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# Decentralization and international tax competition

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**Abstract**

This paper models tax competition between two countries that are divided into regions. In the first stage of the game, the strategy variable for each country is the division of a continuum of public goods between central and regional government provision. In the second stage, the central and regional governments choose their tax rates on capital. A country's decentralization level serves as a strategic tool through its influence on the mix of horizontal and vertical externalities that exists under tax competition. In contrast to standard tax competition models, decentralizing the provision of public goods may improve welfare.


*JEL classification:* H40; H71; H77
*Keywords:* Capital taxation; Decentralization; Federalism; Tax competition

## 1. Introduction

The roles of central and lower-level governments in a federal system are imperfectly understood. Much of the local public economics literature treats these roles as exogenous. The different levels of government are each given control of various tax and expenditure instruments, and the central government can employ various policies to influence the behavior of lower-level governments. The theory developed by Tiebout (1956) justifies a

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large role for local governments by emphasizing the ability of mobile households to "vote with their feet." By doing so, these households effectively reveal their preferences for local public goods, and local governments use this information to efficiently provide these goods. In contrast, the central government encounters difficulties in inducing individuals to reveal their preferences for public goods. But only recently have researchers focused on formal models of informational asymmetries in a federal system.[2] A weakness of this literature is that these asymmetries are assumed rather than derived.

It is now well-understood that the behavior of independent governments is unlikely to be optimal in any reasonable sense, and a central government is needed to correct the various externalities and income distribution problems that arise in a system of independent governments. There exists a particularly large literature on tax competition, under which, governments compete for scarce capital, leading to inefficiently low levels of taxation and public good provision.[3] In contrast to Tiebout models, this literature emphasizes problems with the decentralized provision of public goods by independent governments. However, it seems to stack the deck in favor of centralized provision because it typically assumes away any inefficiencies at the central level.[4]

A more recent literature tries to come to grips with the inefficiencies that would exist under central provision of public goods. In Oates (1972), these inefficiencies consist of uniform provision of public goods across different jurisdictions, which must be traded off against the interjurisdictional externalities that might occur in a decentralized system (e.g., spillovers from public good provision). In contrast, Besley and Coate (2003) examine a model in which the behavior of the legislative system under centralization leads to an unequal (and inefficient) division of public good expenditures across localities. Panizza (1999) examines a model in which the provision of a single public good is subject to greater spatial decay at the central level, and the amount of decentralization is then determined at the central level by balancing the preferences of the median voter with central-government preferences for greater government size.[5] The political economy approach to fiscal federalism remains relatively unexplored.

Using a different approach, the current paper derives an active role for lower-level governments in public good provision. We consider a world economy in which the central governments of two countries provide public goods financed by taxes on mobile capital. Competition for this mobile capital leads to inefficiently low taxes and public good levels, as in the standard tax competition model (e.g., Wilson, 1986 and Zodrow and Mieszkowski, 1986). Unlike the standard model, however, there exists a continuum of public goods and, therefore, the possibility for the central governments to decentralize the provision of some, but not all, public goods. From a single country's viewpoint, both horizontal and vertical tax externalities are involved in the provision of public goods by "regional" governments (e.g., state, local, or provincial). When a single regional government lowers its tax rate, it not only attracts capital away from other regions (a domestic horizontal externality), but also expands the central government's tax base by

[2] See, for example, Raff and Wilson (1997) and Lockwood (1999), and the references therein.
[3] See Wilson (1999) for a review.
[4] An exception is Wilson (2003).
[5] See also Arzaghi and Henderson (2000), which builds on this framework.

attracting additional capital into the country (a vertical externality). As a result, regional governments may under- or overprovide public goods, depending on the relative sizes of these two externalities. The interaction of horizontal and vertical externalities is considered by Keen and Kotsogiannis (2002), who characterize the strength of each externality as a function of the savings and capital–demand elasticities as well as the government's ability to tax rents. In contrast, we demonstrate that the central government can control these relative sizes by manipulating the division of public good provision between the two levels of government. In doing so, it can influence the degree to which the country as a whole competes with the other country for scarce capital (an international horizontal externality). In other words, decentralization emerges endogenously as a tool for gaining a strategic advantage over a rival country in a tax competition game. We also show that the uncoordinated decisions to decentralize by the two competing countries may increase welfare for both of them. In contrast to standard tax competition models, the decentralized provision of public goods may therefore play a welfare-enhancing role.

The next section of this paper describes the model, and Section 3 investigates the equilibrium decentralization policies. Section 4 examines the welfare implications of decentralization for the two countries, and Section 5 concludes.

## 2. The model

Following the standard Zodrow–Mieszkowski model, consider a country consisting of $J$>1 identical regions, each containing a representative resident with fixed endowments of labor and capital. The resident supplies this labor to competitive firms within the region of residence but may supply capital to firms in any region. In other words, capital is interregionally mobile. The firms use a constant-returns technology to produce output from labor and capital. This output is then sold to individuals as a final consumption good and also purchased by the regional governments. Using a constant-returns technology, a regional government transforms its purchased output into publicly provided private goods, which are distributed uniformly across residents. With some abuse of terminology, we refer to these goods as public goods, although there is a constant marginal cost of providing them to another resident.

Departing from the Zodrow–Mieszkowski model, let us assume a continuum of public goods, some of which are supplied by the central government. The same production technology is used for all public goods, with one unit of private output producing one unit of a public good. These public goods enter an individual's utility function symmetrically:

$$u = u(x,G); \quad G = \int_0^1 g(n)^{\alpha} dn; \tag{1}$$

where $u(\cdot)$ is a well-behaved utility function, $x$ is private consumption, $G$ is "aggregate" public good consumption, and $g(n)$ is consumption of public good $n$, with $0 \leq n \leq 1$. We assume that $\alpha$<1, indicating imperfect substitutability between the different public goods.

The symbol $N$ denotes the cutoff between goods supplied by regional governments and the central government, so that $g(n)$ is supplied by regional governments if $n<N$. With public goods entering the model in a symmetric way, each level of government sets $g(n)$ equal to a common value for all $n$ under its control, $g_r$ for regional governments ($n<N$), and $g_c$ for the central government ($n>N$). We refer to a case where $N=0$ as centralization, whereas $N>0$ is called decentralization. If $0<N<1$, then we have partial decentralization.

All residents possess the same endowments of labor and capital, $L^*$ and $K^*$. A resident's budget constraint is $x=rK^*+wL^*$, where $r$ is the after-tax return on capital, and $w$ is the wage rate. The before-tax return on capital in a given region is $r+t+T$, where $t$ and $T$ denote the tax rates levied on capital by the regional and the central government (in equilibrium, all regions choose the same $t$.) There are no other taxes and no transfers or grants from the central government to the regional governments, implying that the government budget constraint for a given region is

$$Ng_r = tK(r+t+T), \tag{2}$$

where $K(\cdot)$ denotes the capital demanded by the region's firms as a function of the before-tax return on capital (also called the "cost of capital"). This function is constructed by equating the marginal product of capital to the before-tax return. The central government's budget constraint is

$$(1-N)g_c = TK(r+t+T), \tag{3}$$

stated in terms of expenditures and tax revenue per region. As noted above, we assume here that the public good is a publicly provided private good, so there are no scale-economy arguments for centralizing the provision of public goods.

Given the fixed world supply of capital, the equilibrium $r$ is determined by the vector of "combined tax rates" for all of the regions, $t+T$ for a region with tax $t$ in a country with central tax $T$. Let $\mathrm{d}r/\mathrm{d}t$ denote the marginal impact of a single region's $t$ on $r$ and define $\mathrm{d}r/\mathrm{d}T$ similarly for a single country's $T$. Both of these derivatives are negative, because a higher cost of capital lowers the demand for capital (i.e., $K'<0$). International capital mobility implies that a rise in $T$ is not fully capitalized into $r$, i.e., $-\mathrm{d}r/\mathrm{d}T<1$. Because a rise in $T$ increases the cost of capital in all of a country's regions, it clearly has a greater impact on $r$ than a rise in a single region's tax rate. If all of a country's region's choose the same tax rates, then

$$0< -\frac{\mathrm{d}r}{\mathrm{d}t} = -\frac{1}{J}\frac{\mathrm{d}r}{\mathrm{d}T}<\frac{1}{J}. \tag{4}$$

Assume now that there exist two identical countries, home and foreign, with the attributes just described, and that capital is mobile between them. We consider a two-stage game, in which the players are both the regional and central governments. The objective at both levels of government is welfare maximization, but regional governments care only about the welfare of their own residents, whereas each central government desires to maximize the common utility obtained by all residents in the country. In the first stage, the central governments play a Nash game in decentralization policies, consisting of a choice of $N$. In the second stage, the central and regional governments play a Nash game in tax rates. A subgame perfect equilibrium is considered, with the central governments correctly anticipating how their initial choices of $N$ affect the equilibrium taxes determined in the next stage of the game. We focus on a symmetric equilibrium, where both countries choose the same $N$s and combined tax rates. For the remainder of this section, we examine the equilibrium conditions for the second-stage game.

Consider first the rules for equilibrium public good provision that governments follow in the second stage of the game after $N$ has been chosen. Assuming $0<N<1$, a regional government chooses its tax rate to maximize the utility of the representative resident, $u(rK^*+wL^*, G)$, with public good levels adjusting to satisfy its budget constraint and the budget constraint for the central government. The requirement that profits equal zero in private production defines a factor–price frontier, $w(r+t+T)$, which relates the wage to the before-tax return on capital. The government takes as given the tax rates chosen by all other governments (including those abroad). However, any change in the region's tax rate affects central government provision through its impact on the capital employed in each region. Thus, the central government's budget constraint becomes

$$(1-N)g_{\mathrm{c}} = T[K(r+t+T)+(J-1)K(r+t^{\mathrm{o}}+T)], \tag{5}$$

where $t$ is the tax rate for the region in question, and $t^{\mathrm{o}}$ is the tax rate for all other regions. Each regional government receives $1/J$th of the expenditures provided by the central government. Hence, a change in $t$ alters $g_{\mathrm{c}}$ by an amount equal to $TK'(1/J+\mathrm{d}r/\mathrm{d}t)/(1-N)$. In contrast, the change in the region's $g_{\mathrm{r}}$ is $K+tK'(1+\mathrm{d}r/\mathrm{d}t)/N$. The optimum is found by differentiating the objective function with respect to $t$, and using these two expressions to obtain

$$u_x\left[(K^*+w'L^*)\frac{\mathrm{d}r}{\mathrm{d}t}+w'L^*\right]+u_G\left[\alpha g_{\mathrm{r}}^{\alpha-1}\left(K+tK'\left(1+\frac{\mathrm{d}r}{\mathrm{d}t}\right)\right)\right.$$
$$\left.+\alpha g_{\mathrm{c}}^{\alpha-1}TK'\left(\frac{1}{J}+\frac{\mathrm{d}r}{\mathrm{d}t}\right)\right]=0. \tag{6}$$

The derivative $w'$ must equal $-K/L^*$ to satisfy the zero-profit condition (using the envelope theorem). Thus, Eq. (6) may be rearranged as follows:

$$\frac{u_G}{u_x}\alpha g_{\mathrm{r}}^{\alpha-1}=\frac{1+\left(1-\frac{K^*}{K}\right)\frac{\mathrm{d}r}{\mathrm{d}t}}{1-t\frac{(-K')}{K}\left(1+\frac{\mathrm{d}r}{\mathrm{d}t}\right)-T\frac{(-K')}{K}\left(\frac{1}{J}+\frac{\mathrm{d}r}{\mathrm{d}t}\right)\left(\frac{g_{\mathrm{r}}}{g_{\mathrm{c}}}\right)^{1-\alpha}}, \tag{7}$$

where $K'$ again denotes the (negative) derivative of capital demand with respect to the before-tax return.

Notice that positive values of $t$ and $T$ both contribute towards raising the marginal cost of public good provision above the marginal resource cost (which equals one in this model). This rule generalizes the standard rule found in the tax competition literature (see Zodrow and Mieszkowski, 1986). The standard rule contains the term involving $t$ in the denominator of Eq. (7), reflecting the cost associated with the capital outflow that occurs when the region raises its tax rate. This term represents a horizontal externality, because other regions obtain more capital when one region raises its tax rate (although the capital supply for the nation as a whole declines). The term involving $T$ reflects the vertical relation between the regional and central governments. The use of tax rates as strategy variables implies that each regional government is treating its central government's tax rate as fixed while fully recognizing the impact of its own tax rate on the central government's supplies of public goods. In particular, the rise in a single region's $t$ lowers the central government's tax base. Because $1/J$ is the region's share of the resulting decline in public good expenditures, the share $(J-1)/J$ is born by other regions, representing the vertical externality. Finally, the term involving $\mathrm{d}r/\mathrm{d}t$ in the numerator allows for terms-of-trade effects associated with imports or exports of capital.

The central government satisfies a similar condition, except that $\mathrm{d}r/\mathrm{d}T$ obviously replaces $\mathrm{d}r/\mathrm{d}t$, and also the central government fully internalizes the vertical externality associated with the impact of a tax change on the regional tax bases (because it cares about the welfare of the residents in all of the country's regions). More precisely, the central government chooses $T$ to maximize $u(rK^*+wL^*,\ G)$, with the public good levels determined by budget constraints (2) and (3). Given the assumption of Nash behavior, the central government treats its regions' $t$ as fixed but recognizes that $g_{\mathrm{r}}$ adjusts to satisfy the regional governments' budget constraints as $T$ changes. Substituting the two budget constraints into the objective function and differentiating with respect to $T$ gives a first-order condition that parallels Eq. (6). Using the equality, $w'=-K/L^*$, this condition may be stated as follows:

$$\frac{u_G}{u_x}\alpha g_{\mathrm{c}}^{\alpha-1} = \frac{1+\left(1-\dfrac{K^*}{K}\right)\dfrac{\mathrm{d}r}{\mathrm{d}T}}{1-\left(t\left(\dfrac{g_{\mathrm{c}}}{g_{\mathrm{r}}}\right)^{1-\alpha}+T\right)\dfrac{(-K')}{K}\left(1+\dfrac{\mathrm{d}r}{\mathrm{d}T}\right)}. \tag{8}$$

The marginal cost of public good provision, given by the right side, still contains tax terms, but only because a rise in $T$ lowers the country's total stock of capital.

Conditions (7) and (8) together determine a country's equilibrium $g_{\mathrm{c}}$ and $g_{\mathrm{r}}$, along with the associated tax rates, given the other country's combined tax rate.

To reduce the complexity of these conditions, let us employ some common functional forms. First, assume that the utility function is log-linear:

$$u = x + \int_0^1 (\ln g)\mathrm{d}n. \tag{9}$$

Second, assume a quadratic production function, in which case $K'$, $\mathrm{d}r/\mathrm{d}t$, and $\mathrm{d}r/\mathrm{d}T$ are constant. In particular, $\mathrm{d}r/\mathrm{d}T=-1/2$.[6]

The exponent $\alpha$ in Eq. (8) equals 0 under the logarithmic utility function for $g$. As a result, Eq. (8) can be rewritten

$$\frac{1}{g_{\mathrm{c}}}=\frac{1+\left(1-\frac{K^*}{K}\right)\frac{\mathrm{d}r}{\mathrm{d}T}}{1-\frac{T}{1-N}\frac{(-K')}{K}\left(1+\frac{\mathrm{d}r}{\mathrm{d}T}\right)},\tag{10}$$

where use has been made of the equality $g_{\mathrm{c}}/g_{\mathrm{r}}=TN/(t(1-N))$. Let us multiply Eq. (10) by $K$, substitute $(1-N)/T$ for $K/g_{\mathrm{c}}$, and rearrange to get

$$T=\frac{1-N}{\left(K+\frac{(-K')}{K}\right)\left(1+\frac{\mathrm{d}r}{\mathrm{d}T}\right)-K^*\frac{\mathrm{d}r}{\mathrm{d}T}}.\tag{11}$$

Proceeding in a similar way, we may use Eq. (7) to obtain

$$\frac{1}{g_{\mathrm{r}}}=\frac{1+\left(1-\frac{K^*}{K}\right)\frac{\mathrm{d}r}{\mathrm{d}t}}{1-\frac{t}{N}\frac{(-K')}{K}\left[1+\frac{\mathrm{d}r}{\mathrm{d}t}-(1-N)\left(1-\frac{1}{J}\right)\right]},\tag{12}$$

which can be solved for $t$:

$$t=\frac{N}{K\left(1+\frac{\mathrm{d}r}{\mathrm{d}t}\right)+\left(1+\frac{\mathrm{d}r}{\mathrm{d}t}-(1-N)\left(1-\frac{1}{J}\right)\right)\frac{(-K')}{K}-K^*\frac{\mathrm{d}r}{\mathrm{d}t}}.\tag{13}$$

Consider the determination of the equilibrium combined tax rates ($\Gamma=T+t$) for the second-stage game. These tax rates can be illustrated by using "reaction curves," which relate one country's combined tax rate to the other country's combined tax rate. To derive home's reaction curve, relating $\Gamma^{\mathrm{h}}$ to $\Gamma^{\mathrm{f}}$, multiply Eqs. (11) and (13) by $K$ and sum to obtain

$$\begin{aligned}\Gamma^{\mathrm{h}}K=&\frac{1-N}{\left(1+\frac{(-K')}{K^2}\right)\left(1+\frac{\mathrm{d}r}{\mathrm{d}T}\right)-\frac{K^*}{K}\frac{\mathrm{d}r}{\mathrm{d}T}}\\&+\frac{N}{\left(1+\frac{\mathrm{d}r}{\mathrm{d}t}\right)+\left(1+\frac{\mathrm{d}r}{\mathrm{d}t}-(1-N)\left(1-\frac{1}{J}\right)\right)\frac{(-K')}{K^2}-\frac{K^*}{K}\frac{\mathrm{d}r}{\mathrm{d}t}}\end{aligned}\tag{14}$$

[6] With more general functional forms, $\mathrm{d}r/\mathrm{d}T$ would equal $-1/2$ when home and foreign choose the same tax rates and therefore employ the same amount of capital, but not necessarily elsewhere.

The capital available to home depends on its combined tax rate and foreign's combined tax rate, through the capital demand function, $K(r(\Gamma^h,\Gamma^f)+\Gamma^h)$, where the after-tax return, $r(\Gamma^h,\Gamma^f)$, equates the world demand for capital to the world supply, $2JK^*$, given the combined tax rates. The right side of Eq. (14) falls with $\Gamma^h$, through its negative impact on $K$, and converges to zero as $K$ goes to zero for high $\Gamma^h$. The left side equals zero at $\Gamma^h=0$ and rises with $\Gamma^h$ until the top of home's "Laffer curve" is reached.[7] Using the optimality conditions for the central and regional governments, it can be shown that equilibrium occurs on the upward-sloping portion of the Laffer curve.[8] Given that the slopes of the two curves differ in sign at this point, the equilibrium must be unique, conditional on $\Gamma^f$. Thus, condition (14) enables us to define a continuous reaction curve. Moreover, $\Gamma^h$ also changes continuously with $N$, representing a shift in the reaction curve.

Equilibrium for the second-stage game occurs where home and foreign's reaction curves cross, as illustrated in Fig. 1 for upward-sloping reaction curves H and F (ignore curves *H'* and *F'* for now). For the case where the two countries have the same decentralization levels, there is a unique symmetric equilibrium in tax rates, located where the two reaction curves cross the 45° line. With the combined tax rates determined by this crossing, the central and regional rates are then uniquely determined by Eqs. (11) and (13).

For the subsequent analysis, we let $\Gamma^e$ and $N^e$ denote the equilibrium values of the combined tax rate and decentralization level for the two-stage game. Both countries choose $N^e$ in the first stage, recognizing that this choice will produce second-stage reaction curves in tax space that cross at $(\Gamma^e, \Gamma^e)$.

The slope of the reaction curves is important for future results. Intuition suggests that it can be positive or negative.[9] On the one hand, a higher foreign tax rate provides home with greater access to capital, enabling it to finance its existing public good levels with lower tax rates. On the other hand, Eqs. (10) and (12) (or Eqs. (7) and (8)) show that a higher capital stock lowers the marginal cost of public good provision, providing incentives for higher tax rates. Both effects appear to be positively related to how elastic home's capital stock is with respect to a rise in foreign's tax rate. But we shall see that reasonably low elasticities favor a negative relation between home and foreign's combined tax rates.

The relevant elasticities are the central and regional tax elasticities, $\varepsilon_c=-K'(T/K)$ and $\varepsilon_r=-K'(t/K)$. In addition, the slope of the reaction curve depends on the marginal costs of public good provision facing the central and regional governments, $m_c$ and $m_r$, given by

[7] Under our assumption of a quadratic production, the Laffer curve is single-peaked; that is, there is only one local maximum.

[8] A rise in $T$ increases $g_c$ and lowers $g_r$, whereas an increase in a single region's $t$ has the opposite effect (and also increases $g_r$ in the country's other regions). If the economy was on the downward-sloping portion of the Laffer curve ($\Gamma^h K$ falls with $\Gamma^h$), we could then use the presence of diminishing marginal utility in public good provision to show that a rise in $T$ lowers utility in the case where $g_c \geq g_r$, whereas a rise in $t$ lowers utility in the case where $g_c \leq g_r$. Thus, this assumption would be inconsistent with a Nash equilibrium in tax rates.

[9] Brueckner and Saavedra (2001) construct examples of upward- and downward-sloping reaction curves, but they assume that preferences are linear, which violates the critical assumption in the current model that different public goods are imperfect substitutes.

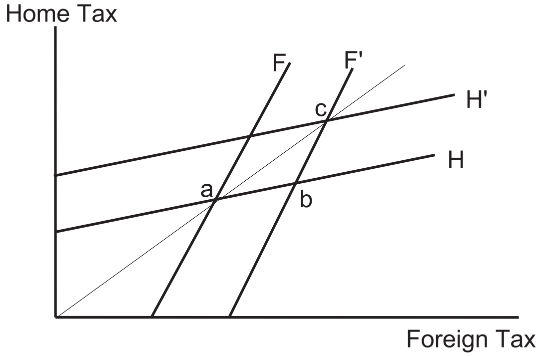


Fig. 1. Reaction Curves.

the right sides of Eqs. (10) and (12). Using these terms, we now prove the following lemma:

**Lemma 1.** *The slope of a country's reaction curve is S/(1+S), where*

$$S=\left(\frac{\varepsilon_{\rm c}}{1-N}-\frac{1}{m_{\rm c}}\right)\frac{\varepsilon_{\rm c}}{4}+\left(\left(N-\frac{1}{2J}(2N-1)\right)\frac{\varepsilon_{\rm r}}{N}-\frac{\left(1-\frac{1}{2J}\right)}{m_{\rm r}}\right)\frac{\varepsilon_{\rm r}}{2}. \tag{15}$$

**Proof.** Because foreign's taxes affect home's taxes through home's capital stock $K$, let us first differentiate the sum of Eqs. (11) and (13) with respect to $K$:

$$\frac{{\rm d}\Gamma^{\rm h}}{{\rm d}K}=\frac{T^2}{1-N}\left(\frac{(-K')}{K}-K\right)\frac{1}{2K}+\frac{t^2}{N}\left(\left(N-\frac{1}{2J}(2N-1)\right)\frac{(-K')}{K}-\left(1-\frac{1}{2J}\right)K\right)\frac{1}{K} \tag{16}$$

Use the tax elasticities, $\varepsilon_{\rm c}=-K'(T/K)$ and $\varepsilon_{\rm r}=-K'(t/K)$, along with first-order conditions (10) and (12), written as $N/(tK)=m_{\rm r}$ and $(1-N)/(TK)=m_{\rm c}$, to rewrite Eq. (16) as follows:

$$\frac{{\rm d}\Gamma^{\rm h}}{{\rm d}K}=\left(\frac{\varepsilon_{\rm c}}{1-N}-\frac{1}{m_{\rm c}}\right)\frac{T}{2K}-\left(\left(N-\frac{1}{2J}(2N-1)\right)\frac{\varepsilon_{\rm r}}{N}-\left(1-\frac{1}{2J}\right)\frac{1}{m_{\rm r}}\right)\frac{t}{K}. \tag{17}$$

Now a rise in $\Gamma^{\rm f}$ changes home's $K$ by $K'[({\rm d}r/{\rm d}\Gamma^{\rm f})+(1+({\rm d}r/{\rm d}\Gamma^{\rm h}))({\rm d}\Gamma^{\rm h}/{\rm d}\Gamma^{\rm f})]$, where ${\rm d}r/{\rm d}\Gamma^{\rm h}={\rm d}r/{\rm d}\Gamma^{\rm f}=-1/2$, and ${\rm d}\Gamma^{\rm h}/{\rm d}\Gamma^{\rm f}$ is the slope of home's reaction curve. Solving for this slope gives ${\rm d}\Gamma^{\rm h}/{\rm d}\Gamma^{\rm f}=S/(1+S)$, where $S=({\rm d}\Gamma^{\rm h}/{\rm d}K)(-K'/2)$. Multiplying Eq. (17) by $-K'/2$ then gives Eq. (15). □

Lemma 1 suggests that negatively sloped reaction curves can easily occur under empirically reasonable magnitudes for the tax elasticities. We say more about this possibility below.

## 3. Equilibrium decentralization

This section demonstrates that countries decentralize at least some public good provision ($N^e>0$). Moreover, we also present conditions for both countries to partially decentralize public good provision and conditions under which more than half of the public goods are decentralized.

To demonstrate these results, we first examine the relationship between the decentralization levels, chosen in the first stage of the game, and the equilibrium tax rates determined in the second stage. Our first result concerns the second-stage game under full centralization:

**Lemma 2.** *The equilibrium $T$ and $t$ under full centralization ($N=0$) are also the equilibrium $T$ and $t$ when $N=1/2$ in one country and $N=0$ or $1/2$ in the other country.*

**Proof.** In the initial symmetric equilibrium, $K=K^*$ in both countries. Now, change $N$ from 0 to 1/2. Noting that $\mathrm{d}r/\mathrm{d}T=-1/2=J(\mathrm{d}r/\mathrm{d}t)$, it is easily shown that this change has no impact on the sum of the right sides of Eqs. (11) and (13). Hence, neither country's reaction curve shifts, implying no change in the equilibrium tax rates. □

Lemma 2 tells us that if both countries are fully centralized, then one or both of them can decentralize in a way that leaves the equilibrium tax rates unchanged. Moreover, this decentralization does not alter public good levels; at each $n$, $g(n)$ remains at its centralized value.

This result may be understood by recalling that the Nash game in tax rates played in the second stage is characterized by two externalities from a given country's viewpoint. First, there is the usual fiscal externality from horizontal tax competition among home's regions, which tends to create too little provision of public goods (and, correspondingly, lower taxes than the central government would choose). Second, there is the vertical externality. When one region increases its tax rate, the total amount of capital supplied to home declines, causing a drop in the central government's tax revenue. As a result, the central government must reduce its public good supplies, which harms all regions. This consideration tends to create too much public good provision at the regional level.

Thus, the vertical and horizontal externalities have opposite signs. However, when only a small fraction of the public goods are decentralized, the vertical externality dominates. The reason is that the magnitude of each externality depends on the level of taxation at each level of government. With regional governments providing few public goods, regional taxes are small relative to central taxes. Hence, the horizontal externality is small relative to the vertical externality, implying overprovision of the public good. On the other hand, when regional governments provide most of the public goods, the domestic horizontal externality dominates. Thus, there exists some intermediate value of $N$ under which there is neither overprovision nor underprovision. In other words, regional governments choose the same public good levels that are chosen in the fully centralized economy. Still, horizontal externalities remain at the international level.

It is interesting to note that the $N$ identified in Lemma 2 would rise if we increased the number of countries. For $J$ countries, we would have $\mathrm{d}r/\mathrm{d}T=-1/J$, and thus, $N=1-(1/J)$ would yield the same equilibrium tax rates (the solution to Eqs. (11) and (13)) as $N=0$. Notice that this $N$ rises with $J$. With more countries, the importance of the horizontal externality declines relative to the vertical externality within any single country because a rise in one region's tax rate provides other regions in the same country with less capital; more of this capital escapes to other countries. Thus, $N$ must be higher for the horizontal and vertical externalities to offset each other.

Consider now how home can manipulate its reaction curve in the second-stage game by unilaterally altering its decentralization policy in the first stage. We focus on the height of this reaction curve when foreign's combined tax rate is at the equilibrium value, $\Gamma^{\mathrm{e}}$. Because a fall in home's $N$ increases the importance of the vertical externality relative to the horizontal externality, one might expect this fall to increase home's equilibrium combined tax rate. The problem with this reasoning is that, for low values of $N$, few public goods are supplied at the relatively high level of $g_{\mathrm{r}}$. In fact, Lemma 2 implies that if $\Gamma^{\mathrm{h}}$ rises as $N$ is reduced below 1/2, then it must eventually fall to its initial value as $N$ approaches 0. But then, there are two values of $N$ between 0 and 1/2 that support a given $\Gamma^{\mathrm{h}}$ above its centralized value in the second-stage tax game (provided $\Gamma^{\mathrm{h}}$ is not too high). Given the presence of diminishing marginal utility in public good provision, intuition suggests that home's welfare should be greater under the higher $N$ because it involves increasing $g_{\mathrm{r}}$ by a relatively small amount for a relatively large number of goods compared to the lower $N$. Hence, we should never see the lower $N$ in a symmetric equilibrium. The following lemma confirms this reasoning:

**Lemma 3.** *Holding $\Gamma^f$ fixed at $\Gamma^e$, a marginal reduction in home's $N$ from $N^e$ raises its optimal $\Gamma^h$.*

**Proof.** Using the government budget constraint for regions, substitute $g_{\mathrm{c}}/K$ for $T/(1-N)$ in Eq. (10) and rearrange to obtain:

$$g_{\mathrm{c}} = \frac{1}{1+\left(1-\dfrac{K^*}{K}\right)\dfrac{\mathrm{d}r}{\mathrm{d}T}+\dfrac{(-K')}{K^2}\left(1+\dfrac{\mathrm{d}r}{\mathrm{d}T}\right)}, \tag{18}$$

Similar manipulations of Eq. (12) give

$$g_{\mathrm{r}} = \frac{1}{1+\left(1-\dfrac{K^*}{K}\right)\dfrac{\mathrm{d}r}{\mathrm{d}t}+\dfrac{(-K')}{K^2}\left[1+\dfrac{\mathrm{d}r}{\mathrm{d}t}-(1-N)\left(1-\dfrac{1}{J}\right)\right]}. \tag{19}$$

Let us evaluate these conditions at the symmetric equilibrium for the two-stage game where $K=K^*$. Assume first that $N^{\mathrm{e}}>1/2$. Substituting this $N$ into Eq. (19) and comparing the result with Eq. (18) then shows that $g_r < g_c$. If $\Gamma^h$ remained constant following a reduction in $N$, then there would be no change in home's $K$. Consequently, Eqs. (18) and (19) would imply no change in $g_c$ and a rise in $g_r$. Total expenditures would therefore rise: $N^e dg_r + (g_r - g_c)dN > 0$. To rebalance the government budget, $\Gamma^h$ must therefore rise. If $N^e = 1/2$, then $g_r = g_c$, and a similar argument again demonstrates that $\Gamma^h$ rises as $N$ falls.

Next, assume that $N^e < 1/2$, in which case Eqs. (18) and (19) imply that $g_r > g_c$. We first show that increasing $N$ to 1/2 must lower $\Gamma^h$. Holding $\Gamma^h$ fixed at its initial level, observe that this rise in $N$ has no effect on the $g_c$ that satisfies Eq. (18), whereas Eq. (19) is now satisfied only if $g_r$ falls until it equals $g_c$. We may then conclude that total expenditures fall below the revenue level associated with the initial $\Gamma^h$: $N^e g_r + (1 - N^e) g_c = g_c < \Gamma^h K$. Budget balance then requires that $\Gamma^h$ fall below its original value (which increases $K$, thereby raising the $g_c$ and $g_r$ that satisfy Eqs. (18) and (19)).

Because an increase in $N$ to 1/2 has been shown to lower $\Gamma^h$, a marginal increase in $N$ will raise $\Gamma^h$, contrary to Lemma 3, only if an intermediate increase in $N$ leaves $\Gamma^h$ unchanged. But then, Eq. (18) implies that this intermediate increase leaves $g_c$ unchanged, whereas Eq. (19) implies that $g_r$ falls. To summarize, we are reducing the relatively high $g_r$ for public goods ranging from 0 to $N^e$, whereas, we are increasing public good supplies from $g_c$ to $g_r$ for public goods ranging from $N^e$ to some higher level, $N^e + \Delta N$. With $\Gamma^h$ unchanged, budget balance requires that the total expenditures remain unchanged. Given diminishing marginal utility in public good provision, this reallocation of a fixed level of expenditures must raise home welfare, contradicting the optimality of $N^e$.[10] By similar reasoning, a marginal increase in $N$, starting from $N^e < 1/2$, cannot leave $\Gamma^h$ unchanged. Thus, we have demonstrated that a marginal increase in $N$ must lower $\Gamma^h$. □

We now show that if both countries are initially fully centralized, then each country would have an incentive to unilaterally choose some level of decentralization. If reaction curves slope up, home welfare can be increased by setting $N$ slightly below 1/2. By Lemmas 2 and 3, this move to decentralization shifts up home's reaction curve at $\Gamma^f = \Gamma^e$, as illustrated in Fig. 1. Foreign responds by raising $\Gamma^f$, and the resulting flow of capital into home benefits home by raising its regional and central tax bases. Put differently, the taxation of capital raises home's marginal product of capital above its opportunity cost of capital, implying that it benefits from additional capital at the margin. Because there are no imports or exports of capital in the initial symmetric equilibrium, there are no terms-of-trade effects associated with changes in $r$. Moreover, the inefficiencies in public good provision are negligible, if $N$ is only slightly less than 1/2, because $g_r$ remains close to $g_c$. If reaction curves slope down, then the welfare-improving rise in foreign's tax rate can be achieved by setting $N$ slightly above 1/2. By Lemmas 2 and

[10] Because the two country's are playing a Nash game in their decentralization levels, home treats foreign's $N$ as fixed when it adjusts its own $N$. Note also that foreign's initial $\Gamma^f$ in the second-stage game will remain an equilibrium choice: because $\Gamma^h$ is not changing, home and foreign's reaction curves cross at the same common value $\Gamma^h$ and $\Gamma^f$ following the change in $N$. (multiple crossings of the reaction curves may occur in some cases, and the change in $N$ could affect the location of these asymmetric equilibria. In such cases, we assume that the economy remains at the symmetric equilibrium.)

3, this decentralization policy shifts down home's reaction curve, inducing foreign to raise $\Gamma^{\mathrm{f}}$.[11]

In neither case is it desirable for home to choose full centralization, given that foreign is pursuing the full centralization strategy. We have seen that the taxes and public good levels chosen under full centralization correspond to those chosen under a decentralization strategy with $N$=1/2. By Lemma 3, home can shift its reaction curve up or down by altering $N$ from this value, and for a small enough change, any resulting inefficiencies in public good provision are second-order in importance. A symmetric argument applies to foreign. We conclude:

**Proposition 1.** *In any symmetric equilibrium for the two-stage game, both countries choose some level of decentralization.*

We have seen that a country can shift its reaction curve up or down by implementing the appropriate decentralization policy. However, decentralizing public good provision produces inefficiencies because the supplies of public goods by regional governments differ from what the central government would have chosen. A country's optimal decentralization policy involves a tradeoff between the strategic advantage of a further shift in its reaction curve, and the marginal efficiency loss from the change in $N$ needed to achieve this shift. To say more about the equilibrium $N$, we now present a lemma that relates these inefficiencies in public good provision to the value of $N$:

**Lemma 4.** *Holding $\Gamma^f$ fixed at $\Gamma^e$, a marginal reduction in home's $N$ from $N^e$ raises home's welfare if $1/2<N^e\leq 1$, and lowers home's welfare if $0<N^e<1/2$.*

**Proof.** Consider first the case where $N^{\mathrm{e}}>1/2$, in which case Eqs. (18) and (19) imply $g_{\mathrm{r}}<g_{\mathrm{c}}$. By the envelope theorem, the welfare impact of a marginal fall in $N$ does not depend on how home's $T$ changes, because it is set optimally, conditional on $N$ (and $\Gamma^{\mathrm{f}}$). In other words, we are free to change $T$ in any desired direction as $N$ falls without altering the welfare impact of this change in $N$. Let us choose this change so that $\Gamma^{\mathrm{h}}$ remains fixed. By Eq. (19), regional governments reoptimize by increasing $g_{\mathrm{r}}$. With total revenue fixed, expenditures must also stay fixed: $(1-N^{\mathrm{e}})\mathrm{d}g_{\mathrm{c}}+N^{\mathrm{e}}\mathrm{d}g_{\mathrm{r}}+(g_{\mathrm{r}}-g_{\mathrm{c}})\mathrm{d}N=0$. Because the second and third terms are positive, $g_{\mathrm{c}}$ must therefore decline: $\mathrm{d}g_{\mathrm{c}}<0$. To summarize, public good supplies are rising where they are low (either by $\mathrm{d}g_{\mathrm{r}}$ or by $g_{\mathrm{c}}-g_{\mathrm{r}}$), and they are falling where they are high (by $\mathrm{d}g_{\mathrm{c}}$). Inasmuch as public goods exhibit diminishing marginal utility, this reallocation of a fixed amount of expenditures across different public goods must raise welfare.

Assume now that $N^{\mathrm{e}}<1/2$ in equilibrium, in which case, Eqs. (18) and (19) imply that $g_{\mathrm{c}}<g_{\mathrm{r}}$. By Lemma 3, $\Gamma^{\mathrm{h}}$ rises as $N$ falls below $N^{\mathrm{e}}$. By Eq. (18), the resulting decline in $K$ reduces $g_{\mathrm{c}}$. By the envelope theorem, we are once again free to alter the change in $T$ without affecting the welfare change. Thus, let us reduce $T$ enough to eliminate the

[11] This result requires that the slopes of the reaction curves exceed $-1$ at the initial equilibrium, but this is a condition for a stable equilibrium, and Lemma 3 can be used to show that it must hold. If multiple equilibria exist, then we consider equilibria that change continuously with $N$ in a small neighborhood of $N$=1/2. Also, recall that a country can always shift its reaction curve up or down when the other country is pursuing a centralization strategy because $N$=0 is equivalent to $N$=1/2.

rise in $\Gamma^{h}$. To keep the central government's budget satisfied, $g_c$ must fall further. With $\Gamma^{h}$ unchanged, $K$ is also unchanged. Consequently, it follows from Eq. (19) that the drop in $N$ raises $g_r$. Finally, unchanged total revenue implies unchanged total expenditures:

$$N^{e}dg_r + dN(g_r - g_c) + (1 - N^{e})dg_c = 0, \tag{20}$$

with $dg_c<0$ and $dg_r>0$. In words, a fixed amount of expenditures is reallocated, with a rise in the highest public good level $g_r$, offset by a drop in the lowest public good level $g_c$, and a drop from the highest to lowest public good level $g_r-g_c$, for public goods between $N^e$ and $N^e-dN$. Because the public goods exhibit diminishing marginal utility, it follows that the utility gains from the rise in $g_r$ for all $n$ above $N^e$ fall short of the utility losses from the declines in public good supplies below $N$. Thus, the total change in welfare is negative. □

Armed with Lemmas 3 and 4, we may now relate the slopes of the reaction curves to the degree of decentralization:

**Proposition 2.** *The equilibrium decentralization level satisfies $0<N^e<1/2$ if reaction curves slope up and $N^e>1/2$ if reaction curves slope down.*

**Proof.** Consider a symmetric equilibrium in which $N^e>1/2$, and suppose that reaction curves slope up, contrary to the proposition. Then a small upward shift in home's reaction curve (created by changing $N$) leads to a rise in $\Gamma^{f}$, which causes capital to flow from foreign to home. Holding home's combined tax rate fixed at its initial level, home's tax base expands, causing public good supplies to increase. For this reason, home benefits from the rise in $\Gamma^{f}$. But Lemma 3 implies that this upward shift is obtained by lowering $N$, and Lemma 4 then implies that home's welfare rises, conditional on $\Gamma^{f}=\Gamma^{e}$. Combining the two contributions to welfare, we may conclude that $N^e$ could not have been optimal for home, a contradiction.

The case where $N^e<1/2$ is handled in the same way, employing the other parts of Lemmas 3 and 4. □

If the reaction curves slope up, Proposition 2 implies that both levels of government supply public goods. For the case of downward-sloping reaction curves, however, Proposition 2 shows that the level of decentralization is substantial, involving more than half of the public goods, and we cannot rule out the possibility that the central governments vanish as public good providers.

Although Proposition 2 relates $N^e$ to the slopes of the reaction curves, the slopes themselves depend on $N^e$. Lemma 1 may give a distorted view of this dependence because terms that depend positively on $N^e$ are to some extent counterbalanced by terms that depend negatively on $N^e$. Nevertheless, the potential dependence raises the question of whether a country might use its choice of $N$ to affect the slope of its reaction curve, thereby altering subsequent strategic incentives. We next deal directly with this issue by deriving sufficient conditions for the location of $N^e$ that depend neither directly on $N^e$ nor on the division of the combined tax rate between the central and regional rates (which themselves depend on $N^e$). To state these conditions, let $\varepsilon^D = -K'(R/K)$, where $R = r + \Gamma$; that is, $\varepsilon^D$ is the demand elasticity for capital.

**Proposition 3.** *$N^e > 1/2$ if*

$$\varepsilon^D \frac{\Gamma^e}{R} < \frac{2}{3}, \tag{21}$$

and

*$0 < N^e < 1/2$ if*

$$\varepsilon^D \frac{\Gamma^e}{R} > \frac{2 - \frac{1}{J}}{2 - \frac{1}{2J}} \tag{22}$$

**Proof.** For the first part of the proposition, assume to the contrary that Eq. (21) holds but $N^e \leq 1/2$. We now derive a contradiction of Proposition 2 by showing that reaction curves slope down in this case. Eq. (15) provides an expression for the sign of this slope. Noting that $N-(2N-1)/(2J)$ obtains a maximum of 1/2 over all $N$ ranging from 0 to 1/2, we may observe first that a sufficient condition for Eq. (15) to be negative is $(-K')/K - K < 0$. Multiply this expression by the combined tax rate $\Gamma$ and use the budget constraint $\Gamma K = N g_r + (1-N) g_c$ to obtain $(-\Gamma K')/K - (N g_r + (1-N) g_c) < 0$. Next, substitute from the equilibrium conditions for $g_c$ and $g_r$, given by Eqs. (10) and (12) with $K = K^*$ for the symmetric equilibrium, use $\mathrm{d}r/\mathrm{d}T = (\mathrm{d}r/\mathrm{d}t)J = -1/2$, and collect terms to obtain

$$\frac{(-K')}{K}\left[\Gamma + \frac{T}{2} + t\left(N + \frac{1}{2N}(1-2N)\right)\right] < 1. \tag{23}$$

The left side is increasing in $N$. Thus, Eq. (23) holds for all $N \leq 1/2$ if it holds for $N = 1/2$; that is, if

$$\frac{(-K')}{K}\frac{3\Gamma}{2} < 1. \tag{24}$$

Because condition (24) is a rearranged version of Eq. (21), we may conclude that Eq. (21) implies that reaction curves slope down, contradicting Proposition 2.

For the second part of the proposition, assume to the contrary that Eq. (22) holds but $N^e \geq 1/2$. We now derive a contradiction of Proposition 2 by showing that reaction curves slope up in this case. Returning to Eq. (15), note now that $N-(2N-1)/(2J)$ obtains a minimum of 1/2 over all $N$ ranging from 1/2 to 1. Thus, a sufficient condition for reaction curves to slope up is

$$\frac{1}{2}\frac{(-K')}{K} - \left(1 - \frac{1}{2J}\right)K > 0 \tag{25}$$

Proceeding as before, multiply Eq. (25) by $\Gamma$, substitute $Ng_{\rm r}+(1-N)g_{\rm c}$ for $\Gamma K$, and finally substitute from Eqs. (10) and (12) with $K=K^*$ to obtain

$$\frac{(-K')}{K}\left[\frac{\Gamma}{2-\frac{1}{J}}+\frac{T}{2}+t\left(N+\frac{1}{2J}(1-2N)\right)\right]>1 \tag{26}$$

Because the left side is increasing in $N$, it holds for all $N\geq 1/2$ if it holds for $N=1/2$. Substituting this $N$ into Eq. (26) then give

$$\frac{(-K')}{K}\Gamma\frac{2-\frac{1}{2J}}{2-\frac{1}{J}}>1 \tag{27}$$

Because Eq. (27) is a rearranged version of Eq. (22), we may conclude that Eq. (22) implies that reaction curves slope up, which again contradicts Proposition 2. □

With Eq. (21), we now have a sufficient condition for downward-sloping reaction curves that does not depend on the level of decentralization. To get some feel for the likelihood that Eq. (21) is satisfied, note that the demand elasticity for capital, $-K'(R/K)$, equals the substitution elasticity between labor and capital, divided by labor's income share. Labor's income share is about 3/4, and substitution elasticities below one are often assumed (one corresponding to the Cobb–Douglas case). Assuming one for the substitution elasticity, the demand elasticity would then be 4/3. In this case, tax rates below 50% satisfy Eq. (21). Given the increasingly low taxes on internationally mobile capital in the world economy, such taxes do not seem unreasonably low. Note finally that Eq. (21) is only a sufficient condition. Whereas the right side equals 2/3, the right side of Eq. (22) goes to one as the number of regions goes to infinity, yielding a much more stringent sufficient condition for upward-sloping reaction curves.

To conclude, reaction curves slope down in reasonable cases, and this slope implies that more than half of the public goods are produced by lower-level governments.

## 4. Welfare

The welfare effects of decentralization depend on the slopes of the reaction curves. First, welfare rises in the case where reaction curves slope up. In this case, decentralization leads to a welfare-enhancing rise in tax rates but again at the cost of inefficiencies in the relative supplies of different public goods. But these costs can never offset the gains from higher tax rates. To see this, we can decompose the move from centralization to decentralization into two steps. First, shift up foreign's reaction curve, moving the equilibrium from point $a$ to point $b$ in Fig. 1. Home benefits from the implied tax changes because it becomes the low-tax country and therefore experiences an inflow of capital. This inflow expands its tax base, thereby increasing its provision of public goods. In addition, there is a beneficial terms-of-trade effect for home associated with home's new status as a capital importer. Inasmuch as both countries' taxes rise, the after-tax return on capital falls, thereby benefiting home in this role.

Having shifted up foreign's reaction curve, let home now implement the equilibrium level of decentralization, thereby also shifting up its reaction curve. The resulting change in tax rates is depicted by the move from point $b$ to point $c$ in Fig. 1. By a standard-revealed preference argument, home clearly benefits from this change; otherwise, it would not implement it. Because the two countries are identical, a similar argument must show that decentralization also benefits foreign.

Thus, decentralization can serve a welfare-enhancing role in this model. It does so by offsetting the welfare losses from tax competition between the two countries. This competition leads to taxes and public good levels that are inefficiently low. By decentralizing in a way that creates relatively strong vertical externalities, the central governments induce their regional governments to increase their public good supplies above those that would be chosen by the central governments alone.

But when reaction curves slope down, it is clear that decentralization is welfare worsening. In this case, both countries are decentralizing in an effort to lower their reaction curves. By shifting down its reaction curve, home causes foreign's equilibrium combined tax rate to rise, which benefits home by inducing capital to flow from foreign to home. But when both countries shift down their reaction curves, the result is a decline in both of their combined tax rates, without any change in the allocation of capital. Public goods are underprovided when the two countries are fully centralized, and so, this decline in tax rates aggravates the underprovision problem. In addition, we have seen that decentralization results in an inefficient allocation of tax revenue between the two levels of government, with the chosen $g(n)$'s now differing. For both reasons, welfare is lower than it would be if both countries were centralized.

## 5. Concluding remarks

In traditional models of fiscal federalism, an important role for the central government is to correct the externalities created by the independent behavior of communities or regions. There is a large literature on the use of intergovernmental grants for this purpose, and various restrictions on the behavior of lower-level governments may also be used. However, central governments are not immune to political pressures that limit the usefulness of such instruments. Thus, it seems useful to explore ways of designing the structure of a federal system to reduce the harmful effects of externalities without the need for an active central government role. In this paper, we have examined the division of public good provision between different levels of government as one aspect of this design. This division works not so much by reducing the size of horizontal and vertical externalities but rather by offsetting one against another until their net effect is optimal (but nonzero, given their use as a strategic device in this model). The analysis therefore departs quite dramatically from the first-best analysis of externalities, which says that they should be targeted directly with the appropriate subsidies or taxes. Instead, it points to the value of analyzing different externalities together rather than in isolation, and designing a federal system that optimally controls their net impact. For the particular externalities under consideration, horizontal and vertical, we hope to have demonstrated the usefulness of departing from the common practice of treating their relative importance as exogenous.

As an alternative method for correcting these externalities, the central government could use intergovernmental grants to influence the policy choices of regional governments. For an economy characterized by tax competition, the use of these grants has been studied by Wildasin (1989), DePater and Myers (1994), and Bucovetsky et al. (1998). In these papers and the current context, this approach requires the central government to commit to a grant system in the initial period, prior to the determination of regional taxes. If it is relatively difficult to alter the assignment of public expenditure responsibilities to different levels of government, then this assignment might serve as a better commitment device.[12]

Our stylized model may hold some lessons in the context of capital mobility within and across the U.S. and the European Union. Both entities have central and regional governments, and at the same time, there is a fair amount of investment across the Atlantic. The results of our analysis provide new arguments in the debate over fiscal decentralization both in the EU and the U.S. In general, these debates typically ignore aspects of international capital mobility.

For example, in the EU, most of the existing spending and taxing power rests with the national governments.[13] Some people object to giving more fiscal power to the EU, perhaps out of fear that there would be too much waste due to a big bureaucracy. Others would like to see more coordination of tax policies in order to reduce the inefficiencies from horizontal tax competition among nation states. Our analysis suggests that allocating more fiscal authority to the EU level might improve the welfare of European citizens when competing with the U.S. for internationally mobile capital.[14]

Relative to the EU, spending power in the U.S. is much more evenly distributed between the federal government and the states. Yet, it is interesting to note how expenditures are financed at each level. Although the importance of the corporation tax at the federal level has declined over the last few decades, corporate tax revenues play a more minor role in state budgets. Obviously, our model cannot fully address this discrepancy because we do not allow for multiple tax instruments. Our analysis may suggest, however, the conjecture that individuals would be better off in the U.S. if more revenues were collected at the state level from the internationally mobile factor.

[12] The political system can also be used as a commitment device. For example, Persson and Tabellini (1992) study tax competition in the case where taxes are chosen by policymakers representing the preferences of the median voter. They show that tax competition makes the median voter select a more leftist government, which favors more income redistribution and therefore a higher tax on capital. In this way, the tendency of tax competition to reduce capital taxes is partially mitigated.

[13] The EU budget is about 1% of member countries' GDP, whereas national government spending at all levels is often in the range of 40–50% of national GDP.

[14] Proposition 2 shows that the level of centralization should be substantial when reaction curves slope up, but it also does not rule out a sizable level when they slope down.

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