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 the provision of a continuum of public goods between the central and regional governments. 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 exist under tax competition. In contrast to standard tax competition models, decentralizing the provision of public goods may be welfare-enhancing.

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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. A few distinct approaches exist here. According to Tiebout (1956), the ability of mobile households to "vote with their feet" leads to the efficient provision of public goods by local governments. Builders of Tiebout models typically justify the involvement of local governments in public good provision by appealing to the difficulties a central government would encounter 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.[1] 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.[2] 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.[3]

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 of the interjurisdictional externalities that might occur in a decentralized system (e.g., spillovers from public good provision). In contrast, Besley

[1] See, for example, Raff and Wilson (1997) and Lockwood (1999), and the references therein.

[2] See Wilson (1999) for a review.

[3] An exception is Wilson (2000).

and Coate (2000) 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 determined at the central level by balancing the preferences of the median voter with central-government preferences for greater government size.[4] 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 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 (the horizontal externality), but also expands the central government's tax base by attracting additional capital into the country (the vertical externality). As a result, regional governments may under- or over-provide public goods, depending on the relative sizes of these two externalities. 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 so doing, it can influence the degree to which the country as a whole competes with the other country for scarce capital. 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 can be welfare-improving for both of

[4] See also Arzaghi and Henderson (2002), which builds on this framework.

them. In contrast to standard tax competition models, the decentralized provision of public goods can therefore play a welfare-enhancing role

The next section of this paper describes the model, and Section 3 investigates the optimal decentralization policies for a country. 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 a system of $N > 1$ identical regions, each containing a representative resident who supplies labor to competitive firms within the region. These firms use a constant-returns technology to produce output from this labor and mobile capital. This output is then sold to individuals as a final consumption good, and purchased by the region's government as the sole input in the production of public goods. There is a continuum of public goods, some of which may be produced by the central government, again using private output as the sole input. Specifically, an individual's utility function takes the form,

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

where x is private consumption, G is "aggregate" public good consumption, and g(n) is consumption of public good n, with $0 < n < 1$. We assume that x and G enter the utility function as normal goods, and that $\alpha < 1$, indicating imperfect substitutability between the different public goods. We shall denote by n* 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 ($n > n^*$).

All residents possess the same endowments of labor and capital, L* and K*. Thus, 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, implying that the government budget constraint for a given region is

$$n^* g_r = tK(r + t + T), \tag{2}$$

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"). In contrast, 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. We assume here that the public good is a publicly-provided private good in the sense that there is a constant marginal cost of providing it to another resident. Hence, there are no scale-economy arguments for centralizing the provision of the public good.

Assume now that there exist two identical countries, home and foreign, with the attributes just described, and that capital is mobile between them. We shall consider a symmetric Nash equilibrium in tax rates. The players in this game are both the regional and central governments. But before competition in tax rates occurs, the two central governments play a Nash game in decentralization policies, consisting of a choice of n*. The objective of both central and regional governments is welfare maximization, but regional governments care only about the welfare of their own residents, whereas each central government desires to maximize common utility obtained by all residents in the country. A subgame perfect equilibrium is investigated, with the countries correctly anticipating how their initial choices of n* affect the equilibrium taxes in the next stage of the game.

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 dr/dt denote the marginal impact of a single region's t on r, and define dr/dT similarly for a single country's T. Both of these derivatives are

negative, since 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., -dr/dT < 1. Since 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. In particular, the symmetry between regions implies

$$0 < -\frac{dr}{dt} = -\frac{1}{N}\frac{dr}{dT} < \frac{1}{N}. \tag{4}$$

Consider now the rules for equilibrium public good provision that governments follow in the second stage of the game, after n* has been chosen. Appendix A shows that each regional government chooses its t to satisfy

$$\frac{u_G}{u_x}\alpha g_r^{\alpha-1} = \frac{1+\left(1-\frac{K^*}{K}\right)\frac{dr}{dt}}{1-\tau\varepsilon\left(1+\frac{dr}{dt}\right)-\beta\varepsilon\left(\frac{1}{N}+\frac{dr}{dt}\right)\left(\frac{g_r}{g_c}\right)^{1-\alpha}}, \tag{5}$$

where ε is the demand elasticity for capital with respect to the before-tax return (measured positively), τ = t/(r + t + T), and β = T/(r + t + T). Notice that positive values of τ and β both contribute towards raising the marginal cost of public good provision above one (which is the marginal resource cost 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 τ in the numerator, reflecting the cost associated with the capital outflow that occurs when the region raises its tax rate. This term represents a horizontal externality, since 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 β 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, and the region's share of the resulting decline in public-good expenditures is 1/N. Since the remaining share, (N-1)/N, is born by other regions, it represents the vertical externality. Finally, the term involving dr/dt in the numerator allows for terms-of-trade effects associated with imports or exports of capital. This term will vanish in the symmetric equilibria that we consider, since no country will import or export capital.

Now the central government satisfies a similar condition, except that dr/dT obviously replaces dr/dt, and also the central government fully internalizes the vertical externality associated with the impact of a tax change on the regional tax bases (since it cares about the welfare of the residents in all regions). From Appendix A, this condition is

$$\frac{u_G}{u_x}\alpha g_c^{\alpha-1} = \frac{1+\left(1-\frac{K^*}{K}\right)\frac{dr}{dT}}{1-\left(\tau\left(\frac{g_c}{g_r}\right)^{1-\alpha}+\beta\right)\varepsilon\left(1+\frac{dr}{dT}\right)}, \qquad (6)$$

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.

Condition (6) defines a relation between g_c and g_r, which is depicted by curve CC in Figure 1. At sufficiently high levels of g_r, the marginal cost becomes prohibitively high, reducing g_c to zero. Thus, the curve is generally downward sloping, although we cannot rule out upward sloping-segments without further restrictions.

To find where on CC the economy operates under a given level of decentralization (n*), let us divide both sides of (5) by both sides of (6) and rearrange to obtain a necessary condition for both levels of government to be in equilibrium:

$$1-\left(\frac{g_c}{g_r}\right)^{1-\alpha} = \varepsilon\left(1-\frac{1}{N}\right)\left(\beta\left(1+\frac{dr}{dT}\right)+\tau\frac{dr}{dT}\left(\frac{g_c}{g_r}\right)^{1-\alpha}\right). \qquad (7)$$

By substituting from the government budget constraints to express the tax rates in terms of the public good levels, we may rewrite (7) as follows:

$$1-\left(\frac{g_c}{g_r}\right)^{1-\alpha} = g_c\,\frac{-K'}{K^2}\left(1-\frac{1}{N}\right)\left((1-n^*)\left(1+\frac{dr}{dT}\right)+n^*\frac{dr}{dT}\left(\frac{g_r}{g_c}\right)^{\alpha}\right). \qquad (8)$$

This condition is illustrated by curve DD in Figure 1. As g_r goes to zero, the left side of (8) goes to minus infinity unless g_c goes to zero. For this reason, the DD curve lies below the CC curve at low levels of g_r. Note also that at high levels of g_r, g_c must also be high. Otherwise the right side of (8) will be highly negative, whereas the left side is positive. For these reasons, we have drawn DD as an upward sloping curve that eventually rises above the CC curve, although once again we cannot rule out downward-sloping segments without further restrictions. Intuitively, g_r and g_c must generally move in the same direction to insure that each level of government faces the same marginal cost of raising G one unit (which it equates to the marginal benefit, u_G/u_x).

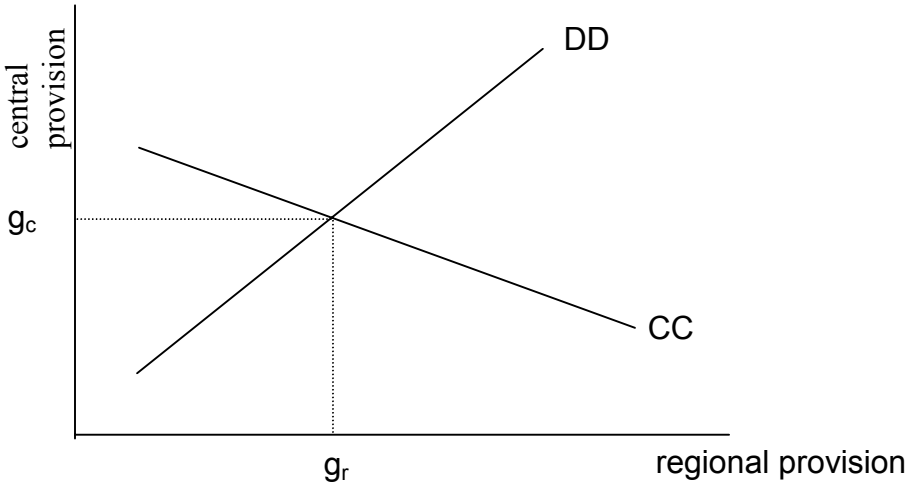

Figure 1

The equilibrium for the country is represented by the point where these two curves cross. For second-best problems of this type, we cannot rule out multiple crossings or even no crossing, due to discontinuities in the CC or DD curves (which might occur if dr/dT is highly sensitive to the level of taxation). Our strategy will be to examine the properties of any symmetric equilibrium for the two countries that does exist. We do assume that a country's equilibrium g_r and g_c vary continuously with its level of decentralization, measured by n*, and that the slopes of the reaction curves in tax space satisfy the normal condition for stability where they cross, as depicted in Figure 2 for the case of upward-sloping reaction curves.[5] Appendix B demonstrates that reaction curves can slope up or down, and so we consider both cases.[6]

3. Equilibrium Decentralization

This section demonstrates that both countries have some positive level of decentralization in any symmetric equilibrium (i.e., $n^* > 0$). The proof is by contradiction. We show that if both countries were centralized and setting their tax rates at their Nash values, given centralization, then each country would have an incentive to unilaterally decentralize the production of at least some public goods. In other words, decentralization is always the best response to the "centralization strategy." It follows that the only symmetric equilibrium is where both countries decentralize, at least partially. We also rule out asymmetric equilibria where one country decentralizes and the other remains fully centralized. Throughout the discussion, the policies for home are analyzed, since foreign behaves similarly.

A central preliminary result is that there exists some level of decentralization under which home behaves exactly as it would with full centralization. In particular, the central and regional governments all choose the same values for the g(n)'s under their control, and this common value is the one that would be chosen under full centralization.

[5] For Figure 2, this means that the slope of each reaction curve is less than one where they cross. The continuity assumption holds in the case of where the relation between a country's output and capital usage is represented by a quadratic production function, since then the derivatives dr/dT and K' are constant.

[6] To avoid unnecessary complications, we assume throughout the paper that the sign of this slope does not change over the relevant range of tax rates. In the knife-edge case of a horizontal reaction curve for home (vertical for foreign), the strategic considerations discussed in this paper would disappear.

As a result, the combined unit tax rate, t + T, is identical to the T chosen under full centralization.

Before turning to the formal proof of this claim, we first explain it intuitively. As described above, there are two externalities here from home's viewpoint. First, there is the usual fiscal externality from horizontal tax competition, 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 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.

This result is now stated and proved as a lemma:

Lemma 1. If foreign follows the centralization strategy and home decentralizes half of its pubic goods (n* = ½), then home's regional and central governments both set g(n) equal to the common g(n) that would prevail under full centralization.

Proof. If home is fully centralized (n* = 0), then it chooses the same tax rate as foreign in the symmetric Nash equilibrium. This tax rate satisfies the central government's optimality condition, given by (6), with the regional tax rate, τ, set equal to zero (and

with K = K* in the numerator, since the two countries have the same tax rates). To construct a (partially) decentralized equilibrium that replicates this centralized equilibrium, we move some public goods to the regional level (n* > 0) but keep their levels unchanged. In this case, the combined tax rate is unchanged, and (6) continues to hold.

For this level of public good provision to be in equilibrium, n* must be set where it also satisfies the regional governments' optimality condition, given by (5). In other words, the g_r in (5) must also satisfy (6), implying that regional governments are following the same rules used by the central government and therefore choosing the same g. The intuitive argument provided before the lemma claimed that this n* exists where the regional governments have reached a size at which the horizontal and vertical externalities offset each other. In fact, condition (8) confirms this argument. If home and foreign choose identical combined tax rates, then they possess identical capital supplies, and we can solve for dr/dT = - ½.[7] In this case, both sides of (8) equal zero when n* = ½ and $g_c = g_r$. This completes the proof. Q.E.D.

It is interesting to note that the n* identified in Lemma 1 would rise if we increased the number of countries. For J countries, we would have, dr/dT = -1/J, and the level of n* at would both sides of (8) equaled zero would then be n* = 1 – (1/J), which rises with J. This result may be easily explained. With more countries, the importance of the horizontal externality declines relative to the vertical externality, 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 the other country. Thus, n* must be higher for the horizontal and vertical externalities to offset each other.

Now consider marginal changes in home's n* from n* = ½. These changes will generally distort the behavior of regional governments, causing their public good choices to differ from those of the central government. However, the optimality of public good levels under the initial n* implies that this distortion is second-order, holding fixed the

[7] In equilibrium, the difference in the two countries' combined tax rates equals the difference in their marginal products of capital. Letting f(K) denote the production function, this marginal product is $f'(K_i)$ for country i (i = H,F). Thus, we can solve for home's dr/dT to obtain $dr/dT = - f'(K_F)/[f'(K_H) + f'(K_F)]$, which equals ½ in the symmetric equilibrium.

tax chosen by the foreign government. But the foreign tax does change, because it responds to the change in home's combined tax rate. We first investigate how the change in n* affects home's combined tax rate.

Lemma 2. Starting from the n* = ½ for home, and holding fixed foreign's tax rate at its full-centralization value, a marginal reduction in n* causes home's equilibrium combined tax rate to rise.

Proof. Return to the Figure 1, which depicts the equilibrium for n* = ½ as the intersection of the DD and CC curves. A crucial property of the latter curve is that a small move down the CC curve from this equilibrium must increase the combined tax rate. To see this, suppose instead that g_c falls enough as g_r rises to keep the combined tax rate unchanged (implying no change in the elasticity ε or dr/dT). With $\tau + \beta$ staying fixed, it is clear that $\tau(g_c/g_r)^{1-\alpha} + \beta$ falls, lowering the right side of (6). On the other hand, G and x are unchanged (to a first-order approximation), since total public good expenditures have not changed and the initial equality between g_c and g_r implies equal marginal utilities. Thus, the left side of (6) rises, due to the fall in g_c. By the second-order conditions for g_c, a higher g_c is needed to satisfy (6). It follows that tax revenue increases.

Now suppose that n* falls below ½. Holding g_r and g_c fixed at their common value under the initial n*, there is no change in total expenditures on the public goods and, hence, the combined tax rate. Thus, condition (6) is undisturbed, implying that the CC curve continues to intersect the original DD curve at the same point (although its shape elsewhere may change). However, the fall in n* raises the right side of (8) above zero, and equilibrium is restored with g_c/g_r falling to make the left side positive too. Thus, the fall in n* moves the economy down the CC curve, which can be represented in Figure 1 as a shift in the DD curve to the right. It follows that the fall in n* raises home's combined tax rate. Q.E.D.

We have basically shown that a reduction in home's n* raises its reaction curve, relating its combined tax rate to the tax rate chosen by foreign. In Figure 2, this shift is illustrated by reaction curves HH and H'H'. This result can be understood by again appealing to comparison of horizontal and vertical externalities. At n* = ½, these two externalities are exactly offsetting each other. But lowering n* transfers expenditures to the central government, thereby increasing the importance of vertical externality relative to horizontal externality. Since the vertical externality leads to "overprovision" of public goods, it is not surprising to learn that $\tau + \beta$ rises.

Reversing the above arguments shows that a rise in n* lowers home's reaction curve. Thus decentralization becomes desirable because it provides a method by which home can manipulate its reaction curve, thereby achieving a strategic advantage over foreign.[8]

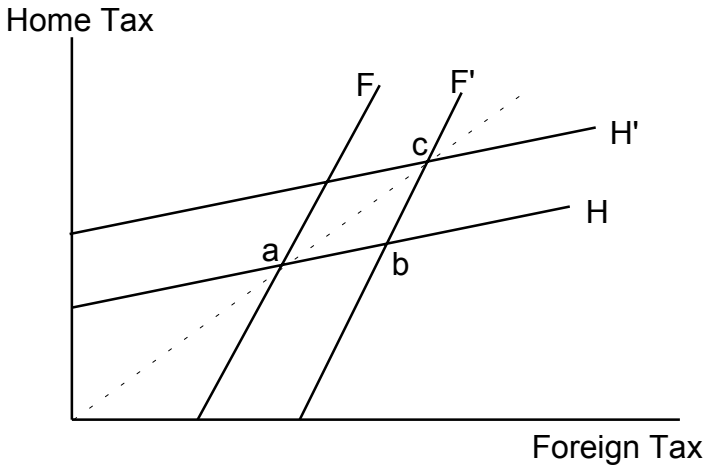

Figure 2

Exactly how n* should be set to achieve this desirable effect depends on the slopes of the reaction curves. If reaction curves slope up, as often assumed, then home should undertake a decentralization strategy that raises its reaction curve. Doing so induces foreign to raise its taxation of capital, and home benefits from this change

through the resulting inflow of capital (induced by reduction in the equilibrium r).[9] If reaction curves slope down, then home has an incentive to lower its reaction curve, since foreign's equilibrium tax rate now rises. In neither case, however, 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 $n^* = ½$. By Lemma 2, 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, both countries choose some level of decentralization.

The next proposition identifies a case where decentralization is necessarily partial:

Proposition 2. If reaction curves slope up, then decentralization is necessarily partial in a symmetric equilibrium: some public goods are produced by the central government and others are produced by the regional governments.

Proof. Suppose instead that $n^* = 1$ in both countries. In this case, there is only a horizontal externality. If we then reduce home's n^* to zero, this externality will be eliminated, and public good provision will rise (compare (5) and (6)). Holding foreign's tax rate fixed, home's welfare necessarily increases, since the central government's objective is to maximize welfare, summed across regions. In addition, the higher tax rate imposed by home implies an upward shift in home's reaction curve. As we previously noted, this change is also beneficial to home, since it leads to a higher tax rate for foreign.

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[8] Although Lemma 2 is a local result, concerning how a small change in n^* affects home's reaction curve in a small neighborhood of the initial equilibrium, the subsequent propositions do not require stronger global comparisons.

[9] A capital inflow benefits home because the tax on capital raises the marginal product of capital above the opportunity cost of capital. Since home country becomes a capital importer, the drop in r also represents a beneficial terms-of-trade effect.

Thus, the move to full centralization raises welfare, which contradicts the optimality of $n^* = 1$. Q.E.D.

Thus, a central conclusion is that each country will often desire to produce public goods at both levels of government. For the case of downward-sloping reaction curves, however, we cannot rule out the possibility that the central governments vanish as public good providers.

The standard Zodrow-Mieszkowski model can exhibit multiple equilibria, including asymmetric equilibria, where identical regions choose different tax policies. To focus on the decentralization issue, however, let us assume that reaction curves in tax space cross only once and ask whether the decision about whether to decentralize can be a separate source of asymmetry. We showed that one country would desire to decentralize if the other country is centralized. But is it possible for one country to desire to remain fully centralized, given that the other has decentralized? The answer is "no." To see this, suppose now that home decentralizes, conditional on foreign choosing a policy of full centralization. Would foreign desire to maintain this policy? Assume first that reaction curves slope up, and recall that home decentralizes in this case as a means of raising its reaction curve, thereby inducing foreign to raise its tax rate. As shown in Figure 2, this shift increases home's combined tax rate above foreign's tax rate. As the low-tax country, foreign is a net importer of capital. But then foreign can gain from decentralization for two reasons. Suppose that it sets $n^* = ½$, which replicates the centralization policy. If it now reduces n^*, we have seen that its reaction curves shifts up. Hence, foreign experiences the same source of gains that led home to decentralize, i.e., it induces home to raise its combined tax rate, producing a beneficial capital flow from home to foreign. But there is also a second source of gains for foreign. Given its initial status as a capital importer, it gains from the resulting terms-of-trade effects. In particular, the rise in both countries' combined tax rates depresses the after-tax return on capital, which necessarily benefits a capital-importing country. Thus, foreign will choose to decentralize, given that home is decentralized. In other words, the only possible

equilibrium involves decentralization by both countries. For the case where reaction curves slope down, a similar argument again implies decentralization by both countries.

4. Welfare

The welfare effects of decentralization depend on the slopes of the reaction curves in tax space. In the case where reaction curves slope down, however, it is clear that decentralization is welfare worsening. In this case, both countries are decentralizing in an effort to lower their reaction curves. But the result is that their combined tax rates both decline, 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.

On the other hand, 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 Figure 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. Since 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 Figure 1. By a standard revealed-preference argument, home clearly benefits from this change;

otherwise, it would not implement it. Since the two countries are identical, a similar argument must show that decentralization also benefits foreign.

To conclude, decentralization serves 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.

5. Concluding Remarks

In traditional models of fiscal federalism, an important role for the central government is 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 aspect of this design. Interestingly, 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 externality, we hope to have demonstrated the usefulness of departing from the common practice of treating their relative importance as exogenous.

Our stylized model may hold some lessons in the in the context of capital mobility within and across the U.S. and the European Union. Both countries 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.[10] 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.[11]

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.

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[10] 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.

[11] Here and below, we consider the case of upward-sloping reaction curves, in which case the analysis shows that the federal system should be designed to increase taxes on mobile capital.

Appendix A

This appendix derives conditions (5) and (6) in the text. For (6), the central government solves the problem:

(P.1) Max $u(rK^* + wL^*, G)$

T, g_c, g_r

s.t. $(1 - n^*)g_c = TK(r + t + T);$ (A.1)

$n^*g_r = tK(r + t + T);$ (A.2)

where G is given by (1) and w is determined by r+t+T via a factor price frontier, denoted w(r+t+T). Given the assumption of Nash behavior, the central government treats t as fixed but recognizes that g_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 the following first-order condition:

$$u_x\left[\left(K^* + w'L^*\right)\frac{dr}{dT} + w'L^*\right] + u_G\left[\alpha g_c^{\alpha-1}K + \left[\alpha g_c^{\alpha-1}T + \alpha g_r^{\alpha-1}t\right]K'\left[1 + \frac{dr}{dT}\right]\right] = 0. \quad \text{(A.3)}$$

For zero profits, we must have (using the envelope theorem), w' = - K/L*. Substituting this expression into (A.3), dividing through by u_xK, and rearranging gives,

$$\frac{u_G}{u_x}\alpha g_c^{\alpha-1}\left[1 - \left(t\left(\frac{g_c}{g_r}\right)^{1-\alpha} + T\right)\left(\frac{-K'}{K}\right)\left(1 + \frac{dr}{dT}\right)\right] = 1 + \left(1 - \frac{K^*}{K}\right)\frac{dr}{dT}. \quad \text{(A.4)}$$

Noting that –K'R/K equals the elasticity ε, we may then rearrange (A.4) to get (6).

The problem for a single region is set up in a similar way, except that we must now distinguish between this region and the other regions in the country. Thus, the central government's budget constraint becomes,

$$(1 - n^*)g_c = T[K(r + t + T) + (N - 1)K(r + t^o + T)], \qquad (A.5)$$

where t is the tax rate for the region in question, and t^o is the tax rate for all other regions. Each regional government receives 1/Nth of the expenditures provided by the central government. Hence, a change in t alters each g_c going to the given region by an amount equal to TK'[1/N + dr/dt]/(1-n*). In contrast, the change in each g_r for the region is once again K + tK'[1 + dr/dt]/n*. By differentiating the objective function given in (P.1) with respect to t and using these two expressions, we obtain a first-order condition that differs from (A.3) in an understandable way:

$$u_x\left[\left(K^* + w'L^*\right)\frac{dr}{dt} + w'L^*\right] + u_G\left[\alpha g_r^{\alpha-1}K + \alpha g_r^{\alpha-1}tK'\left[1 + \frac{dr}{dt}\right] + \alpha g_c^{\alpha-1}TK'\left[\frac{1}{N} + \frac{dr}{dt}\right]\right] = 0 \qquad (A.6)$$

By once again using the equality, w' = - K/L*, we may transform (A.6) into (5) in the text.

Appendix B

This appendix provides examples of upward- and downward-sloping reaction curves, relating the home country's combined tax rate, t+T, to the foreign country's combined tax rate.[12] First, we assume that the production function is quadratic: $f(K) = \gamma K - \eta K^2$. With a quadratic production function, a country's demand curve for capital (relating the marginal product of capital to K) is linear. In this case, dr/dT is a constant, which simplifies matters considerably. Next we assume that the utility function takes the form

$$u = x + \int_0^1 \log g(n)\, dn\,, \tag{B.1}$$

which corresponds to the special case of (1) where α goes to zero.

To express the central government's optimality condition for this special case, substitute $\alpha = 0$ into (6), and substitute $-K'R/K$ for the elasticity ε:

$$\frac{1}{g_c} = \frac{1+\left(1-\frac{K^*}{K}\right)\frac{dr}{dT}}{1-\frac{T}{1-n^*}\frac{(-K')}{K}\left(1+\frac{dr}{dT}\right)}, \tag{B.2}$$

where use has been made of the equality, $g_c/g_r = Tn^*/(t(1-n^*))$. Next multiply both sides of (B.2) by K times the denominator on the right side of (B.2), and substitute $(1-n^*)/T$ for K/g_c:

$$\frac{1-n^*}{T}\left(1-\frac{T}{1-n^*}\frac{(-K')}{K}\left(1+\frac{dr}{dT}\right)\right) = K + (K-K^*)\frac{dr}{dT}. \tag{B.3}$$

Rearranging terms gives

[12] Brueckner and Saavedra (2001) also 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 good levels are imperfect substitutes.

$$\frac{1-n^*}{T} = \left(K + \frac{(-K')}{K}\right)\left(1 + \frac{dr}{dT}\right) - K^* \frac{dr}{dT}. \tag{B.4}$$

Now a rise in foreign's combined tax rate shifts capital to home, represented by a rise in K. Thus, we may differentiate (B.4) with respect to K to show that T rises (falls) with foreign's tax rate if

$$\frac{d(-K'/K)}{dK} < (>) -1 \tag{B.5}$$

Thus, the critical consideration here is how the capital demand derivative K' changes relative to capital demand as K rises. Since K' is fixed, we know that –K'/K falls. For sufficiently elastic demand, however, the fall in –K'/K will be greater than one in absolute value, implying T rises with foreign's combined tax rate.

Consider finally how home's regional tax rate changes with foreign's combined tax rate. Once again using $\alpha = 0$ and the condition, $g_r/g_c = (t(1-n^*))/(Tn^*)$, optimality condition (5) can be written:

$$\frac{n^*}{t} = \frac{K + (K - K^*)\dfrac{dr}{dt}}{1 - t\left(\left(1 + \dfrac{dr}{dt}\right) + \left(\dfrac{1}{N} + \dfrac{dr}{dt}\right)\left(\dfrac{1-n^*}{n^*}\right)\right)\dfrac{(-K')}{K}} \tag{B.6}$$

Manipulation gives a condition somewhat more complicated than (B.5):

$$\frac{n^*}{t} = \left(K\left(1 + \frac{dr}{dt}\right) + \left(1 + \frac{dr}{dt} - (1-n^*)\left(1 - \frac{1}{N}\right)\right)\frac{(-K')}{K}\right) - K^* \frac{dr}{dt}. \tag{B.7}$$

As before, a sufficiently large negative impact of K on –K'/K implies an upward-sloping reaction curve, but now the critical condition is:

$$\frac{d(-K'/K)}{dK} < (>) - \frac{1+\frac{dr}{dt}}{1+\frac{dr}{dt}-(1-n^*)\left(1-\frac{1}{N}\right)} < -1 \qquad \text{(B.8)}$$

where dr/dt = - 1/(2N). The condition for t to rise with the foreign combined tax rate is somewhat more stringent than (B.5). As the number of regions goes to infinity, the ratio in (B.8) converges to 1/n*.

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