The political economy of capital market integration and tax competition

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Abstract

This paper investigates the effect of capital market integration (CMI) on capital taxes in a political economy framework in which policy is influenced by lobbying of interest groups. CMI increases the efficiency cost of the capital tax, which introduces incentives to reduce the tax rate, but also reduces lobbying by owners of capitalists, which introduces countering incentives to increase the tax rate. CMI can therefore result in a higher capital tax rate. When the market share of each country is small, CMI may increase government supply of public goods and enhance efficiency, which implies that, in the presence of policy endogeneity through lobbying, decentralized policymaking can be more efficient than centralized policymaking.

Key words: capital mobility, fiscal federalism, globalization, interest groups, political economy, tax competition.

JEL classification: F21, H41, H71

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1. Introduction

The effect of globalization on public policy has been the focus of much attention and debate. Theoretical models predict that integration of capital markets intensifies tax competition among jurisdictions and reduce capital tax rates (Hillman, 2009, chapter 9). The empirical evidence, on the other hand, is not conclusive. Some empirical studies indicate that globalization indeed has a significantly negative impact on capital taxes (e.g., Bretschger and Hettich, 2002; Devereux et al., 2008). Other studies find that the negative effect of increased capital mobility on tax rates is insignificant or even that the capital tax rates increase with capital mobility (see, e.g., Garrett (1995), Quinn (1997), Garrett and Mitchell (2001), Swank and Steinmo (2002), and Dreher (2006)).

The standard tax-competition model is capable of predicting only a decline in capital tax rates as a consequence of capital market integration (henceforth CMI). A satisfactory model should be able to explain the mixed results. Researchers have therefore modified the standard tax competition model. Wilson (1987) demonstrated that the presence of trade leads to multiple equilibrium tax rates, and one of which is higher than the tax rate in the closed economy. By introducing asymmetric tax competition, DePater and Myers (1994) showed that a capital-importing country has an incentive to set a higher capital tax rate in order to depress the net rate of return on capital. Noiset (1995) showed that, when spending provides local benefits, tax competition can increase the local capital tax. Huizinga and Nielsen (1997) pointed out that higher foreign ownership share of domestic firms leads to a rise in the capital tax rate if profits are not fully taxed.

I investigate the effect of CMI on the capital taxes in a political economy framework.[1] Persson and Tabellini (1992), Lockwood and Makris (2006), and Haufler et al. (2008) have looked at the effect of CMI through voting. It seems unlikely that decisions about tax rates are made by voting. Rather we should investigate the role of interest groups. Haufler (1997) and Lorz (1998) have considered the influence of interest groups but in settings than differ from mine. Differences between these latter papers and the present paper are described in section 3.3.

[1] The paper is therefore part of the literature on the political endogeneity of policy. See early studies, see for example Hillman (1982, 1989), Hillman and Ursprung (1988), Grossman and Helpman (2002).

My endogenous policy model builds on Zodrow and Mieszkowski (1986), who described several identical countries. Each government imposes a tax on capital according to the source principle and uses tax revenue to finance a public consumption good. There are two types of residents, capitalists and workers, in a country. CMI increases capital mobility, which increases the efficiency cost of capital taxes and leads policymakers to lower capital tax rates. When policymakers are subject to political influence, CMI can either increase or reduce capital tax rates. When the economy is closed, capitalists bear the entire capital tax burden. Capitalists have an incentive to lobby for a lower capital tax rate. They gain from an increase in private consumption, which outweighs their loss from a decline in the public consumption. When the economy is open, a part of the tax burden is shifted to the workers. Since the capitalists do not bear the entire tax burden, their gains from lobbying to reduce the capital tax rate are reduced as a result of CMI. If tax competition among governments is sufficiently intense, most of the capital tax burden is shifted to the workers, and thus capitalists may even lobby for a higher tax rate. This effect through political endogenous policy has not been considered. I show how the political effect can reverse conventional conclusions.

A well-known conclusion is that tax competition results in sub-optimal supply of public goods. I show that interest groups can either enhance or reduce efficiency, depending on the extent of the tax competition. If tax competition is intense, capitalists bear a small proportion of the capital tax burden, and so they will lobby for a higher capital tax rate to benefit from a larger supply of the public good. Lobbying thus mitigates the under-provision of public goods, or even leads to overprovision. If tax competition is mild, lobbying by capitalists' lobbying results in a lower tax rate, and thus aggravates the problem of under-provision of public goods.

The above conclusion is related to another result of the standard tax competition model, that is, that an increase in intensity of tax competition lowers supply of public goods and increases the inefficiency of tax competition (Hoyt, 1991). I show that, in the presence of lobbying, the opposite may occur, again because of capitalists' lobbying incentives.

A centralized government eliminates capital mobility. The equilibrium policy in the closed economy can be interpreted as that under centralized policymaking. Similarly, the equilibrium policy in the open economy can be interpreted as that under

decentralized policymaking. It has been argued that the inefficiency of tax competition stems from decentralized policymaking and that a remedy for the inefficiency of tax competition is to centralize policymaking or to coordinate policy among countries. The findings of this paper, however, show that in the presence of lobbying, centralized policymaking is not necessarily more efficient than decentralized policymaking.[2]

Section 2 introduces the model underlying the analysis. Section 3 discusses the political effect of CMI and explains why CMI may increase capital tax rates. I turn to the effect of lobbying on tax competition in section 4 and show how lobbying can reverse conclusions of the standard tax competition model. Section 5 extends the basic model to incorporate lobbying by workers and endogenous labor supply. Concluding remarks are in section 6.

2. The model

In this section we construct a simple model close to the setting of Zodrow and Mieszkowski (1986). There are M identical countries. Given symmetry, subscripts denoting countries are omitted. Each country has two types of residents: capitalists and workers. Residents of the same type are homogeneous. Workers are endowed with one unit of labor time and inelastically supply labor to firms as an input and receive the wage w. To demonstrate this point as clearly as possible, we assume that workers do not have to pay taxes on labor income in the basic model.[3] Each capitalist is endowed with $\bar{k}$ units of capital. Each country contains a perfectly competitive industry, which is composed of a large number of identical firms. The firms transform labor and capital into a consumption good by a constant-returns technology. The labor input is internationally immobile, whereas the capital input may or may not be internationally mobile.

There are n^{κ} capitalists in each country. The utility function of a representative capitalist is[4]

[2] Several papers have demonstrated situations in which centralized policymaking may be less efficient than the decentralized policymaking, including Brennan and Buchanan (1980), Kehoe (1989), Edwards and Keen (1996), and Bordignon et al. (2008). Their settings and reasoning are different from those in this paper.

[3] We consider endogenous labor supply and a tax on labor income in section 5.

[4] A similar specification can be found in Lockwood and Makris (2006).

$$u^{\kappa} = y^{\kappa} + \gamma^{\kappa} H(z) \tag{1}$$

where y is the level of the private consumption good, z denotes supply of a public good, and γ^{κ} measures the capitalists' relative preference for z. The function H has the properties that $H' > 0$ and $H'' > 0$ for all non-negative z and also $\lim_{z \to 0} H'(z) = \infty$. The public good is financed by capital-tax revenue. An individual capitalist's private budget constraint is given by $y^{\kappa} = r\bar{k}$, where r is the rate of return on capital.

Since all the firms in a country are identical, we can normalize the number of firms to unity. The production function of a country is $f(K)$, where K is the amount of capital employed by the firms.[5] The production function has the properties $f(0) = 0,\ f' > 0,$ and $f'' < 0$. The firms' demand for capital is based on:

$$f'(K) = r + t \tag{2}$$

where t is the source-based tax on capital.[6]

I follow Lockwood and Makris (2006) to determine the rate of return on capital r and the wage rate w. In the closed economy, the rate of return on capital adjusts so that it is profit-maximizing for firms to employ the country's aggregate endowment of capital. The rate of return on capital in the closed economy is given by

$$r_c = f'(\overline{K}) - t \tag{3}$$

where the subscript c refers to the closed economy and $\overline{K}$ denotes the aggregate endowment of capital, which equals $n^{\kappa}\bar{k}$. From (3), we obtain that $dr_c / dt = -1$; i.e., capitalists bear the entire tax burden in the absence of capital mobility.

In the case of an open economy with capital perfectly mobile across countries, the rate of return on capital is determined by the fully integrated capital market. The equilibrium condition of the integrated capital market is

$$\sum_{j=1}^{M} K_j = \sum_{j=1}^{M} \overline{K}_j \,. \tag{4}$$

[5] The fixed labor input is omitted from the expression for the production function.

[6] The adoption of the source principle can be justified by the lack of cooperation from the tax authorities. As a result, the national tax authorities cannot sufficiently monitor worldwide income. See Razin and Sadka (1991) and Rodrik and van Ypersele (2001) on this point.

Since all countries are identical, from (4) we derive the effect of an individual country's changing *t* on the rate of return on capital in the open economy, which is denoted by r_o,

$$\frac{\partial r_o}{\partial t} = -\frac{1}{M} = -s \tag{5}$$

where *s* is the market share of an individual country. The parameter *s* measures the extent of competition among countries; the smaller is *s*, the more intense is the competition. Equation (5) shows that the rate of return on capital decreases if an individual country raises its capital tax-rate. The adverse effect of the capital tax decreases with the number of countries. From (2) and (5), it follows that

$$\frac{\partial K}{\partial t} = \frac{1-s}{f''} < 0. \tag{6}$$

Let us define the gross price of capital $r_o + t$ as ρ, and we can find that $\partial K/\partial \rho = 1/f''$, so that $\partial K/\partial t = (1-s)\partial K/\partial \rho$.

There are n^l workers in each country. A representative worker's preferences are described by

$$u^l = y^l + \gamma^l H(z). \tag{7}$$

Each worker's private budget constraint is given by $y^l = w$. Again, the determination of the wage rate depends on the behavior of the firms. The wage rate adjusts to the point where it is profit-maximizing for the firms to employ all labor supply. Thus the aggregate labor income for all workers equals

$$n^l w(K) = f(K) - K f'(K). \tag{8}$$

We note that K equals $\overline{K}$ when the economy is closed.

3. The political effects of capital market integration

Capitalists in each country organize themselves as a lobbying group to offer political contributions to the policymaker in their country.[7] For the present, we

[7] We do not consider the case of a foreign lobby, in which a country's capitalists make political

assume that workers constitute a large part of the total population and are thus too numerous to overcome the free-rider problem and organize themselves into a lobbying group. The workers' lobbying is discussed in section 5.

The timing of events is as follows. First, the capitalists offer the policymaker a contribution schedule, which is contingent upon the policy chosen by the policymaker. Then the policymaker determines the capital tax rate and collects the political contributions. Given the capital tax rate, the firms determine their demand for capital.[8]

To obtain the subgame perfect Nash equilibrium, we solve the game backwards. We have analyzed the firms' demand for capital in Section 2. Now we move on to the determination of the capital tax rate. The policymaker is assumed to maximize a weighted sum of the political contributions received and aggregate gross-of-contributions social welfare (as in Grossman and Helpman, 1994), which equals

$$\theta m(t) + W(t) \tag{9}$$

where m represents the capitalists' political contributions, $W(\cdot)$ is social welfare, and $\theta \geq 0$ is the weight given by the policymaker to political contributions relative to the social welfare. θ is exogenous in the model but may depend on the interest groups' lobbying skills or political connections.

Social welfare is the sum of utilities of the capitalists and the workers. The total utility of capitalists is

$$W^{\kappa} = n^{\kappa}\left[y^{\kappa} + \gamma^{\kappa} H\left(z\right)\right]. \tag{10}$$

For the workers,

$$W^{l} = n^{l}\left[y^{l} + \gamma^{l} H(z)\right]. \tag{11}$$

The social welfare function is $W = W^{\kappa} + W^{l}$.

Following Dixit et al. (1997), we focus on the truthful subgame perfect Nash

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contributions to foreign policymakers. Legal donations to politicians are restricted to natives in some democracies. For example, in 1966, the US Congress prohibited political contributions in a US election by a foreign government, political party, corporation or individual. See however Hillman and Ursprung (1988) on foreign lobbying and indirect means of transfer of benefits to foreigners.

[8] This model is static in the sense that rents are created and contested at the same point in time. The issue of enduring rents is investigated by Aidt and Hillman (2008) in a dynamic framework.

equilibrium, in which the capitalists' contribution schedule is globally truthful;[9] that is, the political contribution function of the capitalists everywhere reflects their true welfare.[10] Under the global-truthfulness assumption, the equilibrium capital tax rate can be obtained by solving the following problem:

$$\max_{t} \; G(t) = \theta W^{\kappa}(t) + W(t) = (1+\theta) W^{\kappa} + W^{l}. \tag{12}$$

The policymaker maximizes a weighted social welfare function, in which the capitalists receive a weight of $1+\theta$, and the workers receive the smaller weight of unity.

The political equilibrium capital tax rate, which is denoted by $\hat{t}$, is determined by the following first-order condition:

$$\frac{\partial G}{\partial t} = \theta \frac{\partial W^{\kappa}}{\partial t} + \frac{\partial W}{\partial t} = 0. \tag{13}$$

We refer to the first term and the second term on the right-hand side of (13) as the political effect and the welfare effect, respectively. The standard tax competition model recognizes only the welfare effect.

3.1. The closed economy

We first characterize the equilibrium tax rate in the closed economy. We first look at the political effect, which is the product of θ and $\partial W^{\kappa}/\partial t$, which reflects the lobbying incentive of the capitalists. If $\partial W^{\kappa}/\partial t < 0$, capitalists exert a downward political pressure on the capital tax; if $\partial W^{\kappa}/\partial t > 0$, capitalists will lobby for a higher tax rate. In the closed economy, $\partial W^{\kappa}/\partial t$ is given by

$$\frac{\partial W^{\kappa}}{\partial t} = n^{\kappa} \frac{\partial y^{\kappa}}{\partial t} + n^{\kappa} \gamma^{\kappa} H'(z) \frac{\partial z}{\partial t}. \tag{14}$$

The above equation shows that the capitalists' lobbying incentive depends on two

[9] The global-truthfulness assumption, which simplifies our exposition, is not essential to the following analysis. The main results remain the same without this assumption.

[10] Bernheim and Whinston (1986) show that a truthful function is always a best response to any strategy of the opponent. Thus, they argue that truthful Nash equilibria may be focal among the set of Nash equilibria. This can justify the assumption of global-truthfulness.

components. The first, $n^{\kappa} \cdot \partial y^{\kappa} / \partial t$, is the effect of the capital tax on the private income, to which we refer as the private-income effect. Since $y^{\kappa} = r_c \bar{k}$ and $r_c = f'(\bar{K}) - t$, we have $\partial y^{\kappa} / \partial t = -\bar{k}$. As a result, an increase in *t* lowers the capitalists' income, and the private-income effect is negative. A negative private-income effect leads the capitalists to lobby for a lower capital tax rate, so as to receive more private consumption.

The second component, $n^{\kappa} \cdot \gamma^{\kappa} H'(z) \cdot \partial z / \partial t$, measures the effect of t on the public good, which we refer to as the public-consumption effect. In the closed economy, the government budget constraint is given by $Nz = tn^{\kappa}\bar{k}$, where $N = n^{\kappa} + n^{l}$. We can rewrite the above equation in per capita terms:

$$z = t\alpha^{\kappa}\bar{k} \tag{15}$$

where $\alpha^{\kappa} = n^{\kappa} / N$. The amount of the public good increases with *t*, which can be seen by differentiating (15) with respect to *t*:

$$\frac{\partial z}{\partial t} = \alpha^{\kappa}\bar{k} > 0. \tag{16}$$

Thus, the public-consumption effect is positive, and it leads the capitalists to raise the capital tax rate. Although the private-income effect and public-consumption effect work in opposite directions, we demonstrate below that the private-income effect will outweigh the public-consumption effect in equilibrium. This means that the capitalists will exert a downward political pressure on the capital tax rate.

The welfare effect also consists of two components: the effect of *t* on the capitalists' welfare, which is given by (14), and the effect of *t* on the workers' welfare, which can be obtained by differentiating the aggregate welfare of the workers with respect to *t*:

$$\frac{\partial W^{l}}{\partial t} = n^{l}\frac{\partial y^{l}}{\partial t} + n^{l}\gamma^{l}H'(z)\frac{\partial z}{\partial t}. \tag{17}$$

Since the capitalists bear the full capital tax burdens in the closed economy, a change in *t* does not affect the workers' income; i.e., $\partial y^{l} / \partial t = 0$. Moreover, as in the case of the capitalists, the public-consumption effect for the workers is positive, and thus $\partial W^{l} / \partial t$ is positive as well. Combining (14) with (17) gives the welfare effect in the

closed economy as follows:

$$\frac{\partial W}{\partial t} = n^{\kappa}\frac{\partial y^{\kappa}}{\partial t} + n^{l}\frac{\partial y^{l}}{\partial t} + \left(n^{k}\gamma^{k} + n^{l}\gamma^{l}\right)H'(z)\frac{\partial z}{\partial t}. \tag{18}$$

Our goal is to obtain the equilibrium condition for the provision of the public good, which is described by the (unweighted) marginal rate of substitution (MRS) between the public consumption and the private consumption. This can be done by substituting (14) and (18) into (13), which gives

$$H'_c = \frac{1+\theta}{\phi} \tag{19}$$

where $\phi = (1+\theta)\alpha^{\kappa}\gamma^{\kappa} + \alpha^{l}\gamma^{l}$, in which $\alpha^{l} = n^{l}/N$. The above equation implicitly defines the equilibrium capital tax rate in the closed economy, which is denoted by $\hat{t}_c$.

We have argued that the private-income effect outweighs the public-consumption effect in equilibrium. This can be seen by substituting (19) into (14), which gives:

$$\frac{\partial W^{\kappa}(\hat{t}_c)}{\partial t} = -\frac{\alpha^{l}\gamma^{l}}{\phi}\overline{K} < 0. \tag{20}$$

We can also verify that $H'_c(\theta > 0)$ is greater than $H'_c(\theta = 0)$, which means that the capitalists' lobbying leads to a suboptimally low level of the public good, and a suboptimally low capital tax rate.[11]

3.2. The open economy

We first look at the political effect. In the open economy, an increase in the capital tax rate results in the flight of capital, which reduces the public-consumption effect. This can be seen by differentiating the government budget constraint, which now becomes $z = tK/N$, with respect to *t*, which gives

$$\frac{\partial z}{\partial t} = \left[1-(1-s)\varepsilon\right]\frac{K}{N} \tag{21}$$

where $\varepsilon = -(\partial K/\partial\rho)\cdot(t/K) > 0$.

Since K is equal to $\overline{K}$ in the symmetric equilibrium, the effect of t on the

[11] Since the level of the public good is positively related to the capital tax rate, a lower level of the public good ensures a lower capital tax rate.

amount of z becomes $\partial z/\partial t = \left[1-(1-s)\varepsilon\right]\alpha^{\kappa}\bar{k}$. Comparing this effect with the counterpart in the closed economy case, which equals $\partial z/\partial t = \alpha^{\kappa}\bar{k}$, shows that CMI gives rise to a smaller public-consumption effect. Other things being equal, a smaller public- consumption effect reduces the capitalists' political pressure to raise *t.*

The lobbying incentive of the capitalists also depends on the private-income effect. In the open economy equilibrium, the private-income effect is equal to $\bar{K}\cdot\partial r_o/\partial t$. According to (5), the private-income effect can be rewritten as $-s\bar{K}$. Recall that the private-income effect in the closed economy is $-\bar{K}$. Thus, capital mobility results in a smaller private-income effect, which reduces the capitalists' downward political pressure on *t*. The reason for this is that the capital mobility shifts a part or all of the capital tax burden to the workers, and thus the capitalists will lobby for a lower tax rate less intensively.

Combining the private-income effect with the public-consumption effect determines the capitalists' lobbying incentive in the open economy as follows:

$$\frac{\partial W^{\kappa}}{\partial t} = -s\bar{K} + \alpha^{\kappa}\gamma^{\kappa}\, H'(z)\left[1-(1-s)\varepsilon\right]\bar{K}. \tag{22}$$

Recall that $\partial W^{\kappa}/\partial t$ in the closed economy equilibrium must be negative. In the open economy equilibrium, however, $\partial W^{\kappa}/\partial t$ could be positive. Inserting the equilibrium MRS in the open economy equilibrium, which will be derived in (27), into (22) reveals the capitalists' lobbying incentive as follow: $\partial W^{\kappa}/\partial t = \left(\bar{K}/\phi\right)$ $\left[(1-s)\alpha^{\kappa}\gamma^{\kappa} - s\alpha^{l}\gamma^{l}\right]$. There exists a critical value of s, denoted by $\hat{s}$, such that

$$\hat{s} = \frac{\alpha^{\kappa}\gamma^{\kappa}}{\alpha^{\kappa}\gamma^{\kappa} + \alpha^{l}\gamma^{l}}. \tag{23}$$

If $s < \hat{s}$, the capitalists seek to raise the capital tax rate. If $s > \hat{s}$, the opposite occurs.

The following lemma describes the net effect of CMI on the political effect:

Lemma 1. *Capital market integration reduces the capitalists' downward political pressure on the capital tax rate, regardless of the extent of tax competition among competing countries.*

Proof. See Appendix A.

We now turn to see how CMI affects welfare. The effect of *t* on capitalists' welfare has been obtained in (22). The effect of an increase in *t* on the workers' aggregate income is given by

$$\frac{\partial n^l y^l}{\partial t} = -(1-s)K < 0. \tag{24}$$

Recall that in the closed economy, the capitalists bear the full burden of the capital tax, so the workers' income is independent of *t*. In the open economy, at least a part of the tax burden is shifted to the workers because of capital mobility, and thus the workers' aggregate income decreases with *t*. The effect of *t* on the public consumption is the same as in (21). By substituting (21) and (24) into (17), we obtain the impact of *t* on the workers' aggregate welfare in the open economy as follows:

$$\frac{\partial W^l}{\partial t} = -(1-s)\bar{K} + \alpha^l \gamma^l H'(z)\left[1-(1-s)\varepsilon\right]\bar{K}. \tag{25}$$

The welfare effect can be obtained by combining (22) with (25), which gives:

$$\frac{\partial W}{\partial t} = -\bar{K} + \left(\alpha^\kappa \gamma^\kappa + \alpha^l \gamma^l\right) H'(z)\left[1-(1-s)\varepsilon\right]\bar{K}. \tag{26}$$

Comparing the above equation with (18), the welfare effect in the closed economy, shows that CMI reduces the welfare effect.[12] With a smaller welfare effect, the policymaker will choose a lower capital tax rate as a result of CMI, which is what the standard tax competition model proposes.

To obtain the equilibrium condition for the provision of the public good, we substitute (22) and (25) into (13), which gives:

$$H_o' = \frac{1+s\theta}{\phi\left[1-(1-s)\varepsilon\right]}. \tag{27}$$

Now we can address the major issue: the effect of CMI on the capital tax rate; specifically, we are about to compare $\hat{t}_o$ with $\hat{t}_c$. Since $H'(\cdot)$ decreases with *t*, we can obtain the relationship between $\hat{t}_o$ and $\hat{t}_c$ by comparing H_o' with H_c'. If H_o' is greater than H_c', then $\hat{t}_o$ is lower than $\hat{t}_c$, indicating that CMI results in a lower capital tax rate. If H_o' is less than H_c', then the opposite occurs. By comparing (27)

[12] Equation (18) can be rewritten as $\partial W/\partial t = -\bar{K} + \left(\alpha^\kappa \gamma^\kappa + \alpha^l \gamma^l\right) H'(z)\bar{K}$. Clearly, $\partial W/\partial t$ is smaller in the open economy than in the closed economy.

with (19), we derive a critical value of θ, $\hat{\theta}$, which equals

$$\hat{\theta} = \frac{\varepsilon}{1-\varepsilon}. \tag{28}$$

If $\theta > \hat{\theta}$, then $H_o' < H_c'$, and $\hat{t}_o > \hat{t}_c$. If $\theta < \hat{\theta}$, then $H_o' > H_c'$, and $\hat{t}_o < \hat{t}_c$.

We summarize the above results in the following proposition:

Proposition 1. *If $\theta > \hat{\theta} = \varepsilon/(1-\varepsilon)$, capital market integration leads to a higher capital tax rate; i.e., $\hat{t}_o > \hat{t}_c$. If $\theta < \hat{\theta}$, CMI results in a lower capital tax rate.*

3.3. Discussions and related literature

Persson and Tabellini (1992), Lockwood and Makris (2006), and Haufler et al. (2008) examine how capital mobility affects capital taxes in voting models. In Persson and Tabellini (1992), the political effect leads to strategic delegation: capital mobility changes voters' decisions and makes them elect a left-wing government. Lockwood and Makris (2006) show that the median voter in the closed economy is the owner of the median capital endowment, whereas the median voter in the open economy case is the owner of the median labor endowment. If the median capital endowment is high, and the median labor endowment is low, then the median voter's ideal tax rate will be lower in the closed economy, and higher in the open economy. By involving the activity of multinational enterprises, Haufler et al. (2008) show that economic integration raises the profits of multinational firms and thus enhances the redistributive gain from increasing taxes. If this effect dominates the increased efficiency cost due to economic integration, the median voter (a worker) will prefer to raise the tax rate.

Although the political effect is present in these models, I use political pressure of special interest groups to endogenize policy rather than the voting mechanism. Two studies are most related to the present paper. Haufler (1997) considers the political asymmetry between two regions, in which the exogenous political weight of workers is higher in one region than the other. He emphasizes on the asymmetric effects of a reduction in capital mobility cost on workers' political influence. In his paper, CMI increasing the capital taxes occurs only in the asymmetric-country case. In this

present paper, CMI may raise the capital tax rate even in the symmetric equilibrium. Lorz (1998) sets up a world consisting of *N* identical countries. In each country there are *n* households owning different capital endowments. Households with the same capital endowment organize a lobbying group. Capital-poor households prefer a positive capital tax rate, whereas capital-abundant households prefer a capital subsidy. With the assumption of symmetrical distribution of the capital endowments, the political influence of lobbying groups offset each other, resulting in a zero capital tax rate in both open economy and closed economy. My focus is on the effect of capital mobility on the capitalists' political influence. When capital is immobile, the capitalists have an incentive to lower the capital tax rate, because they have to bear the full tax burden. Once the capital markets are fully integrated, capital mobility shifts at least a part of the tax burden to the workers, and thus the capitalists' downward political pressure on the capital tax is reduced. Although CMI lowers the welfare effect, the reduced downward political pressure will outweigh the decline in the welfare effect, provided that θ is sufficiently large. This explains why CMI may give rise to a higher capital tax rate.

Both Haufler (1997) and Lorz (1998) assume fixed government budget constraints, and thus the issue of the underprovision of the public good is absent from their models. This issue, however, is our focus in the next section.

4. Lobbying and tax competition

This section shows that taking the political effect into consideration may reverse some results of the standard model. Since there is no tax competition in the closed economy, we consider only the open economy case in this section.

A well known consequence of tax competition is suboptimal public good supply. Because of a prisoner's dilemma, the equilibrium capital tax rates are set suboptimally low. This result is based on the assumption that each government seeks to maximize its own national welfare.[13]

The first issue we address is whether the presence of lobbying can mitigate the inefficiency due to tax competition. This can be seen by comparing the (unweighted)

[13] If politicians are self-interested, it is well-known that tax competition is beneficial for the citizens. See chapter 9.3 in Hillman (2009) for further details.

MRS in the presence of lobbying with that in the absence of lobbying.

The MRS in the presence of lobbying, denoted by $H_o'(\theta>0, s<1)$, is given by (27). When s equals unity, there is no tax competition, so we consider only the case where s is less than unity. Then substituting $\theta=0$ into (27) gives the MRS in the absence of lobbying as follows:

$$H_o'(\theta=0, s<1)=\frac{1}{\left(\alpha^{\kappa}\gamma^{\kappa}+\alpha^{l}\gamma^{l}\right)\left[1-(1-s)\varepsilon\right]}. \tag{29}$$

The difference between $H_o'(\theta>0, s<1)$ and $H_o'(\theta=0, s<1)$ equals

$$H_o'(\theta>0, s<1)-H_o'(\theta=0, s<1)=\frac{\theta\left[s\alpha^{l}\gamma^{l}-(1-s)\alpha^{\kappa}\gamma^{\kappa}\right]}{\left(\alpha^{\kappa}\gamma^{\kappa}+\alpha^{l}\gamma^{l}\right)\phi\left[1-(1-s)\varepsilon\right]}. \tag{30}$$

The sign of (30) is ambiguous. If $s<\hat{s}=\alpha^{\kappa}\gamma^{\kappa}/\left(\alpha^{\kappa}\gamma^{\kappa}+\alpha^{l}\gamma^{l}\right)$ as defined by (23), then $H_o'(\theta>0, s<1)<H_o'(\theta=0, s<1)$, indicating that the capitalists' lobbying increases supply of the public good. Thus, if tax competition is intense (i.e., s is small), then capitalists' lobbying will mitigate the underprovision of the public goods due to tax competition.

However, capitalists' lobbying may lead to the oversupply of public goods. To illustrate this, we need as a benchmark the condition for the globally optimal provision of the public goods. This condition, which maximizes the joint welfare of all countries, can be obtained by inserting $\theta=0$ and $s=1$ into (27), which is given by:

$$H_o'(\theta=0, s=1)=\frac{1}{\alpha^{\kappa}\gamma^{\kappa}+\alpha^{l}\gamma^{l}}. \tag{31}$$

Subtracting (27) from (31) gives

$$H_o'(\theta>0, s<1)-H_o'(\theta=0, s=1)=\frac{\left(\alpha^{\kappa}\gamma^{\kappa}+\alpha^{l}\gamma^{l}\right)\left[s\theta+(1-s)\varepsilon\right]-\theta\alpha^{\kappa}\gamma^{\kappa}\left[1-(1-s)\varepsilon\right]}{\phi\left(\alpha^{\kappa}\gamma^{\kappa}+\alpha^{l}\gamma^{l}\right)\left[1-(1-s)\varepsilon\right]}. \tag{32}$$

The sign of the above equation is ambiguous. It is likely that $H_o'(\theta>0, s<1)$ is less than $H_o'(\theta=0, s=1)$ when s is small and θ is large.[14] A smaller s implies that the

[14] Specifically, $H_o'(\theta>0, s<1)$ is less than $H_o'(\theta=0, s=1)$ if (i) s is less than

capitalists are likely to lobby for a higher tax rate, and a large θ ensures a dominant political effect. If so, then the capitalists' lobbying will result in a suboptimally high level of the public good. By contrast, if s is sufficiently large or θ is small, then $H_o'(\theta > 0, s < 1)$ is greater than $H_o'(\theta = 0, s = 1)$.

Since the level of the public good increases with the capital tax rate, the above results can be represented in terms of the capital tax rate. Let us define $\hat{t}$ as the equilibrium capital tax rate of the situation where the policymakers are subject to the influence of the capitalists and act non-cooperatively; i.e., this situation is represented by setting $\theta > 0$ and $s < 1$. We also let $\tilde{t}$ be the equilibrium capital tax rate corresponding to the situation where the policymakers are immune to the influence of the lobby, and seek to maximize national welfare. This situation is depicted by $\theta = 0$ and $s < 1$. Finally, t^* denotes the capital tax rate that maximizes the joint welfare of all countries, which can be characterized by setting $\theta = 0$ and $s = 1$.

With H' decreasing with z, the relationship where $H_o'(\theta > 0, s < 1)$ is less than $H_o'(\theta = 0, s < 1)$ implies that $\hat{t}$ is greater than $\tilde{t}$. The ambiguity in (32) reveals that the relationship between $\hat{t}$ and t^* is also ambiguous. In addition, the fact that $H_o'(\theta = 0, s < 1)$ is greater than $H_o'(\theta = 0, s = 1)$ implies that $\tilde{t}$ is less than t^*. By combining these relationships, if $\hat{t}$ is less than t^*, then the condition that s is less than $\hat{s}$ ensures that the capitalists' lobbying is efficiency-enhancing.[15]

The following proposition summarizes what we have found:

Proposition 2. *(i) Capitalists' lobbying may lead to the oversupply of the public good (i.e., $\hat{t} > t^*$), especially when s is small and θ is large. (ii) If $s < \hat{s} = \alpha^\kappa \gamma^\kappa / (\alpha^\kappa \gamma^\kappa + \alpha^l \gamma^l)$, then capitalists' lobbying will mitigate the underprovision of the public good due to tax competition. Furthermore, supposing that $\hat{t} < t^*$, the condition that $s < \hat{s}$ ensures that capitalists' lobbying will increase social welfare. (iii) If $s > \hat{s}$, capitalists' lobbying will aggravate the inefficiency of tax competition.*

Although the result of Proposition 2(ii) is interesting, one might suspect its plausibility. I acknowledge that a situation in which capitalists lobby for a higher tax

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$\tilde{s} = [(1-\varepsilon)\alpha^\kappa \gamma^\kappa] / [(1-\varepsilon)\alpha^\kappa \gamma^\kappa + \alpha^l \gamma^l]$, and (ii) θ is greater than $\tilde{\theta} = (1-s)(1-\varepsilon)\alpha^\kappa \gamma^\kappa - s\alpha^l \gamma^l$.

[15] This result depends on the joint welfare function being a concave function in t. We can verify this point, provided that $H''(z)$ is sufficiently large.

may be uncommon in the real world,[16] which would reduce the significance of the result of Proposition 2(ii). However, I also want to point out an alternative perspective. For instance, when the capitalists can shift most of the tax burden to others, meaning that they pay only a small share of the cost of the public good, they may lobby for higher public good supply instead of lobbying for a higher tax rate, in particular when most of the benefit from the public good accrues to them. In the basic model, since the public good is financed solely by the capital tax, capitalists' lobbying for a higher capital tax is equivalent to their lobbying for a higher level of public expenditure. The latter occurs more frequently than the former in practice. From this perspective, the result of Proposition 2(ii) does not seem to be as unlikely as it would at first appear.

The above result is also related to another consequence of the standard tax competition model; that is, when all countries are identical, an increase in the number of countries (or a decrease in the market share of each individual country) will result in greater underprovision of public goods (see, e.g., Hoyt (1991) and Lorz (1998)). To see this, we differentiate (27) with respect to s and obtain:

$$\frac{\partial H_o'}{\partial s} = \frac{\theta(1-\varepsilon)-\varepsilon}{\phi\left[1-(1-s)\varepsilon\right]^2}. \tag{33}$$

Since the denominator is positive, the effect of s on the MRS has the same sign as the numerator. Suppose that policymakers seek to maximize their own national welfare, which can be represented by setting $\theta = 0$. In this situation, (33) is unambiguously negative. This indicates that, in the absence of lobbying, an increase in the number of countries will reduce the supply of the public good and aggravate the inefficiency of tax competition. The reason for this is that the more intense competition among countries increases the efficiency cost of capital tax, and thus reduces the welfare effect. The reduced welfare effect lowers both the capital tax rate and the level of the public good.

The presence of lobbying, however, may reverse the conventional result. From (33), if $\theta > \hat{\theta} = \varepsilon/(1-\varepsilon)$, then (33) is positive, meaning that the MRS declines as s decreases. This indicates that an increase in the number of competing countries will increase the supply of the public good and thus mitigate the problem of the underprovision of the public good. The reason for this is similar to that indicated previously.

[16] A plausible example is that in 2002 a group of businesses in Kansas in the U.S. supported a tax increase, which was expected to facilitate the establishment of a high-tech economy in Kansas. See http://www2.ljworld.com/news/2002/mar/14/hightech_businesses_to_lobby/.

Thus we have the following proposition:

Proposition 3. *If* $\theta > \hat{\theta} = \varepsilon/(1-\varepsilon)$, *an increase in the number of countries will increase supply of the public good, and thus mitigate the underprovision of the public good. Moreover, it will also enhance efficiency, provided that* $\hat{t} < t^*$.

Lorz (1998) also pointed out that, in the presence of lobbying, an increase in the number of competing countries will enhance social welfare. The reason for this is that an increase in the number of countries reduces the interest groups' lobbying activities, which are regarded as pure waste, and thus enhances efficiency. In this present paper, the political contributions are regarded as a transfer from the interest groups to the policymakers[17] rather than as waste. The enhancement in efficiency in this present paper stems from the capitalists' lobbying that pushes the tax rate closer to the efficient level, whereas the welfare gain in Lorz (1998) comes from the reduction in pure waste.[18]

5. Extensions

5.1. Public-consumption effect

The presence of the public-consumption is somewhat controversial. One might wonder if the capitalists truly recognize the public-consumption effect in the real world. The presence of the public-consumption effect may lead the capitalists to lobby for a higher capital tax rate, which may not be consistent with the empirical evidence. Such a controversy arises from the dual role of the capitalists; they are both tax payers and benefit receivers. Here we consider a somewhat different situation, in which the capitalists are concerned only with the private-consumption effect. We also consider a new type of resident, say, benefit receivers, who benefit from the public good and whose income (y^R) is exogenously determined.

Specifically, a representative benefit receiver's preferences are given by

$$u^R = y^R + \gamma^R H(z). \tag{34}$$

[17] See also Eggert and Sorensen (2008).

[18] In Lorz (1998), the equilibrium capital tax rate is zero, regardless of the number of competing countries.

I assume that the capitalists do not benefit from the public good, so that a representative capitalist's utility function now becomes $u^k = r\bar{k}$.

Suppose that the benefit receivers also organize themselves to engage in lobbying. For ease of comparison, we assume that the benefit receivers' weight given by the policymaker is also equal to θ. Since the capitalists are only concerned with the private-income effect, they will not lobby for a higher capital tax rate. By contrast, the benefit receivers' group cares about only the public-consumption effect, which induces it to lobby for a higher tax rate.

We divide the capitalists' group in the previous sections into two separate groups; one is the tax-payer group and the other is the benefit-receiver group. In the previous setting, the capitalists' group balanced the private-income effect and the public-consumption effect. Although each group now only cares about either the private-income effect or the public-consumption effect, the logic behind the results remains the same. Once s is lower than the critical value $\hat{s}$, meaning that the benefit receivers' political influence outweighs that of the capitalists, CMI will lead to a higher tax rate. We can find that in this new setting all the results remain the same.[19]

5.2. Workers' lobbying

Let us return to the basic setting. I have so far assumed that the workers do not lobby. In this subsection I extend the basic model to consider the case where the workers also organize themselves into another lobbying group. In this situation, the policymaker's objective function is given by

$$G = \theta W^{\kappa} + \delta W^{l} + W \tag{35}$$

where δ represents the weight that the policymaker attaches to the workers. When θ equals δ, the two groups' influences exactly offset each other (Grossman and Helpman, 1994), and thus the equilibrium policy with lobbying will be the same as the equilibrium policy without lobbying. Since this situation is not our major concern, we assume that $\theta \neq \delta$ in what follows.[20]

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[19] Now however ϕ is defined as $(1+\theta)\alpha^p\gamma^p + \alpha^l\gamma^l$.

[20] Settings in which a policymaker attaches different weights to different interest groups can be found in Hillman (1982), Bernheim and Whinston (1986), and Rama and Tabellini (1998).

Since (35) can be rewritten as $G = (\theta - \delta)W^k + (1+\delta)W$, the results of sections 2 to 4 can be directly generalized to the case of lobbying by capitalists and workers, if θ is replaced by $(\theta - \delta)/(1+\delta)$.[21, 22] For example, by replacing θ with $(\theta - \delta)/(1+\delta)$ in section 3, we obtain the MRS in the closed economy and open economy as follows, respectively:

$$H_c' = \frac{1+\theta}{\phi + \delta\alpha^l\gamma^l} \tag{36}$$

$$H_o' = \frac{1+s\theta+(1-s)\delta}{(\phi+\delta\alpha^l\gamma^l)[1-(1-s)\varepsilon]}. \tag{37}$$

By comparing the above two equations, we find that the critical value of $\theta, \hat{\theta}$, becomes $(\varepsilon+\delta)/(1-\varepsilon)$. If $\theta > \hat{\theta}$, then CMI leads to a higher capital tax rate; otherwise, CMI results in a lower tax rate. The increase in the critical value of θ indicates that the workers' lobbying results in CMI being less likely to raise the capital tax rate. This is because CMI shifts at least a part of the capital tax burden to the workers, and thus they will lobby for a lower capital tax rate.

We now turn to the issue of whether lobbying alleviates the inefficiency of tax competition. This can be seen by subtracting the MRS in the absence of lobbying ($\theta = \delta = 0$) from the MRS in the presence of lobbying ($\theta > 0,\ \delta > 0$) to obtain:

$$H_o'(\theta>0,\delta>0) - H_o'(\theta=\delta=0) = \frac{(\theta-\delta)[s\alpha^l\gamma^l - (1-s)\alpha^\kappa\gamma^\kappa]}{(\alpha^\kappa\gamma^\kappa+\alpha^l\gamma^l)(\phi+\delta\alpha^l\gamma^l)[1-(1-s)\varepsilon]}. \tag{38}$$

The above equation shows that if *s* is sufficiently small, then the presence of lobbying will increase supply of the public good, provided that $\theta > \delta$. If $\theta < \delta$, however, even when *s* is small, the presence of lobbying will worsen the inefficiency of tax competition. The situation where $\theta < \delta$ can be regarded as that in which the workers have a greater influence on the policymaking than the capitalists. A smaller *s* leads the workers to bear a greater capital tax burden, and thus triggers more intense downward political pressure from the workers on the capital tax.

5.3. Endogenous labor and two taxes

[21] The author is grateful to a referee for pointing this out.

[22] We note that θ must be non-negative in the previous sections, whereas the new weight $(\theta-\delta)/(1+\delta)$ could be less than zero.

The basic model can be extended to endogenous labor supply with labor income subject to taxation.[23] In order to incorporate the endogenous labor supply decision, we specify the utility function of the representative worker as $u^l = y^l + v(1-\ell) + \gamma^l H(z)$, where ℓ denotes labor supply and $y^l = w\ell$. The function $v(\cdot)$ represents utility from leisure, with the properties that $v'(\cdot) > 0$ and $v''(\cdot) < 0$. From utility maximization, we obtain the labor supply function $\ell = \ell(w)$, with the property that $\ell' > 0$. Note that, due to the separability of the workers' utility function, labor supply is independent of the income level.

The objective function of the representative firm becomes

$$f(K,L) - \rho K - \varpi L \tag{39}$$

where $L = n^l \ell$. The gross cost of capital (ρ) is equal to $r + t$. The gross wage rate (ϖ) equals $w + \tau$, where τ is the labor tax rate. We assume that capital and labor are complementary, such that $f_{KL} > 0$.

We retain the assumption that only the capitalists engage in the lobbying activity, and assume that they can influence both the capital tax and the labor tax. We first discuss the capitalists' lobbying incentive toward the capital tax. The capitalists' incentive toward lobbying for the capital tax is given by

$$\frac{\partial W^\kappa}{\partial t} = n^\kappa \left[-s\bar{k} + \gamma^\kappa H' \frac{\partial z}{\partial t} \right]. \tag{40}$$

The above equation shows that capital mobility reduces the capitalists' downward political pressure on the capital tax, provided that γ^κ is small. This is the same result that we obtained previously.

Then we turn to capitalists' lobbying regarding the labor tax. The effect of the labor tax on the net rate of return on capital is given by[24]

$$\frac{\partial r}{\partial \tau} = s \frac{f_{KL}}{f_{LL} + v''} \leq 0. \tag{41}$$

With the endogenous labor supply, the above equation reveals that a part of the labor tax is shifted to the capitalists, as long as *s* is greater than zero. By using (41), we obtain the capitalists' incentive toward lobbying for the labor tax as follows:

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[23] Bucovetsky and Wilson (1991) deal with two tax instruments in the absence of lobbying.

[24] Totally differentiating (2), (4), and the labor supply condition $f_L - \tau = v'(1-\ell)$ yields (41). The author is grateful to a referee for providing the derivation.

$$\frac{\partial W^{\kappa}}{\partial \tau} = s\frac{f_{KL}}{f_{LL}+v''}\bar{K} + n^{\kappa}\gamma^{\kappa}H'\frac{\partial z}{\partial \tau}. \tag{42}$$

Again, the first term on the right-hand side of (42) is the private-income effect, which decreases with *s* (in absolute terms), and the second term is the public-consumption effect. As in the case of the capital tax, the increased capital mobility reduces the capitalists' downward political pressure on the labor tax, as long as γ^{κ} is not too large.

The capitalists' downward political pressure on the taxes decreasing with capital mobility does not necessarily lead to a higher level of public good, because the policymaker is also concerned with the social welfare. In Appendix B, we derive the (unweighted) MRS between the public good and the private consumption in the open economy as follows:

$$H_o' = \frac{1+s\theta}{\phi[1-(1-s)\varepsilon-(1-s)(\tau+t\kappa)L'/L]} \tag{43}$$

where $\kappa = K/L$ and $L' = n^{\ell}\ell'(w) > 0$. Comparing (43) with (27), the MRS with fixed labor supply, shows that the flexible labor supply increases the capital tax's marginal cost of public funds, and results in a larger MRS, other things being the same.

The MRS in the closed economy is obtained by setting $s = 1$ in (43), which is identical to (19). Then by subtracting (19) from (43), we have

$$H_o' - H_c' = \frac{(1-s)\{-\theta+(1+\theta)[\varepsilon+(\tau+t\kappa)L'/L]\}}{\phi[1-(1-s)\varepsilon-(1-s)(\tau+t\kappa)L'/L]}. \tag{44}$$

We can derive a critical value of θ, $\breve{\theta}$, which equals

$$\breve{\theta} = \frac{\varepsilon+(\tau+t\kappa)L'/L}{1-[\varepsilon+(\tau+t\kappa)L'/L]}. \tag{45}$$

If $\theta > \breve{\theta}$, then the numerator of (44) is negative, meaning that CMI leads to a higher level of the public good. If θ is less than $\breve{\theta}$, then CMI reduces the level of the public good. We note that $\breve{\theta}$ is greater than $\hat{\theta}$ due to the flexible labor supply. If the public good is underprovided in the closed economy, then CMI may enhance the efficiency by enlarging the amount of the public good. Thus, the results obtained in Section 4 remain valid in the extended model.

We also note that, since there are two tax instruments, a higher level of public expenditure does not necessarily imply that the two tax rates rise; it could be that one tax increases but the other one declines. Although we need more assumptions and

more specific functional forms to derive the conditions under which CMI increases either the capital tax or the labor tax, or both, the reduced downward political pressure on the two taxes due to CMI implies the possibility that CMI will increase the two taxes.

6. Concluding remarks

The literature on political endogeneity of policies shows how policies change when interest groups and political responses are taken into account (Hillman 1989; Grossman and Helpman, 2002). I have shown how political endogeneity of policies changes the conclusions regarding integration of capital markets. My results are consistent with the empirical evidence that CMI may raise or lower capital taxes. I have shown how the extent of the tax competition among countries affects the political influence of capitalists, which can reverse conventional results. If tax competition is intense, then the political pressure from the capitalists to reduce the tax rate will only be slight, or they may even seek to increase the tax rate because most of the tax burden is shifted to the workers. As a result, capitalists' lobbying mitigates the underprovision of the public good, and may enhance efficiency. A related result is that the level of the public goods increases with the number of countries, which is different from the finding in Hoyt (1991). My conclusions can be caste in terms of a comparison between centralized and decentralized government.[25]

I have highlighted the effect of the extent of tax competition on lobbies' incentives. Although more intense tax competition is characterized by a smaller market share of each competing country in this paper, I believe that my conclusions can be sustained in other situations resulting in more intense tax competition between countries, such as a reduction in capital mobility costs.

[25] I have not discussed the effect of capital mobility on the amount of political contributions. Since this problem is somewhat complicated, I consider the simplest case in which only the capitalists lobby. Following Grossman and Helpman (1994), we obtain that the capitalists' political contribution is proportionate to the distortion that the equilibrium tax rate imposes on the economy. Specifically, the capitalists' contribution is given by $m = (1/\theta)[W(t_j^*) - W(\hat{t}_j)]$, $j \in \{c, o\}$, where $j = c$ refers to the closed economy, and $j = o$ refers to the open economy. The effect of capital mobility on the amount of political contributions is generally ambiguous. Suppose that the capitalists do not benefit from the public good. In this case, the capitalists would intensively lobby for a lower tax rate in the closed economy, and are willing to provide a large amount of political contributions. By contrast, in the open economy, they would offer a small amount of contribution if s is small. As a result, we expect that the amount of political contributions will decrease with the capital mobility in this case.

In this paper, the policymakers are exogenously determined. Then a question arises: where do the policymakers come from? A more satisfactory setting is to endogenize the determination of the policymakers (e.g., Besley and Coate, 2001). This issue, I believe, merits further research.

Acknowledgements

I thank the editor Professor Arye L. Hillman and two anonymous referees for valuable comments. The remaining errors are the author's sole responsibility. Financial support from the National Science Council [Grant NSC 98-2410-H-004-043-MY2] and National Chengchi University is gratefully acknowledged.

Appendix

A. The proof of Lemma 1:

Proof. Let φ^o and φ^c denote $\partial W^\kappa / \partial t$ in the open economy equilibrium and closed economy equilibrium, respectively. Then we can verify that $\varphi^o - \varphi^c = (1-s)(\alpha^\kappa \gamma^\kappa + \alpha^l \gamma^l)(\bar{K}/\phi)$, which is unambiguously positive, for all s that are less than unity. This implies that either $0 > \varphi^o > \varphi^c$ or $\varphi^o > 0 > \varphi^c$. In both cases, the capitalists' downward political pressure on *t* is reduced as a result of CMI.

B. The derivation of (43):

The zero-profit condition defines a negatively-sloped factor-price frontier:

$$\varpi = \varpi(\rho); \quad \varpi'(\rho) = -K/L = -\kappa. \tag{46}$$

Then the policymaker's problem is to maximize the following Lagrangian:

$$\mathcal{L} = (1+\theta)W^\kappa + W^l + \lambda[(\tau + t\kappa)L - Nz]. \tag{47}$$

Differentiating the above equation with respect to z gives $\lambda = \phi H'$. With this relationship, the first-order condition for *t* is given by

$$\frac{\partial \mathcal{L}}{\partial t} = (1+\theta)\bar{K}\frac{\partial r}{\partial t} + \frac{\partial W^l}{\partial w}\frac{\partial w}{\partial t} + \phi H'\left[K + t\frac{\partial K}{\partial t} + (\tau + t\kappa)\frac{\partial L}{\partial w}\frac{\partial w}{\partial t}\right]$$

$$= -(1+s\theta)\bar{K} + \phi H'\{[1-(1-s)\varepsilon]\bar{K} - (\tau + t\kappa)(1-s)\kappa L'\} = 0 \qquad (48)$$

where we apply the relationships $\partial W^I / \partial w = L$ and $\partial w/\partial t = \partial \varpi/\partial t = -(1-s)\kappa$. Rearranging (48) gives (43).

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