = 0$, so that only the mobile factor is taxed, then the model is effectively the well-known model of Zodrow and Mieszkowski (1986) and Wilson(1986) (ZMW model henceforth), extended to allow for heterogeneity in the ownership of factors of production (and also allowing for endogenous savings). The model is also related quite closely to that of PT. The main differences are that in our model: (i) apart from capital, there is *also* a factor of production which is internationally immobile and its returns are *not* exogenously fixed; and (ii) democracy is direct, rather than representative.

[11] Implicitly, they also take the taxes in other countries as given, but these taxes only affect citizens' payoffs though r_o.

Finally, we note that an analysis of the model as it stands is somewhat involved, because the policy space (τ_w, τ_r) is two-dimensional in each country. Consequently, with unrestricted distributions of capital and labour endowments $\{k_i\}_{i\in N}$, $\{l_i\}_{i\in N}$, voting cycles will generally arise. So, we begin in the next Section, Section 3, by illustrating the tax incidence effect, and obtaining our key results in the special setting where the fixed factor is untaxed i.e. $\tau_w = 0$. In this case, from S_c, S_o, the feasibility constraints on the capital tax are simply $0 \leq \tau_r \leq F'(1)$ in the closed economy, and $\tau_r \geq 0$ in the open economy.

3 Capital Market Integration and Tax Competition with an Untaxed Fixed Factor

3.1 Majority Voting Equilibrium in Closed and Open Economies

First consider the closed economy. Recall that $\tau_w = 0$ by assumption, and set $\tau_r = \tau$. Then, from (8), the payoff of agent $i \in N$ in any country is

$$u_i(\tau) = (F'(1) - \tau)k_i + w(1)l_i \ + v(\tau) \tag{9}$$

It is clear from (9) that *only the weights* k_i *given by capital endowments* will affect voter preferences over τ. Note that the above function $u_i(\tau)$ is strictly concave in τ as v is assumed strictly concave. So, preferences over τ are single-peaked for all $i \in N$. Let τ_i^c be the *ideal tax* of agent i i.e. the tax that maximises (9) subject to the feasibility constraint that $\tau \in [0, F'(1)]$. For an interior solution, this is given by the condition

$$v'(\tau_i^c) = k_i \tag{10}$$

That is, the marginal benefit of the public good is equal to type $i's$ share of the capital stock. This is because the tax is borne entirely by immobile capital, k_i is also $i's$ share of the cost of the public good. Note also that if $k_i > v'(0)$, then we have a corner solution with $\tau_i^c = 0$, and if $k_i < v'(F'(1))$, then we have a corner solution with $\tau_i^c = F'(1)$.

Now, let $p \in N$ be the agent with the median capital endowment.[12] It follows from the fact that τ_i^c is decreasing in k_i that the voter with the median ideal tax is just the median voter with respect to the capital endowment. Then, the outcome of majority voting over τ will be that τ_p^c is chosen. In what follows, we will assume that τ_p^c is interior. So we have proved:

Proposition 1. *Assume $v'(0) \geq k_p \geq v'(F'(1))$. Then, in the closed economy case, the equilibrium tax in each country is $\tau^c = \tau_p^c$, where τ_p^c solves (10) above with $i = p$.*

[12] Formally, for any i, let $A_i = \{j \in N \,|k_j \leq k_i\}$, and $a_i = \#A_i/n$. Then, p is the value of the index for which $a_{p-1} < 0.5 < a_p$

Now consider the open economy case. Here, as each country is small, voters take r_o as fixed and thus from (6), they perceive that $\tilde{k} = k(r_o + \tau)$, with $dk/d\tau = 1/F''(\tilde{k})$. So, from (8), the pay-off of agent i in any country, is

$$u_i(\tau, r_o) \equiv r_o k_i + w(k(r_o + \tau))l_i \; + v(\tau k(r_o + \tau)). \tag{11}$$

It is now clear from (11) that *only the weights* l_i *given by the labour endowment* will affect voter preferences over τ. We will assume that the above function is strictly quasi-concave with respect to τ for any l_i and any r_o, which is sufficient to ensure that preferences over τ are single-peaked for all $i \in N$, given r_o fixed. Let τ_i^o be the ideal tax of a type i agent. This maximises (11) subject to the constraint that the tax be feasible i.e. that $\tau \in [0, \infty)$. Assuming an interior[13] solution, after simple manipulation, we see that τ_i^o satisfies the simple condition:

$$v'(\tau_i^o k(r_o + \tau_i^o)) = \mu(\tau_i^o, k(r_o + \tau_i^o))l_i \tag{12}$$

where

$$\mu(\tau, k) = \frac{1}{\left(1 + \frac{\tau}{kF''(k)}\right)}$$

is the marginal cost of public funds (MCPF) in the open economy, evaluated at any τ, for a fixed r_o. Note that $\mu(\tau_i^o, k(r_o + \tau_i^o)) > 1$ as $\tau > 0$, so an interior solution requires $l_i \leq v'(0)$. If $l_i > v'(0)$, then we have a corner solution with $\tau_i^o = 0$.

From (12), the marginal cost of a unit of the public good to i is now his share l_i of labour, the immobile factor (as the tax now falls entirely on the immobile factor), times the marginal cost of public funds. Given the assumptions made so far, it can be shown straightforwardly[14] that the higher the cost share l_i, the lower the ideal tax τ_i^o at a given interest rate r_o.

Now let $q \in N$ be the agent with the median labour endowment.[15] So, it follows that in the open economy case, the voter with the median ideal tax is now just the median voter with respect to the labour endowment. Then, the outcome of majority voting over τ will be that voter q will prevail. Note that in the open economy case, τ_q^o depends on r_o, but as all countries are identical, the only possible equilibrium is where taxes are the same in all countries, and hence r_o is such that $k(r_o + \tau_q^o) = 1$. If $q's$ ideal tax is interior, it will therefore satisfy

$$v'(\tau_q^o) = \mu(\tau_q^o, 1)l_q \tag{13}$$

[13]Note also from (12) that for any fixed r_o, if $l_i > v'(0)$, then we have a corner solution with $\tau_i^o = 0$.

[14]Strict quasi-concavity of $u_i(\tau, r^o)$ with respect to τ for any l_i and any r^o implies that $\partial^2 u_i(\tau_i^o, r^o)/\partial\tau^2 < 0$. This in turn implies directly that the ratio $v'(\tau_i^o k(r^o + \tau_i^o))/\mu(\tau_i^o, r^o)$ is strictly decreasing with τ_i^o for any l_i. Hence, we can see directly from (12) that the higher l_i, the lower τ_i^o, as long as τ_i^o is interior.

[15]Formally, let $B_i = \{j \in N \,|l_j \leq l_i\}$, and $b_i = \#B_i/n$. Then $q \in N$ is the value of the index for which $b_{q-1} < 0.5 < b_q$.

As in the closed economy case, we wish, for simplicity, to restrict attention to interior equilibrium taxes i.e. those satisfying (13). This requires $v'(0) \geq l_q$. Also, as in equilibrium $r^o = F'(1) - \tau_q^o$, we must restrict attention to equilibrium taxes $\tau_q^o \leq F'(1)$ which imply a non-negative world interest rate. This requires $l_q \geq v'(F'(1))/\mu(F'(1), 1)$. So, we have proved:

Proposition 2. *Assume $v'(0) \geq l_q \geq v'(F'(1))/\mu(F'(1), 1)$. Then, in the open economy case, the equilibrium tax in each country is $\tau^o = \tau_q^o$, where τ_q^o solves (13) above.*

3.2 Capital Market Integration and Tax Competition

Following CMI, three things will happen. First, for any positive tax lower than the revenue-maximising tax, the marginal cost of public funds rises from unity to $\mu > 1$, as the supply of capital is now no longer fixed in each country. Other things equal, this will lower the equilibrium tax, a well-known and standard result.

However, with heterogenous agents, there are two other effects of CMI. First, the identity of the median voter may change i.e. $p \neq q$, which we call *the shifting median voter effect.* In general, a necessary condition for the existence of the shifting median voter effect is that the endowments are not perfectly positively or negatively rank-correlated, i.e. that it is not possible to label citizens so that $k_1 \leq k_2 \leq ...k_n$ and either $l_1 \leq l_2 \leq ..l_n$ or $l_n \leq l_{n-1} \leq ...l_1$.

Second, whether or not there is a shifting median voter, if the median capital share is not equal to the median labour share (i.e. $k_p \neq l_q$), his choice of tax rate will change. This is clear as from (10), the equilibrium tax in the closed economy case is determined by k_p, but from (13), the equilibrium tax in the open economy case is determined by l_q. As already remarked, this is due to the fact that in the closed economy, the tax burden is entirely borne by capital, whereas in the open economy case, it is borne by land. So, we say that there is an *incidence effect* when $k_p \neq l_q$.

To understand the importance of these two effects, our first benchmark result describes what happens if both effects are absent.[16] This occurs, for instance, when the capital share of any i is equal to her labour share i.e. $k_i = l_i = \lambda_i$, all $i \in N$. Then, we can rank agents by this common share i.e. $\lambda_1 \leq \lambda_2 \leq ...\lambda_n$. In this case, the median voter in both closed and open economies is $m = (n+1)/2$ i.e. in our notation, $p = q = m$.

Proposition 3. *If there is no incidence effect or shifting median voter effect i.e. if $p = q = m$ and $k_m = l_m = \lambda_m$, then $\tau^c > \tau^o$.*

Proof. If $k_p = l_q = \lambda_m$, then the conditions defining τ^c, τ^o become

$$v'(\tau^c) = \lambda_m, \; v'(\tau^o) = \mu(\tau^o, 1)\lambda_m$$

So, as $F'' < 0$ and $\tau^o > 0$, $\mu(\tau^o, 1) > 1$, we have $v'(\tau^o) > v'(\tau^c)$. But then by strict concavity of v, $\tau^o < \tau^c$. $\square$

[16] In all following results, we assume that the conditions in Propositions 1 and 2 hold.

That is, we have the standard result[17] that CMI will reduce the equilibrium tax, because capital mobility leads to a higher cost of public funds.

Now we show how this "standard" result can be overturned by the incidence effect. This happens in a very simple and striking way. The general idea is illustrated in Figure 1 below.

Figure 1 in here

The figure graphs the marginal benefit of the public good, g i.e. $v'(g)$, and also the marginal cost to the relevant median voter of providing that level of the public good (k_p in the closed economy, and $l_q\mu(g,1)$ in the open economy). In the Figure, the median voter in the closed economy has a high capital share, and thus desires a low level of g and thus a low tax, but the median voter in the open economy has a low labour share, and thus desires a higher level of g and thus a higher tax. This effect more than offsets the reduction in the tax due to an increase in the marginal cost of public funds generated by capital mobility i.e. the fact that μ is increasing in g.

Of course, the Figure merely illustrates a possibility: the following example shows that this possibility can actually occur.

Example 1 Assume quadratic preferences and technology i.e. $v(g) = g - \zeta g^2/2$, $\zeta > 0$, and $F(k) = k - \phi k^2/2$, $1 > \phi > 0$. The constraints on ϕ ensure that $F(k)$ has the standard properties in the neighborhood of the Nash equilibrium i.e. $F'(1) = 1 - \phi > 0$, $F''(1) = -\phi < 0$. We also need to assume that v' is positive at all feasible taxes, which, from concavity, requires only that $v'(F'(1)) = 1 - \zeta(1-\phi) > 0$.

Also, assume $n = 3$, and suppose for simplicity that voters can be ranked so that $k_1 \leq k_2 \leq k_3$, $l_1 \leq l_2 \leq l_3$, in which case $p = q = m = 2$ and the median voter is not shifting. Choose $(l_1, l_2, l_3) = (0, 0, 1)$ i.e. so the median voter owns no immobile factor, but $(k_1, k_2, k_3) = (0, 0.5, 0.5)$ so the median voter owns half the capital.

First, from (10) the equilibrium tax in the closed economy satisfies

$$k_2 = 0.5 = v'(\tau^c) = 1 - \zeta\tau^c \Longrightarrow \tau^c = \frac{0.5}{\zeta} \tag{14}$$

Also, in the open economy, $l_2 = 0$, so the median voter pays none of the cost of the public good and so chooses to maximise tax revenue $\tau k(r_o + \tau)$. From the production function, $k(r_o + \tau) = (1 - (r_o + \tau))/\phi$, so

$$\tau^o = \arg\max_{\tau} \tau(1 - (r_o + \tau)) = \frac{1 - r_o}{2}$$

But at symmetric equilibrium, all regions have the same capital stock, so the capital market equilibrium condition can be written

$$r_o + \tau^o = F'(1) = 1 - \phi$$

[17] Note that the classic results of Zodrow and Mieszkowski(1986), Wilson(1986) follow from Proposition 3, because if all agents are identical, i.e. $k_i = l_i = \frac{1}{n}$, all $i \in N$, the hypotheses of Proposition 3 are clearly satisfied.

Solving these two conditions simultaneously, we get $\tau^o = \phi > 0$. So, for $\tau^o > \tau^c$, we need only $\phi\zeta > 0.5$. Also, the conditions for an interior solution in Propositions 1 and 2 reduce to

$$\begin{aligned} k_2 &= 0.5 \geq v'(F'(1)) = 1 - \zeta(1-\phi) \\ l_2 &= 0 \geq v'(F'(1))/\mu(F'(1),1) = (1-\zeta(1-\phi))\left(1 - \frac{(1-\phi)}{\phi}\right) \end{aligned}$$

So, the parameter restrictions are: $\phi\zeta > 0.5,\ 0.5 \geq 1-\zeta(1-\phi) > 0,\ \phi \leq 0.5$. These are easily satisfied simultaneously, for example, by $\phi = 0.4,\ \zeta = 1.5$. $\|$

The final and important question then arises as to "how big" the incidence effect (i.e. difference between k_p and l_q) needs to be to get a reversal of the standard result. (In Example 1, for convenience, the difference between the capital and labour shares, $k_p - l_q$, is assumed as large as possible, i.e. 0.5.) To answer this question, note that if the median voters in closed and open economies have capital and labour shares $k_p, l_q > 0$ respectively, then they will choose the same taxes in closed and open economy cases if

$$k_p = \mu(\tau(k_p), 1)l_q \equiv \psi(k_p, l_q)$$

where $\tau(k_p) = v'^{-1}(k_p)$ is the tax chosen by the median voter in the closed economy. Moreover, it is clear from (10),(13) that if $k > \psi(k,l)$, $\tau^o > \tau^c$, and vice versa. Formally, we have:

Proposition 4. *τ^o is greater, equal to, or less than τ^c as $k_p > \psi(k_p, l_q),\ k_p = \psi(k_p, l_q)$, or $k_p < \psi(k_p, l_q)$ respectively.*

Note, due to $\mu > 1$, that $\psi(k,l) > l$. So, the quantity

$$\eta = \left(\frac{\psi(k_p, l_q)}{l_q} - 1\right) \times 100\% > 0$$

is the minimum percentage by which the median capital endowment must exceed the median labour endowment in order to get a reversal of the standard result that the equilibrium tax falls following CMI. Example A1 in the Appendix shows, for appropriate choice of parameter values, that η can be small: indeed, it is possible to choose parameters so that η can be arbitrarily close to zero. The intuition is that for appropriate choice of parameters, the marginal cost of public funds μ can be made arbitrarily close to one around $\tau(k_p)$.

In Proposition 3, we have assumed also that median voter does not shift. However, the inspection of the proof of this proposition makes it clear that non-shifting is not required (the result goes though as long as $k_p = l_q$, even if $p \neq q$). In other words, shifting median voter effect *in itself* has no effect at all on equilibrium taxes[18], and thus on the relationship between τ^c and τ^o. It is, nevertheless interesting (and not noted in the literature, to our knowledge) that the identity of the median voter changes following the opening of the economy.

[18] Another way of seeing this is to take an initial situation where the median voter does not shift ($p = q$), and then consider a permutation of the labour endowments across individuals. So, now there is a shifting median voter. But, the share of the median voter with respect to labour endowments, and thereby the incidence effect, has not changed. So neither τ^o nor τ^c change.

4 Capital Market Integration and Tax Competition: the General Case

4.1 Majority Voting Equilibrium in Closed and Open Economies

First consider the closed economy. From (8), the payoff of agent $i \in N$ in any country is

$$u_i(\tau_w, \tau_r) = (F'(1) - \tau_r)k_i + (w(1) - \tau_w)l_i \ + v(\tau_r + \tau_w) \tag{15}$$

It is now clear from (15) that *both the capital endowment k_i and the labour endowment l_i* will affect voter preferences over (τ_r, τ_w). So, generally, there is multidimensionality in the preference parameters, as well as in the policy space, and indeed, it is possible to show that generally, there will be no Condorcet winner. Our approach, following Persson-Tabellini(2000) Ch 12, is to impose a linear restriction on the relationship between the labour and capital endowments of any agent. This is sufficient to ensure that voters have intermediate preferences (Persson-Tabellini(2000), Definition 4), and so a Condorcet winner exists. Specifically, we assume that $k_i = a + bl_i$, and $a = (1-b)/n$ to ensure that the conditions $\sum_{i \in N} k_i = \sum_{i \in N} l_i = 1$ are satisfied. Then (15) becomes

$$u_i(\tau_w, \tau_r) = (F'(1)b + w(1))l_i - (\tau_r b + \tau_w)l_i + (F'(1) - \tau_r)\left(\frac{1-b}{n}\right) \ + v(\tau_r + \tau_w) \tag{16}$$

Note from (16) that the ideal taxes of agent i only depend on his labour endowment (and the constant $(1-b)/n$). With these preferences, there exists a unique Condorcet Winner $(\tau_w, \tau_r) \in S_c$, which is the ideal tax vector of the individual with the median labour endowment. Above, we defined this individual as q : here, for convenience, we label this voter m, where m denotes the median labour endowment. So, the equilibrium taxes (τ_w^c, τ_r^c) maximise $u_m(\tau_w, \tau_r)$, as defined in (15), subject to the constraint that $(\tau_w, \tau_r) \in S_c$. The following proposition characterises these taxes:

Proposition 5. *(i) Assume $l_m < k_m$, $v'(0) > k_m > v'(F(1))$. Then $\tau_w^c = w(1)$, and $v'(w(1) + \tau_r) = k_m$. (ii) Assume $l_m > k_m$, $v'(0) > l_m > v'(F(1))$. Then $\tau_r^c = F'(1)$, and $v'(F'(1) + \tau_w) = l_m$.*

Proof. The proof is standard, given the objective function (15), the constraints $(\tau_w, \tau_r) \in S_c$, and the strict concavity of v. □

Part (i) of this Proposition[19] is illustrated below in Figure 2. As is clear in that figure, the opportunity cost of the public good for the median voter is k_m. If demand for the public good at this cost is below $w(1)$ - the maximum labour tax - the maximum labour tax is employed, and the remainder of the tax revenue is used to subsidise capital. If demand for the public good at this cost is above $w(1)$, the maximum labour tax is employed, and the additional revenue is raised though taxing capital. Part (ii) has a similar interpretation.

[19]Note that the condition $v'(0) > \max\{k_m, l_m\} > v'(F(1))$ ensures positive provision and positive private consumption in period 2.

Figure 2 in here

Now consider the open economy case. Here, as each country is small, voters take r_o as fixed and thus from (6), they perceive that $\tilde{k} = k(r_o + \tau_r)$. So, from (8), the pay-off of agent i in any country, is

$$u_i(\tau_w, \tau_r, r_o) \equiv r_o k_i + (w(k(r_o + \tau_r)) - \tau_w) l_i \; + v(\tau_w + \tau_r k(r_o + \tau_r)). \tag{17}$$

Now note that *only the weights l_i given by the labour endowment* will affect voter preferences over (τ_w, τ_r). So, the relevant preference space is unidimensional and the intermediate preference condition in Persson-Tabellini(2000) is automatically satisfied, *whatever* the relationship between the labour and capital endowments. So, the voter with the median labour endowment, m, is the median voter, and consequently, the Condorcet-winning taxes (τ_w^o, τ_r^o) in the open economy maximise $u_m(\tau_w, \tau_r, r_o)$ subject to the feasibility constraints on taxes that $(\tau_w, \tau_r) \in S_o$. Note that in the open economy case, (τ_w^o, τ_r^o) depends on r_o, but as all countries are identical, the only possible equilibrium is where taxes are the same in all countries, and hence r_o is such that $k(r_o + \tau_r^o) = 1$. These facts imply the following characterization of equilibrium taxes in the open economy:

Proposition 6. *Assume $v'(0) > l_m$. If $v'(w(1)) \leq l_m$, $\tau_r^o = 0$ and τ_w^o solves $v'(\tau_w) = l_m$. If $v'(w(1)) > l_m$, $\tau_r^o = 0$, and $\tau_w^c = w(1)$.*

Proof. The proof is given in the Appendix.□

Thus the capital tax is set to zero, whatever the labour and capital endowments of the median voter. This result is reminiscent of the well-known finding that under non-cooperation, countries that satisfy the assumptions of the aggregate production efficiency theorem of Diamond and Mirrlees (1971) find it optimal not to tax capital at source.[20]

4.2 Capital Market Integration and Tax Competition

Comparing Propositions 5 and 6, the consequences of CMI for taxation of capital are clear. Generally, the tax on capital changes from τ_r^c to zero. So, whenever $\tau_r^c > 0$ we have confirmation of the "standard" kind of result that international tax competition lowers capital taxes. On the other hand, if $\tau_r^c < 0$, we have the opposite. It then follows immediately from Propositions 5 and 6 that:

Proposition 7. *International tax competition raises capital taxes i.e. $\tau_r^c < 0$ iff $k_m > \max\{l_m, v'(w(1))\}$, and (weakly) lowers capital taxes otherwise.*

To interpret this condition, note that what is required is that both (i) the median voter is a "capitalist" i.e. $k_m > l_m$ and (ii) he does not value the public good too highly i.e. $k_m > v'(w(1)$. The

[20]See, for instance, Gordon (1986) and Razin and Sadka (1991). The assumptions in question are that countries are small open, returns from investment are certain, there is free capital mobility, labour can be taxed, and producers are perfectly competitive. The reason is simple. It is better to tax labour directly than to rely on an indirect labour tax like a tax on capital.

first condition ensures in equilibrium, the tax on labour is always at a maximum, and the second ensures that not all of the tax revenue from the labour tax is used to fund the public good, leaving some excess to fund a capital subsidy.

Note that this comparison is rather simpler than in the case with no labour income tax. However, this simplicity has been purchased at the cost of making a rather strong assumption about the joint distribution of labour and capital endowments. The extent to which this assumption can be relaxed is discussed in Section 5.3.

Before leaving this Section we also discuss briefly the case of non-negative taxes. If subsidies were ruled out then, as it is obvious from the proof of Proposition 6, the ideal policy mix of the median voter under CMI would still be given by Proposition 6 i.e. $\tau_r^o = 0$. Accordingly, if either $k_m < l_m$ or $v'(w(1)) > k_m > l_m$ CMI would lead to an decrease in capital taxes, as Proposition 5 implies that $\tau_r^c > 0$. If, on the other hand, $k_m > l_m$ and $k_m \geq v'(w(1))$ the median voter's ideal capital tax under a closed economy is at the corner, i.e. $\tau_r^c = 0$. So, in the absence of subsidies, if the median voter is a capitalist and does not value the public good highly, capital is not taxed whether the economy is closed or open. Clearly, then, if subsidies cannot be deployed CMI cannot lead to higher capital taxes.

5 Extensions

5.1 Preference Heterogeneity

In Examples 1 and A1, labour income is assumed, for clarity, to be more unequally distributed than capital income: $k_m = 0.5 > 0 = l_m$. However, this is empirically implausible: the available evidence suggests that wage income is less unequally distributed than non-wage income (see for instance Goodman et. al. (1997)). However, it is possible to show that if we also allow heterogeneity in preferences, one can generate the conclusion of a higher tax in the open economy than in the closed one, while having labour income less unequally distributed than capital income: $k_m < l_m$.

The idea is as follows. Assume the simple case with $\tau_w = 0$. Suppose that the utility of agent i from the public good is $\gamma_i v(g)$. Then, making this substitution in (8) and dividing though by γ_i, we can write payoffs up to a factor of proportionality as:

$$u_i = \begin{cases} (F'(1) - \tau_r)\alpha_i + (w(1) - \tau_w)\beta_i \ + v(\tau_r + \tau_w) & \text{(closed)} \\ r_o\alpha_i + (w(\tilde{k}) - \tau_w)\beta_i \ + v(\tau_r\tilde{k} + \tau_w) & \text{(open)} \end{cases} \tag{18}$$

where $\frac{k_i}{\gamma_i} = \alpha_i$, $\frac{l_i}{\gamma_i} = \beta_i$. Call these *preference-adjusted* capital and labour endowments: these will determine the median voters' ideal taxes on the closed and open economies respectively. Then, as Example 2 below shows, the idea is to choose the $\{\gamma_i\}_{i \in N}$ so that the actual distribution of endowments has capital more unequally distributed than labour, but the preference-adjusted capital endowment being less unequally distributed than the corresponding labour endowment: it is the latter that is needed for $\tau_o > \tau_c$.

Example 2. Technology and $v(g)$ are the same as in Example 1. So, the equilibrium tax in the closed economy is given by

$$\alpha_p = v'(t^c\overline{k}) = 1 - \zeta t^c, \tag{19}$$

and the equilibrium tax in the open economy is given by

$$\beta_q = v'(t^o\bar{k})\left(1 + \frac{t^o}{\bar{k}F''(\bar{k})}\right) = (1 - \zeta t^o)(1 - \frac{t^o}{\phi}). \tag{20}$$

Also, assume that $n = 3$.

Now choose $(k_1, k_2, k_3) = (0, 0.1, 0.9)$, $(l_1, l_2, l_3) = (0, 0.3, 0.7)$. Note that $k_2 < l_2 < 1/3$. This is a world where endowments are unequally distributed (the distributions of endowments are left-skewed), with capital income being more unequally distributed than non-capital income. Suppose that $\gamma_3 = 0.9$ and $\gamma_2 = 0.1$. These imply that $(a_1, a_2, a_3) = (0, 1, 1)$ and $(\beta_1, \beta_2, \beta_3) = (0, 3, 7/9)$. So, $a_p = 1 > 7/9 = \beta_q$ and $p = q = 3$. Also, the conditions for interior equilibria with non-negative world interest rate reduce to

$$\begin{aligned} 1 &= v'(0) \geq \alpha_3 = 1 \geq v'(F'(1)) = 1 - \zeta(1-\phi) \\ 1 &= v'(0) \geq \beta_3 = 7/9 \geq v'(F'(1))/\mu(F'(1), 1) = (1 - \zeta(1-\phi))\left(1 - \frac{(1-\phi)}{\phi}\right). \end{aligned}$$

Note then that $t^c = 0 < t^o$, for any ϕ and ζ that satisfy the above inequalities.‖

5.2 Relaxing the Intermediate Preference Assumption

One strong assumption made in Section 4 was that the endowments of capital and labour were linearly related. This was done in order to demonstrate the existence of Condorcet winner in the closed economy, when both labour and capital taxes could be set separately. Here, we briefly argue that this assumption can be relaxed if some minimal assumptions are made on the voting agenda over the set of alternatives S_c.

Assume that $\{k_i\}_{i\in N}, \{l_i\}_{i\in N}$ are perfectly rank-correlated, either positively or negatively. This is equivalent to saying that $k_i = f(l_i)$, where f is either a strictly increasing or a strictly decreasing function. This clearly weakens the assumption that $k_i = a + bl_i$ made in Section 4.1. With this weaker assumption, a Condorcet Winner will generally not exist in S_c. But suppose that we impose *issue-by-issue voting* i.e. majority voting on either τ_r, followed by τ_w, or vice versa. Generally, as $u_i(\tau_w, \tau_r)$ is not additively separable in τ_w, τ_r, the order of items on the agenda will matter. In particular, this will occur when the median voter over τ_w is not the median voter over τ_r (see, for instance, Ordeshook(1986) and Muller(1989)). In this case, issue-by-issue voting will give two possible outcomes, depending on the agenda.

On the other hand, when endowments are perfectly (positively or negatively) rank-correlated, then clearly voter $m = (n+1)/2$ is the median voter over both τ_w, τ_r. In that case, *whatever* the order, m is effectively dictator, so issue-by-issue majority voting will lead to a choice of (τ_w, τ_r) that maximise $u_m(\tau_w, \tau_r)$ over the set of feasible taxes. Then, Proposition 5 - and therefore Proposition 7 - continues to apply.

6 Related Literature

Apart from the seminal work of PT, and the paper of Kessler, Lufesman, and Myers(2002), our paper is related to two parts of the now vast literature on capital tax competition. First, and most importantly, there are papers that have explicitly or implicitly derived conditions under which Nash equilibrium taxes rise in some or all countries following capital market integration.

The relevant work can be subdivided in two. First, there are contributions that study *asymmetries between countries*. For example, DePater and Myers (1994) study a version of the ZMW model but allow for asymmetric countries that do not take the world interest rate as fixed. In that model, if a country is a sufficiently large capital importer it will set a higher tax when capital becomes more mobile. This is intuitive as a tax on capital lowers the interest rate i.e. the cost of capital to an importing country. In a well-known paper, Wilson (1987) considers a model with trade in goods as well as capital: specifically, two goods, one labour-intensive and one capital-intensive. In that model, even if countries are symmetric ex ante, in equilibrium, one set of countries produces the capital-intensive good and set low tax rates (these countries import capital), and the other set of countries produce the labour-intensive good and set high tax rates (these countries export capital). In the first group of countries taxes are lower under perfect capital mobility. This can be thought of as a model of *endogenous* asymmetry across countries. Of course, the results of these papers are weaker than ours, in the sense that in equilibrium, only a *subset* of the countries raise their taxes following capital market integration.

Second, some recent papers present symmetric models where under certain conditions, taxes in *all* countries rise following capital market integration. The first, Huizinga and Nielsen (1997) relies on a *tax-exporting* argument. They allow agents in one country to own share of the immobile factor (land) in the other countries. So, following capital market integration, the capital tax set in any country i is partially shifted to owners of land in other countries. If the level of foreign ownership is large enough, taxes in all countries rise following capital market liberalization.[21] Noiset(1995) and Wooders, Zissimos and Dhillon(2001) consider a second variant of the ZMW model where the tax funds a public

[21] A further paper that fits this category is Keen and Kotsogiannis (2002), where tax jurisdictions are identical, but there is a federal government which taxes capital as well. This feature introduces a vertical tax externality: countries do not take into account the erosion of the federal tax base which results from an increase in local capital tax. If this vertical externality is large relative to the standard horizontal tax externalities, then over-taxation will result.

infrastructure good, rather than a final good. If, at Nash equilibrium, the degree of complementarity between capital and the infrastructure input is sufficiently large,[22] taxes with capital mobility will be inefficiently high. The intuition is simply that with strong complementarity, countries have an incentive to overinvest in infrastructure.

Our distinctive contribution to this literature is that we show that a tax rise following CMI is possible when the political process is modelled realistically, not because of some economic modification or elaboration of the ZMW model. Specifically, in our model, a benevolent (i.e. welfare maximizing) dictator would always choose lower taxes in the open economy: higher taxes arise because of the interaction of the "dictatorship" of the median voter with the tax incidence effect.

The second related literature comprises several papers that have studied choice of taxes via majority voting in variants of the ZMW and related models. Grazzini and van Ypersele (1999) have asymmetric countries and also heterogeneity of capital endowments. They study Nash equilibrium taxes in the open economy with majority voting in each country, but do not study the closed economy equilibrium (their focus is on when a proposal for a minimum tax on capital will be unanimously accepted). Consequently, they do not identify the incidence and shifting median voter effects. Kessler et. al. (2000)'s model is very similar to Grazzini and van Ypersele (1999): heterogenous countries, and also agents within a country differing with respect to capital (but not labour) endowments.[23] They study Nash equilibria with majority voting in both countries both with and without capital mobility. However, their additional assumptions ensure that in any country, the equilibrium tax is *always* lower with capital mobility than without[24].

7 Conclusions

This paper provides one possible explanation for why taxes on capital may not fall, but *rise*, following capital market integration. Our explanation is based on three simple ingredients: equilibrium tax-shifting in the ZMW model, heterogeneity between agents within countries, and decision-making through a political process such as majority voting, rather than benevolent dictatorship. These interact to produce the incidence effect on equilibrium taxes following capital market integration. If the differences between the median preference-adjusted endowments of the mobile factor (capital), and the fixed factor

[22]Specifically, the cross-partial derivative of output with respect to capital and infrastructure must be sufficiently large at Nash equilibrium. An assumption sufficient to rule this out was made by Zodrow and Mieszkowski(1986) in their original paper, so they also found under-taxation with an infrastructure public good.

[23]In fact, they just allow for two groups, rich and poor.

[24]Specifically, in their model, tax revenue is not spent on a public good but is returned in the form of a grant to every agent. This can be formally captured in our model by writing $\gamma_i = 1$ and $v(g) = g$. Then, it is clear that in the closed economy case, the median voter p will choose the maximum feasible tax because $v'(g) = 1 > k_p$, and indeed, that is their result. So, the open-economy tax cannot be higher than the closed-economy tax.

(land) are large enough, the incidence effect may more than offset the usual effects of tax competition, and cause equilibrium taxes to rise. We also show that the same logic applies to the case where capital and labour can be taxed separately.

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9 Appendix

Example A1. Preferences and technology are the same as in Example 1. Also, $n = 3$. We first write down conditions that hold on k_2, l_2, the endowments of the median voter. Thus, as $n = 3$, the median voer cannot own more than half the endowment of any asset, i.e. $k_2, l_2 \leq 0.5$. Combining this with A1, we get:

$$1/2 \geq k_2 \geq 1 - \zeta(1 - \phi)$$

For this set of parameter values to be non-empty, we require

$$\zeta \geq 1/2 + \zeta\phi \tag{21}$$

Again, combining $l_2 \leq 0.5$ with A2, we get:

$$1/2 \geq l_2 \geq [1 - \zeta(1 - \phi)](\frac{2\phi - 1}{\phi})$$

and for this set to be non-empty, we require

$$\phi \leq \frac{3\phi\zeta + 1 - \zeta}{3/2 + 2\phi\zeta} \tag{22}$$

Also, recall that

$$\zeta < 1 + \phi\zeta \tag{23}$$

from $v'(F'(1)) > 0$. So, together, (21),(22),(23) with $\phi \in (0, 1)$ and $\zeta > 0$ define a feasible set for ϕ, ζ. Next, note that in this example,

$$\begin{aligned}
\eta &= \frac{\psi}{l} - 1 \\
&= \mu(\tau(k_2), 1) - 1 \\
&= \frac{1}{1 + \tau(k_2)/F''(1)} - 1 \\
&= \frac{1}{1 - (1 - k_2)/\zeta\phi} - 1 \\
&= \frac{(1 - k_2)}{c - (1 - k_2)} \\
&\leq \frac{1}{c - 1}
\end{aligned}$$

where $c = \zeta\phi$. So, it is clear that as $c \to \infty$, then $\eta \to 0$. Finally, it is possible to show that we can choose[25] feasible ζ, ϕ such that $c = \phi\zeta$ for any $c > 0$. So, we can choose parameter values such that $\eta \simeq 0$ to any desired approximation. □

[25] To see this define first $\frac{3c+1-\zeta}{3/2+2c} \equiv f(\zeta)$. Given this definition we have that the feasible set of $\phi \in (0, 1)$ and $\zeta > 0$ is given by $\phi \leq f(\zeta)$ and $\zeta \in [0.5 + c, 1 + c)$. Note now that $\phi\zeta = c$ implies that $\phi = c/\zeta \equiv h(\zeta)$. Thus in order to show the validity of the argument in the main text we need to show, given any $c > 0$, that $h(\zeta) \in (0, 1)$ and $h(\zeta) \leq f(\zeta)$ for some $\zeta \in [0.5 + c, 1 + c)$. Note that $h'(\zeta) < 0$, $f'(\zeta) < 0$, $h(\zeta) \in (0, 1)$, $0 < h(1 + c) < f(1 + c) < h(1/2 + c) < f(1/2 + c) < 1$. Then, one can choose $\zeta \in [\zeta^*, 1 + c]$ where ζ^* is the maximum of $0.5 + c$ and of the largest solution of $h(\zeta) = f(\zeta)$.

Proof of Proposition 6. The equilibrium taxes maximise (17) subject to $\tau_w \leq w(k(r_o + \tau_r))$, $0 \leq \tau_r\tilde{k} + t_w$. Ignoring the latter constraint, the first-order conditions are:

$$\begin{aligned} -l_m + v'(\tau_w + \tilde{k}\tau_r) - \xi &= 0 \\ -\tilde{k}l_m + v'(\tau_w + \tilde{k}\tau_r)[\tilde{k} + \tau_r k'] - \xi\tilde{k} &= 0 \end{aligned}$$

So, if the constraint $\tau_w \leq w(k(r_o + \tau_r))$ is not binding, $\xi = 0$, and we have

$$\begin{aligned} -l_m + v'(\tau_w + \tilde{k}\tau_r) &= 0 \\ -\tilde{k}l_m + v'(\tau_w + \tilde{k}\tau_r)[\tilde{k} + \tau_r k'] &= 0 \end{aligned}$$

At equilibrium, $\tilde{k} = 1$, and so

$$\begin{aligned} -l_m + v'(\tau_w + \tau_r) &= 0 \\ -l_m + v'(\tau_w + \tau_r)[1 + \tau_r k'] &= 0 \end{aligned}$$

The unique solution to these equations is $\tau_r = 0$, $l_m = v'(\tau_w)$. Given $v'(0) > l_m$ we have that $\tau_w > 0$ and thereby positive provision. For the constraint $\tau_w \leq w(k(r_o+\tau_r))$ not to be binding at this solution, we require $\tau_w \leq w(1)$, and thus $l_m \geq v'(w(1))$.

If the constraint $\tau_w \leq w(k(r_o + \tau_r))$ is binding, $\xi > 0$ and we have $\tau_w = w(k(r_o + \tau_r)) = w(1)$ in equilibrium. Also, in equilibrium, as $\tilde{k} = 1$, τ_r and ξ solve

$$\begin{aligned} -l_m + v'(w(1) + \tau_r) - \xi &= 0 \\ -l_m + v'(w(1) + \tau_r)[1 + \tau_r k'] - \xi &= 0. \end{aligned}$$

and hence $\tau_r = 0$, and $\xi = v'(w(1)) - l_m$. As $\tau_r = 0$ and $\tau_w = w(1)$, provision is positive. For the constraint $\tau_w \leq w(k(r_o+\tau_r))$ to be binding at this solution, we require $\xi > 0$ and thus $l_m < v'(w(1))$. □

10 Graphs

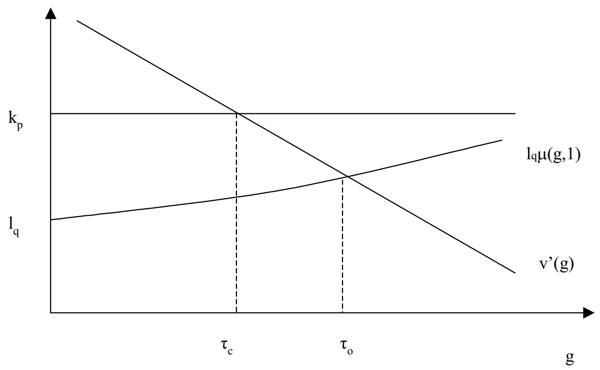

Figure 1:

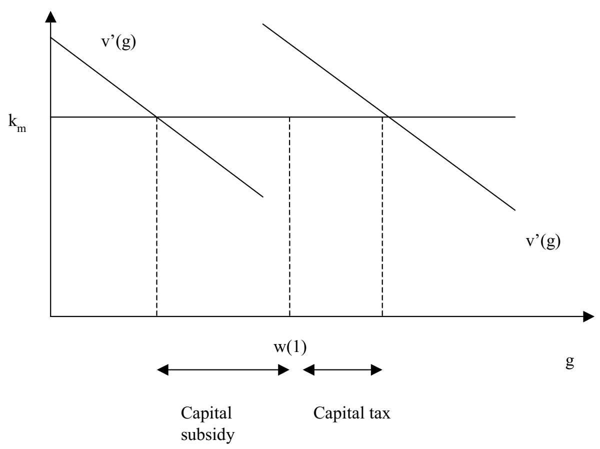

Figure 2: