Cities in Fiscal Equalization

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Abstract: Redistributive grants schemes, such as fiscal equalization, are a common characteristic of local public finance in several countries. However, large and small jurisdictions are treated differently by the respective fiscal equalization schemes that often tend to favor larger jurisdictions. This paper provides a theoretical analysis showing that efficiency considerations might justify a preferential treatment of large jurisdictions. More specifically, we show that an efficient grant scheme would enable large jurisdictions such as cities to provide more public services. Under some conditions, the resulting budget of cities will exceed that of small towns in per-capita terms. Moreover, in a setting with local capital taxation we find that an efficient equalization scheme would also allow cities to retain a larger share of own funds.

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1 Introduction

Facing difficulties in raising own funds because of mobility and intergovernmental competition local governments in many countries engage in revenue sharing. A common approach to revenue sharing, referred to as fiscal equalization, is to set up a redistributive system of fiscal transfers ensuring that revenues after fiscal redistribution are equalized across jurisdictions. While the details vary, fiscal equalization usually consists of a combination of unconditional grants allocated to the jurisdictions and some explicit or implicit transfer obligations since jurisdictions with higher tax revenues receive less equalization grants or have to pay higher contributions to fund the equalization scheme.

Fiscal equalization often entails a quite significant redistribution of funds and the associated distortions and incentive effects call for an appropriate design of equalization schemes. A fundamental problem in this regard is related to the spatial structure of the economy. In general, as is emphasized in a large urban economics literature, local jurisdictions strongly and systematically differ in size and productivity. The most striking characteristic is that they typically show a rather skewed distribution in terms of population size and density. This raises the question of whether fiscal equalization should aim at equalizing per-capita revenues between small places, towns, and cities.

The local public finance literature (*e.g.*, Wildasin, 1986) suggests that differences in population size have important implications for the cost of providing public services. For instance, since public services usually display some degree of non-rivalry the per-capita cost of providing public services declines with population size. Thus, cities might be able to provide the same level of public services at lower costs and, therefore, might need less funds than small towns. Moreover, as emphasized in the tax competition literature, asymmetries in the size of jurisdictions might give rise to differences in the marginal cost of raising public funds (*e.g.*, Bucovetsky, 1991, and Wilson, 1991). Accordingly, due to their larger share in the market for mobile factors, cities might face less elastic tax bases and, hence, would be willing to provide more public services even without grants. These two arguments seem to suggest that an equalization system should provide less funds to cities as compared to small towns, at least on a per-capita basis.

In practice, fiscal equalization systems in countries such as Austria, Germany, and Spain do treat large and small municipalities differently. Yet, the grant schemes in these countries distribute funds on the basis of population numbers that are inflated for larger municipalities and cities, implying a favorable treatment of these jurisdictions.[1] To provide an example, Figure 1 illustrates the favorable treatment of larger municipalities in the case of North Rhine-Westfalia, the largest German state, which runs a strongly redistributive equalization system.[2] The solid line depicts *fiscal need* in per-capita terms, which is, basically, the granted per-capita level of spending as defined in the Municipal Finance Law.[3] Accordingly, the fiscal need of larger cities with more than about 600,000 residents is almost 60% higher in per-capita terms than that of municipalities below 25,000 inhabitants. The dots in the figure represent the actual budget size. As they are distributed around the curve of fiscal need we see that the equalization system is quite effective in ensuring that cities do have more public funds at their disposal than small towns even in per-capita

[1]In these countries the distribution of funds is based on fictitious or weighted rather than actual population numbers. Formally, fiscal need fn_i is defined as

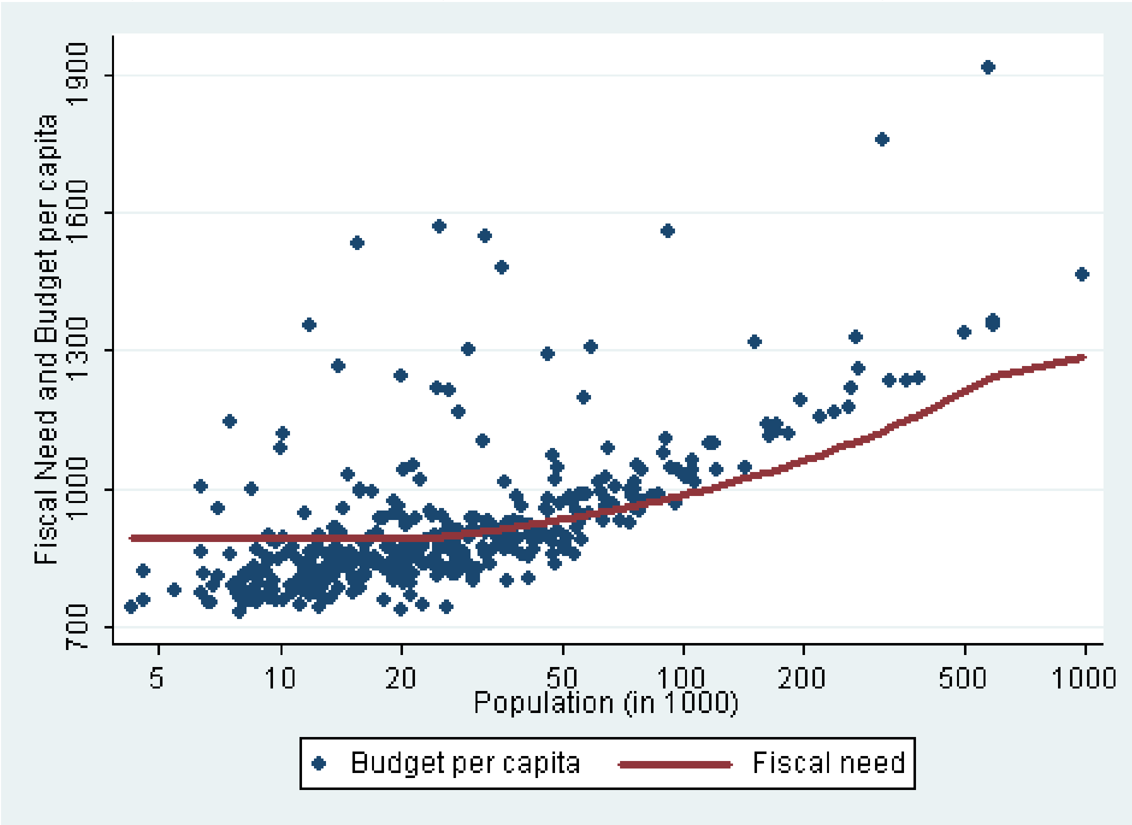
$$fn_i \;=\; z\, n_i\, w_i,$$

where z is the basic figure of fiscal need per capita, n_i is the number of inhabitants, and w_i is a weight or factor that is unity for small municipalities but larger than unity for cities depending on population size. For instance, in Austria the weight is unity if the population is below 10,000 inhabitants and is increasing with population size up to a figure of $2\frac{1}{3}$ for municipalities with more than 50,000 inhabitants. In Spain, the weight is unity for the calculation of fiscal need of jurisdictions with less than 5,000 inhabitants, the weight of cities with more than 500,000 is 1.85. In Germany, different rules apply across states. For example, the largest state, North Rhine-Westfalia, displays weights that vary between unity for municipalities below 25,000 inhabitants and a figure of 1.57 for cities with more than 634.000 inhabitants.

[2]The strong degree of fiscal redistribution is documented by the fact that the equalization grants compensate for 90% of the difference between fiscal need (see below) and fiscal capacity. See Buettner and Holm-Hadulla (2008) for more details.

[3]*Cf.* “Gemeindefinanzierungsgesetz des Landes Nordrhein-Westfalen 2007.”

Figure 1: Municipal Budget and "Fiscal Need" in the largest German State



Euro per-capita figures. Solid line depicts the fiscal need per capita according to the Municipal Finance Law 2007 of North Rhine-Westfalia. Dots represent the actual revenues in per capita terms after fiscal redistribution for the 396 municipalities in this year.

terms.

The traditional justification for the special treatment of large jurisdictions in the German case goes back to Popitz (1932) who observed that public spending in per-capita terms rose with population size among Prussian municipalities. This finding is paralleled also in the US case, where Schmandt and Stephens (1963) and Shapiro (1963) note that local expenditures plotted against population size display a marked U-shaped pattern. Accordingly, average per-capita expenditures of local governments show a minimum in counties with a population size of 20,000-50,000 residents, and per-capita expenditures are strongly increasing with population size in counties with more residents. While the empirical observation of higher per-capita expenditures of cities has motivated the design of fiscal equalization schemes in Germany and other countries, the apparent inconsistency of heavily redistributive equalization mechanisms that, however, systematically favor cities has triggered much critical discussion in Germany, both in the political sphere and among economists.[4]

In the local public finance literature, however, the treatment of cities in systems of fiscal equalization has been rarely discussed. Contributions that are touching this issue do not endorse the preferential treatment of cities: Fenge and Meier (2002) show that subsidizing higher cost of public service provision in cities would induce excess agglomeration, and, hence, result in welfare losses. Solé-Ollé and Bosch (2005) provide an empirical analysis showing that the per-capita cost of public service provision of large municipalities in Spain is lower than assumed by the fiscal equalization system.

The contribution of this paper is to reconsider the justification for a special treatment of cities in a system of fiscal equalization, explicitly taking into account the different conditions for public service provision in large as compared to small jurisdictions. These include cost differences due to the non-rivalry in the consumption of public services as well as differences in the marginal cost of raising own public funds. In a first step, we analyze

[4] *E.g.*, Boes (1970), Kuhn (1983), Peffekoven (1987), Homburg (1994), Zimmermann (2001), Kitterer and Plachta (2008).

the role of size differences for the supply of public services in a setting with efficient tax instruments. While in most countries local governments do not have access to such tax instruments, the efficient case serves as a useful benchmark in a discussion of the allocation of funds across municipalities. In a second step, we focus on the role of fiscal equalization in a setting with inefficient tax instruments. Here the analysis builds on the literature about efficient equalization which emphasizes that fiscal equalization grants might have important effects on tax effort (*e.g.*, Dahlby and Wilson, 1994, Koethenbuerger, 2002, Bucovetsky and Smart, 2006, Buettner, 2006).

Taking account of differences in productivity as the underlying force driving interregional size differences our results support a preferential treatment of larger jurisdictions with regard to both the lump-sum and the taxing capacity-dependent component of a typical equalization scheme. In other words, while we note that cities have a cost advantage in the provision of public services and are facing lower cost of raising own funds, we find that an efficient equalization system that takes account of the spatial structure of the economy would enable cities to provide more public services and to retain a larger share of own funds. Under some conditions, this would even imply that the budget of cities after fiscal redistribution exceeds that of small towns in per-capita terms.

The paper is organized as follows. The next section discusses the implications of size differences for an efficient allocation with public and private goods. Section 3 is concerned with the role of equalization transfers in a setting with a distortive capital tax. Section 4 provides our conclusions.

2 City Size and Public Service Provision

Consider an economy with N jurisdictions, $i = 1, 2, ..., N$. Jurisdiction i hosts n_i households each inelastically supplying one unit of labor. Firms are situated in a central business district and produce a uniform good using labor and capital according to a linear homogeneous production function $F_i(n_i, K_i)$. Given perfect capital mobility, the marginal product of capital is equal to a uniform rate of return

$$F_{iK}(n_i, K_i) = \iota.$$

Besides labor income resident households receive income from savings s_i at the common rate of return ι. They derive utility from the consumption of a private good (x_i), of housing space (q_i), and of public goods or services z_i, formally

$$u_i = v(x_i, z_i, q_i).$$

To keep the analysis simple let us assume that each household consumes the same amount of housing $q_i = 1$ such that the utility function simplifies to

$$u_i = u(x_i, z_i) = v(x_i, z_i, 1).$$

Each jurisdiction hosts an urban area that serves as center of production and is the place of residence for the mobile population. Consider the case of a monocentric city (see Fujita, 1989, for a discussion). A household located at the urban fringe, which is in distance b to the city center, would face cost of housing comprising commuting cost of kb and direct cost of housing corresponding to the price of land. At the urban fringe the latter corresponds to the opportunity cost of land ω. Due to household mobility, differences in the direct cost of housing within the city reflect differences in commuting cost. Thus, the (total) cost of housing, *i.e.* direct cost of housing plus commuting cost, are constant across the city. However, the cost of housing varies across cities if the population size differs. With all households commuting to the central business district we have the following equilibrium condition for the housing market

$$n_i = \int_0^{b_i} T(\delta)\, d\delta,$$

where $T(\delta)$ captures the available housing space at distance δ from the city center.[5] Hence, the distance from the urban fringe to the city center is an increasing function of the total population size $b_i = b(n_i)$. As a consequence, the cost of housing in the city amounts to

$$h_i \equiv h(n_i) = \omega + kb(n_i)$$

and is increasing in population size.

2.1 Efficient Provision of Local Public Services

Following Wildasin (1986) the public goods or services are provided at cost $C(n_i, z_i)$ which is increasing in the quantity provided as well as in population size. With regard to financing the provision of the local public services, let us start with the assumption that there is a fully efficient set of tax instruments. Hence, we insert the cost of public service provision directly into the households' budget constraint

$$n_i F_{in} + \iota s_i n_i \quad - \quad (x_i + h(n_i))\, n_i - C(n_i, z_i) = 0,$$

where ι is the common return to savings. We assume that the local jurisdiction maximizes the utility of a representative household under this constraint, formally

$$\mathcal{L}_i = u(x_i, z_i) + \mu_i \left[n_i F_{in} + \iota s_i n_i \quad - (x_i + h(n_i))\, n_i - C(n_i, z_i) \right].$$

[5]In the simple case of a circular city we have $T(\delta) = 2\pi\delta$.

The optimality conditions are

$$\frac{\partial \mathcal{L}_i}{\partial x_i} = u_{ix} - \mu_i n_i = 0$$

$$\frac{\partial \mathcal{L}_i}{\partial z_i} = u_{iz} - \mu_i C_{iz} = 0.$$

This can be arranged to obtain the familiar Samuelson condition

$$n_i \frac{u_{iz}}{u_{ix}} \quad = \quad C_{iz},$$

where the marginal cost of public funds are unity. Only an increase in the level of public service provision itself is associated with extra cost.

However, this policy is not necessarily efficient. As noted by Wildasin (1986), from the viewpoint of a central planner an efficient policy would maximize the following Lagrangian

$$\begin{aligned}\mathcal{L}^{cp} = u\left(x_i, z_i\right) + \sum_{j \neq i}^{M} \nu_j [u(x_j, z_j) - u(x_i, z_i)] \\ +\mu \sum_{j=1}^{M} [n_i F_{jn} + \iota s_j n_j \quad - \left(x_j + h\left(n_j\right) n_j\right) - C\left(n_j, z_j\right)] \\ +\varphi \left[N - \sum_{j=1}^{M} n_i \right].\end{aligned}$$

Note that we include an equal utility constraint that might reflect the central planner's preference for equity. An alternative interpretation is that the planner acknowledges that only equal levels of utility are consistent with a spatial equilibrium. While the first-order conditions (FOC) with respect to public and private consumption are the same as above, a further condition characterizes the optimal allocation of labor.

$$\frac{\partial \mathcal{L}^{cp}}{\partial n_i} = \mu \left(F_{in} - x_i - h_i - h_{in} n_i - C_{in}\right) - \varphi = 0.$$

Because this efficiency condition holds for all jurisdictions, it implies that a reallocation of labor cannot increase welfare

$$F_{in} - x_i - h_i - h_{in}n_i - C_{in} = F_{jn} - x_j - h_j - h_{jn}n_j - C_{jn},$$

and is, therefore, referred to as the locational efficiency condition (Wildasin, 1986).[6]

2.2 Size Differences

Suppose that total factor productivity is subject to region-specific productivity differences, and let us introduce a productivity parameter γ_i that shifts total factor productivity according to $F_i(n_i, K_i) = \gamma_i \tilde{F}(n_i, K_i)$. If $\gamma_i > \gamma_j$, region i has a higher productivity such that $F_{in} > F_{jn}$ at the same level of population. As a consequence, the population will be higher $(n_i > n_j)$. To see why, consider the locational efficiency condition. If, $n_i = n_j$, housing cost and the cost of public service provision are unchanged. Hence, either private or public consumption or both would have to be higher in region i. With more consumption of x_i and/or z_i utility would be higher in i such that the equal-utility constraint is violated. With equal utility, however, the locational efficiency condition would be disturbed and the central planner would need to reallocate labor to the more productive region. The additional labor supply would result in a decline in marginal productivity and in higher cost of housing until the locational efficiency is restored. Hence, the population size in region i would have to be larger and we can state the following lemma:

Lemma 1 (Size of Jurisdictions)
If residents of all jurisdictions enjoy the same level of utility, jurisdictions with higher productivity have a larger population.

[6] An important issue in local public economics concerns the set of tax instruments that would ensure that a decentralized equilibrium will actually meet the locational efficiency condition. If a head tax is set equal to the marginal crowding cost $\tau_{in} = C_{in} + h_{in}n_i$ the locational efficiency condition is fulfilled. At the same time, however, another tax instrument is needed to balance the local government's budget constraint (see Wildasin, 1986, for a discussion).

Given some degree of non-rivalry in the consumption of public goods, the size of the jurisdiction affects the cost of public good provision. Since, if consumption of public services is not completely rival, $\frac{C_{iz}}{n_i}$ is declining with the jurisdiction's population. From the Samuelson condition we know that, as a consequence, the relation between public and private consumption will be higher in the larger jurisdiction. Moreover, with the same level of utility in all jurisdictions, x_i would be smaller in order to compensate for higher z_i. Thus, building on the inverse relationship between the per-capita marginal cost of public good provision and the population size we can derive the following proposition:

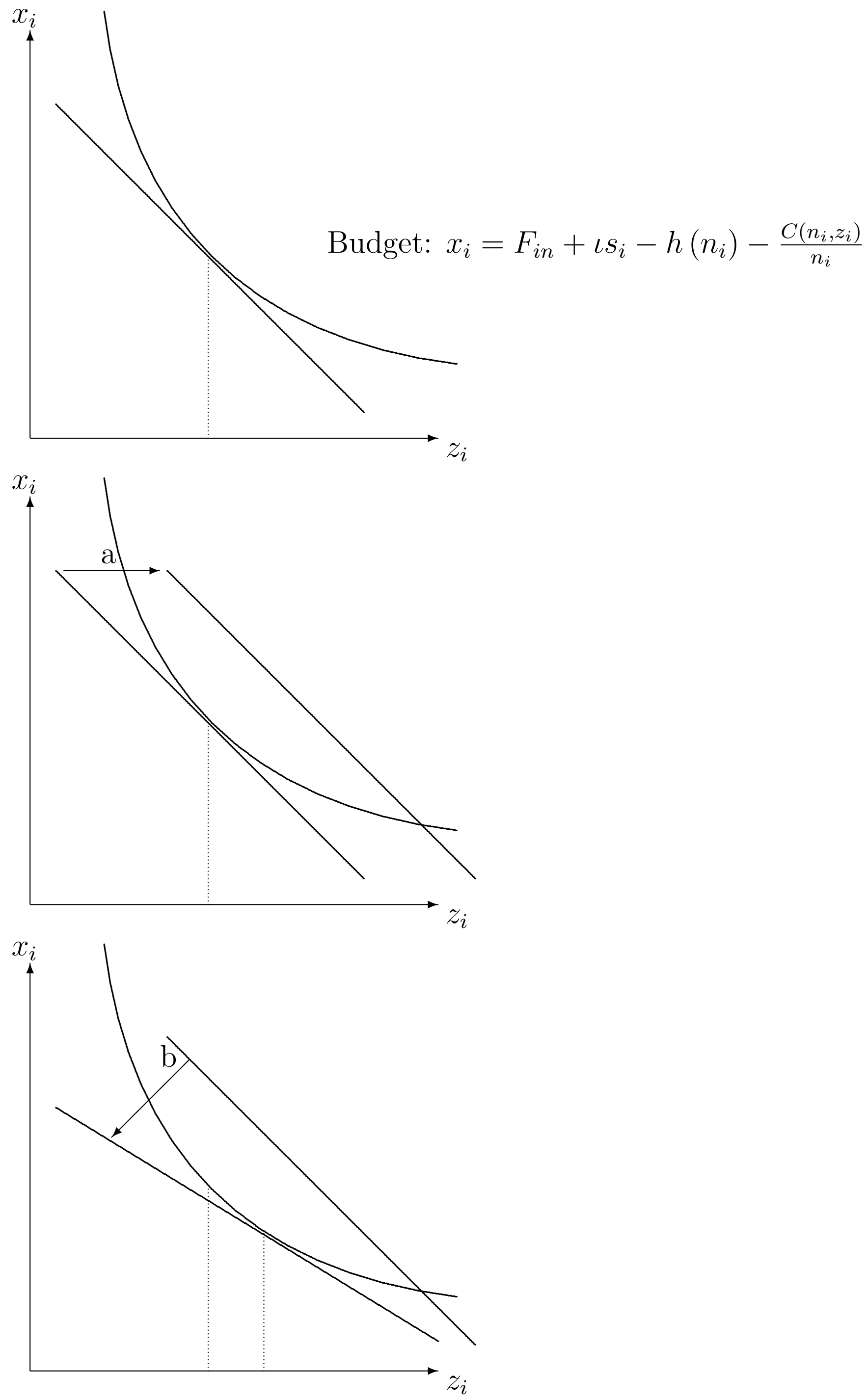
Proposition 1 (Cost-Advantage of Cities)
If public services show some degree of non-rivalry in consumption, an efficient allocation will enable larger jurisdictions to provide more public services.

A formal proof is given in the appendix.

The consequences of productivity differences and of the associated size differences are illustrated in Figure 2. At a given population size, a productivity increase would shift the budget constraint upwards and to the right (see arrow "a") such that at given z_i each household could consume more of the private good.

However, in order to restore a situation with the same level of utility everywhere, the population would have to be larger. To see this note that a population increase would cause a decline in the marginal product of labor and result in larger housing cost. As a consequence, the budget constraint would shift back down (see arrow "b"). Moreover, if we assume some degree of non-rivalry in public consumption, the marginal per-capita cost $\frac{C_{iz}}{n_i}$ would decline with increasing population size. With a larger population, therefore, the budget line becomes flatter. Provided the jurisdiction is small relative to the country the utility level in the economy is unaffected by the productivity shock and the associated local government's decisions. Hence, the efficient population size is reached if tangency is obtained with respect to the initial indifference curve.

Figure 2: Comparative Static Effects of a Productivity Increase



While our analysis shows that under some relatively weak assumptions the more productive region will provide a higher level of public services it is not obvious that public spending is larger in per capita terms. If z_i would stay constant, per-capita cost $\frac{C_i}{n_i}$ would decline. However, z_i is increasing and, hence, the per capita cost of public good provision might rise. If z_i increases strongly, the latter effect would dominate and the budget might actually be larger even in per-capita terms. In fact, the effect on the budget can be characterized in terms of the Hicksian price elasticity of demand. If demand for the public goods or services responds rather strongly to a marginal cost-reduction, the per-capita budget will be higher in the larger jurisdiction.

Proposition 2 (Budget-Size of Cities)
If public services show some degree of non-rivalry in consumption, and if the Hicksian demand for public services is sufficiently elastic, in an efficient allocation the budget of jurisdictions with larger population size is larger in per-capita terms relative to jurisdictions with less population.

For a formal proof, see Appendix 5.2.

This argument of demand effects might be reinforced in the presence of heterogeneity between households. Consider a case, where two types of households exist, which differ in their preferences for public services. If larger jurisdictions have a cost advantage in public service provision, Tiebout sorting would actually result in a concentration of high public service demand in the city.

The cost advantage of cities has also been noted by Oates (1989) who argues that it can explain why the range of government services provided in a large city is greater. A particularly important issue in this regard is the substitutability between private and public goods. If complete substitution is possible, a jurisdiction may decide not to provide certain types of public services if the costs are particularly high.

Proposition 3 (Substitution and City Size)
If public services show some degree of non-rivalry in consumption, and if the utility function allows for complete substitution, small jurisdictions are more likely to choose not to provide public services, in particular, if there are indivisibilities in the provision of these services.

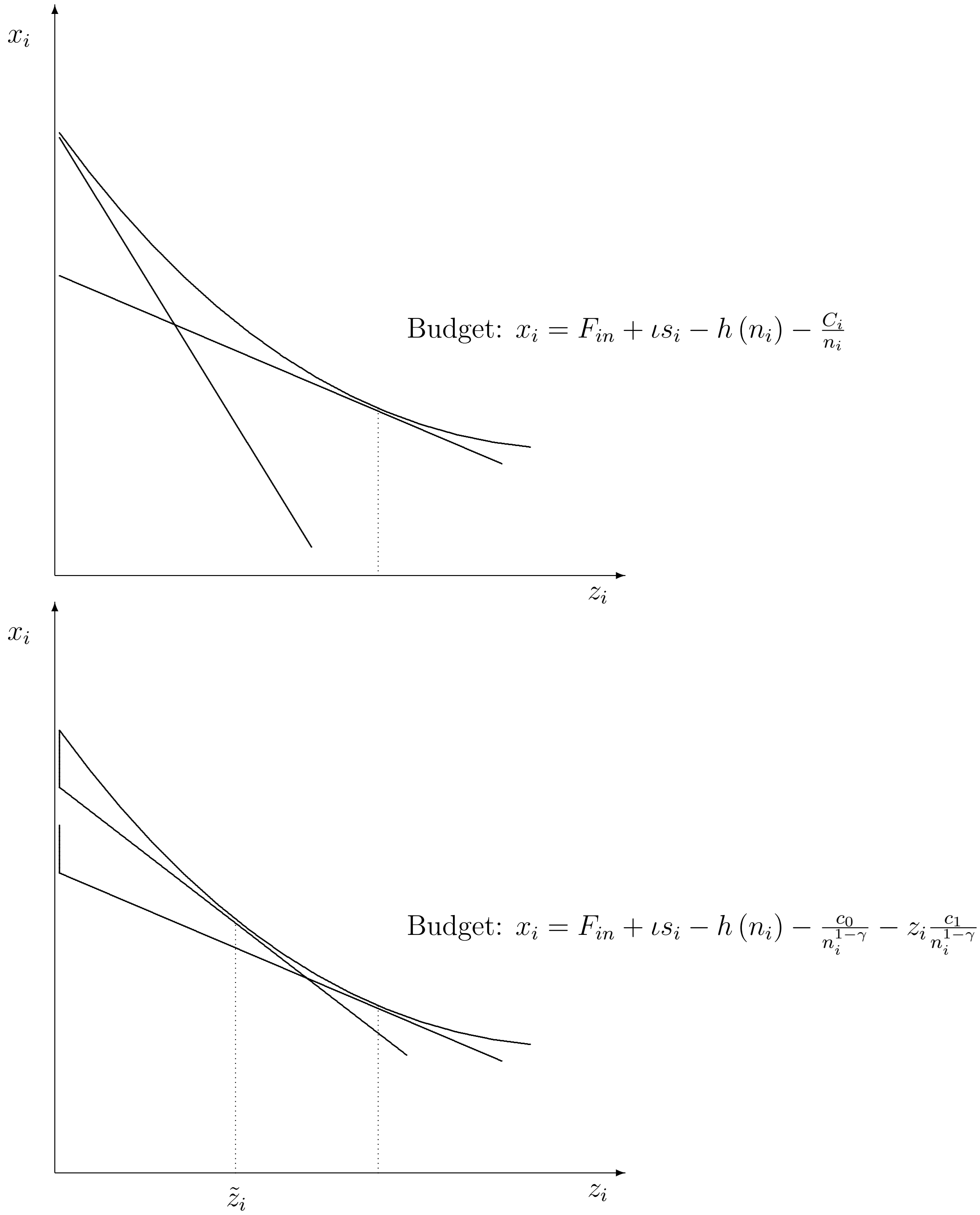
While a formal proof is given in the appendix, the intuition is illustrated by Figure 3. In the upper panel we depict a situtation where complete substitution is possible. With lower population size the budget line becomes steeper, and, eventually, no interior solution is obtained. The lower panel shows the case with indivisibilities in the provision of public services according to a cost function

$$C\left(n_i, z_i\right) = \left(c_0 + c_1 z_i\right) n_i^{\gamma}, \text{ for } z_i > 0, \text{ and } C\left(n_i, z_i = 0\right) = 0.$$

With this cost function the feasible budget constraint becomes non-convex: it has kink at a level of $z_i = 0$. As a consequence, at a certain threshold level of population size, the local jurisdiction may become indifferent between providing public services at a level of $\tilde{z}_i$ or not providing public services at all. Smaller jurisdictions would then shut down public service provision altogether.

It might seem to be a rather strong assumption that the indifference curves cut the vertical axis as this implies that public services can be substituted entirely by the private good. However, note that a point at the vertical axis only implies that the *own* provision of public services is zero. In many cases residents of i could still benefit from the provision of public services provided by a neighboring jurisdiction. While a thorough discussion of benefit spillovers in the context of size differences is beyond the scope of this paper, we may note that the cost advantage of cities in the provision of public services might further contribute to a larger budget in metropolitan areas where households consume public services from different locations. Given those benefit spillovers the marginal benefit from public services rises. This suggests that the budget of a large jurisdiction that exerts important spillovers might be larger, provided a mechanism exists that ensures that the willingness to pay for

Figure 3: Complete Substitution of Public Services



public services in adjacent jurisdictions is resulting in an expansion of public services.

3 City Size and Tax Competition

The previous section has focused on city-size differences in a setting with an efficient set of tax instruments. This efficient case serves as a useful benchmark for the allocation of fiscal equalization grants across local jurisdictions and may justify why the conceded budget in per-capita terms, *i.e.* the fiscal need, is higher in larger jurisdictions and cities. However, fiscal equalization affects the finances of jurisdictions not only by allocating grants that allow jurisdictions to extend their supply of public services. An important characteristic of fiscal equalization is that the grants are tied to the taxing capacity. In fact, in the presence of fiscal equalization jurisdictions with higher taxing capacity receive less equalization grants or have to pay higher contributions to fund the equalization scheme. As has been emphasized in the literature on tax competition and fiscal equalization, these implicit or explicit transfer obligations have important implications in a setting with inefficient tax instruments. Concerned with inefficiencies from capital tax competition Wildasin (1989) discusses Pigouvian subsidies as a means to raise tax effort. Dahlby and Wilson (1994) analyze the role of fiscal equalization grants tied to taxing capacity in changing the tax effort of local jurisdictions. Smart (1998) shows that fiscal equalization grants provide incentives to raise distortionary taxes. Koethenbuerger (2002) notes that these grants could actually replicate the Pigouvian solution to tax-competition inefficiencies. Bucovetsky and Smart (2006) determine the key elements of an efficient fiscal equalization system in a setting with capital tax competition and show that the optimal degree of redistribution is inversely related to the tax-rate elasticity of capital supply. Against this background, this section considers whether large and small jurisdictions should be treated differently also with regard to the incentives provided by the taxing capacity-dependent component of an equalization scheme.[7]

3.1 Tax Competition without Equalization

We extend the above analysis by assuming that on the revenue side the government is constrained to two sources of funds: a capital tax and unconditional grants.[8] This setting allows us to specify the government budget constraint as

$$\tau_{iK} K_i + G_i = C(n_i, z_i).$$

Although the private budget constraint does not contain taxes

$$x_i n_i + h(n_i) n_i = F_{in} n_i + s_i \iota n_i,$$

we have to take into account that local taxation of capital will affect household income, indirectly. This follows since the tax rate τ_{iK} raises the user cost of capital ρ_i and drives a wedge between the marginal product of capital and the uniform rate of return on capital

$$F_{iK}(n_i, K_i) = \rho_i \equiv \iota + \tau_{iK}. \quad (1)$$

In this setting, the optimal policy of a local government maximizes the Lagrangian

$$\begin{aligned} \mathcal{L}_i^{loc} &= u(x_i, z_i) + \lambda_i [\tau_{iK} K_i + G_i - C(n_i, z_i)] \\ &+ \mu_i [n_i F_{in} + \iota s_i n_i - n_i x_i - h(n_i) n_i]. \end{aligned}$$

[7] In the political debate about the municipal fiscal equalization system in Germany not only fiscal need is discussed controversially (see Introduction), but also the definition of fiscal capacity. Representatives of smaller municipalities argue, for instance, that the definition of the taxing capacity by applying average tax rates on the local tax base would discriminate against smaller jurisdictions, which usually set lower tax rates due to tax competition (*e.g.*, Busse, 2004).

[8] Note that this setting is restrictive in that it can not be ensured that locational efficiency obtains in general. However, the following discussion focuses on the distortive effects of capital taxation.

The FOCs with respect to public and private consumption are

$$\frac{\partial \mathcal{L}_i^{loc}}{\partial x_i} = u_{ix} - \mu_i n_i = 0$$

$$\frac{\partial \mathcal{L}_i^{loc}}{\partial z_i} = u_{iz} - \lambda_i C_{iz} = 0.$$

This can be arranged to obtain a modified Samuelson condition

$$n_i \frac{u_{iz}}{u_{ix}} \quad = \quad C_{iz} \, \frac{\lambda_i}{\mu_i}$$

where $\frac{\lambda_i}{\mu_i}$ denotes the marginal cost of public funds.

Of course, the marginal cost of public funds is determined by the capital tax rate which is the government's instrument for transferring private into public funds. We can derive this cost from the FOC with regard to the tax rate which is given by

$$\frac{\partial \mathcal{L}_i^{loc}}{\partial \tau_{iK}} = \lambda_i \left[K_i + \tau_{iK} \frac{dK_i}{d\tau_{iK}} \right] + \mu_i \left[n_i F_{inK} \frac{dK_i}{d\tau_{iK}} + s_i n_i \frac{d\iota}{d\tau_{iK}} \right] = 0.$$

What is required here, is a balance between the shadow value of the additional revenue generated by a tax increase and the shadow value of its adverse impact on private income. If the capital account is balanced $s_i n_i = K_i$, we can show that the adverse impact of the tax increase on income is simply proportional to the tax base,[9] and we can rewrite the

[9]Differentiation of the capital demand equation $F_{iK} = \iota + \tau_{iK}$ yields

$$\frac{dK_i}{d\tau_{iK}} = \frac{1}{F_{iKK}} \left(1 + \frac{d\iota}{d\tau_{iK}} \right).$$

Since $n_i F_{in} = F_i(K_i, n_i) - K_i F_{iK}$ we know that $n_i F_{inK} = -K_i F_{iKK}$ and, thus,

$$n_i F_{inK} \frac{dK_i}{d\tau_{iK}} = -K_i \left(1 + \frac{d\iota}{d\tau_{iK}} \right).$$

Inserting this expression into the FOC, taking account of $s_i n_i = K_i$, and rearranging yields Equation (2).

marginal cost of public funds as

$$\frac{\lambda_i}{\mu_i} = \frac{K_i}{K_i + \tau_{iK} \frac{dK_i}{d\tau_{iK}}}. \tag{2}$$

While the numerator states the loss in private consumption resulting from a tax increase due to the incidence of the capital tax, the denominator depicts the additional public funds associated with a tax increase. Accordingly, the larger the adverse effect of a tax increase on the local tax base the smaller is the denominator and the larger is the marginal cost of public funds.

As has been noted by Wildasin (1989), under conditions of interjurisdictional capital mobility the marginal cost of public funds faced by the individual jurisdictions is larger than in a cooperative setting since at least a part of the adverse tax-base effect reflects an increase in the tax base of other jurisdictions. Hence, Equation (2) may be referred to as the *perceived* marginal cost of public funds in the non-cooperative case. Consider the optimal policy in a fully cooperative situation by invoking a federal planner who determines the tax policy in one jurisdiction under the condition that all jurisdictions obtain the same level of utility. This federal planner's decision problem is given by[10]

$$\begin{aligned} \mathcal{L}^{fed} = u(x_1, z_1) &+ \sum_{j=2}^{M} \nu_j [u(x_j, z_j) - u(x_1, z_1)] \\ &+ \lambda \left[\sum_{i=1} \tau_{iK} K_i - \sum_{i=1} C(n_i, z_i) \right] \\ + \sum_{i=1}^{M} \mu_i [n_i F_{in} + \iota s_i n_i &- n_i x_i - h(n_i) n_i] \\ &+ \varphi \left[N - \sum_{i=1}^{M} n_i \right]. \end{aligned}$$

[10]While we assume that the federal planner is able to redistribute public funds across jurisdictions we follow Bucovetsky and Smart (2006) and assume that the federal planner cannot redistribute private funds. In this regard the federal planner differs from the central planner that was used in the previous section. However, this difference reflects our current focus on local tax policy.

As is shown in Appendix 5.4 the corresponding *social* marginal cost of public funds (Wildasin, 1989) is

$$\frac{\lambda}{\mu_i} = \frac{K_i}{K_i + \tau_{iK}\frac{dK_i}{d\tau_{iK}} + \sum_{j\neq i}\tau_{jK}\frac{dK_j}{d\tau_{iK}}}. \tag{3}$$

In comparison with expression (2), the marginal cost is lower as the denominator now includes the positive fiscal externality of a tax increase.

3.2 Efficient Equalization

As Bucovetsky and Smart (2006) as well as Koethenbuerger (2002) suggest, an efficient equalization scheme would eliminate the gap between the perceived cost of funds in the non-cooperative case (2) and the social cost of funds (3). In our case, what is needed is simply a redistributive scheme of grants such that

$$G_i = Z_i - \vartheta_i K_i,$$

where G_i denotes grants allotted to jurisdiction i. Two components can be distinguished: Z_i is a lump-sum component representing the amount of *virtual grants* received by the jurisdiction if its tax base were actually zero. $\vartheta_i K_i$ is the fiscal capacity-dependent component. The *marginal contribution rate* ϑ_i defines the extent to which an increase in the tax base results in lower grants. Expressed relative to the tax rate we obtain the *rate of equalization*

$$req_i \equiv \frac{\vartheta_i}{\tau_{iK}},$$

i.e. the fraction of own tax revenues implicitly taken away by the equalization system.

With this fiscal equalization scheme, the optimal policy of a local government would aim to maximize

$$\mathcal{L}_i^{equal} = u(x_i, z_i) + \lambda_i [(\tau_{iK} - \vartheta_i) K_i + Z_i - C(n_i, z_i)]$$
$$+\mu_i [n_i F_{in} + \iota s_i n_i \quad - n_i x_i - n_i h(n_i)] .$$

The FOC with respect to the tax rate in this case is given by

$$\frac{\partial \mathcal{L}_i^{equal}}{\partial \tau_{iK}} = \lambda_i [K_i + (\tau_{iK} - \vartheta_i) \frac{dK_i}{d\tau_{iK}}] + \mu_i [n_i F_{inK} \frac{dK_i}{d\tau_{iK}} + s_i n_i \frac{d\iota}{d\tau_{iK}}] = 0.$$

As above, we make use of $n_i F_{inK} = -K_i F_{iKK}$ and derive the marginal cost of public funds perceived by jurisdiction i for the case where $s_i n_i = K_i$ and obtain

$$\frac{\lambda_i}{\mu_i} = \frac{K_i}{K_i + (\tau_{iK} - \vartheta_i) \frac{dK_i}{d\tau_{iK}}}. \tag{4}$$

Following Bucovetsky and Smart (2006) the efficient equalization scheme consists of an appropriate choice of $\vartheta_1, \vartheta_2, ... \vartheta_i, ... \vartheta_M$ and $Z_1, Z_2, ... Z_i, ... Z_M$ such that the perceived cost of public funds is equal to the social cost of public funds and the utility level in each jurisdiction is the same. Thus, the efficient choice of ϑ_i ensures that marginal cost of raising public funds as defined by Equations (3) and (4) coincide. Rearranging terms, we find that the efficient choice of the marginal contribution rate corresponds with the additional tax revenue that an increase in τ_{iK} induces in all other jurisdictions relative to the effect on the own tax base, *i.e.*

$$\vartheta_i^{\star} = -\frac{\sum_{j \neq i} \tau_{jK} \frac{dK_j}{d\tau_{iK}}}{\frac{dK_i}{d\tau_{iK}}}. \tag{5}$$

The numerator captures the fiscal externality, the denominator captures the direct impact on the own budget.

Consider the case where the overall capital supply is increasing in the net-rate of return ι

with elasticity η. As is shown in the Appendix 5.5, if the elasticity of capital demand is equal across jurisdictions $\epsilon_i, \epsilon_j = \epsilon$ and if tax rates are identical $\tau_{iK} = \tau_K$, the condition for the optimal contribution rate can be simplified. Expressed relative to the local tax rate we get the following expression for the rate of equalization

$$req_i^\star = \frac{\vartheta_i^\star}{\tau_K} = \frac{\epsilon}{\epsilon + \eta \frac{\rho_i}{\iota} \frac{K}{K-K_i}}. \tag{6}$$

At first sight the simplifying assumptions might seem rather restrictive. However, note that there are no differences in preferences and that the central planner ensures that size differences do not affect the marginal cost of public funds across jurisdictions. Thus, identical tax rates are a natural outcome of this model. Moreover, a constant elasticity of capital demand is obtained for instance with a simple Cobb-Douglas production function, and, hence, does not seem overly restrictive.

As Bucovetsky and Smart (2006) note in a slightly different setting, the optimal rate of equalization declines with the elasticity of capital supply η. However, Equation (6) has another interesting implication regarding the optimal rate of equalization under conditions of size differences of the jurisdictions:

Proposition 4 (Efficient Redistribution and Size Differences)
With local taxation of mobile capital and a positive elasticity of the total capital supply, and if the elasticity of capital demand is similar across jurisdictions, an efficient fiscal equalization scheme displays a lower rate of equalization for large jurisdictions and a higher rate for small jurisdictions.

To see this, consider the denominator in (6). If jurisdiction i is small, $\frac{K}{K-K_i}$ which is the inverse of the capital share of other jurisdictions, is close to unity. But, if jurisdiction i is large this term increases as the capital share of other jurisdictions declines. As a consequence, the denominator increases and the rate of equalization $req_i^\star$ declines.

The intuition for this result is simply that the effect of capital taxation on the tax base of a jurisdiction that employs a larger share of total capital is to a larger extent determined by the aggregate capital supply elasticity and to a lesser extent related to interjurisdictional mobility. Thus, there is less need to provide an incentive to raise tax effort in larger jurisdictions. This result is related to the theory of asymmetric tax competition (Bucovetsky, 1991, and Wilson, 1991), where it is shown that smaller jurisdictions will act more competitively and set lower tax rates.

4 Conclusions

This paper has addressed the question of how a system of fiscal equalization should deal with size differences between jurisdictions from an efficiency perspective. While this issue has not received much attention in the previous literature, existing equalization systems in several countries feature special provisions that favor cities. This is most strikingly illustrated by the practice of municipal fiscal equalization in Austria, Germany, and Spain where funds are distributed based on population numbers that are inflated for larger municipalities and cities. Using the example of the largest German state we illustrate that the preferential treatment has important consequences: despite a substantial degree of redistribution, cities enjoy much larger budgets than small municipalities in per-capita terms.

The contribution of this paper is to show that a preferential treatment of cities in systems of fiscal equalization might be justified by efficiency considerations. For this purpose we set up a model where mobile residents consume a private good, and housing, as well as public goods or services, and where jurisdictions differ in productivity. These productivity differences give rise to size differences in terms of population which in turn result in a cost advantage in public service provision for larger jurisdictions if there is some degree of non-rivalry in the consumption of public services. This implies that an efficient distribution of funds would allow cities to expand public relative to private consumption. If the demand for public services is elastic or if public services can be substituted completely by the private good, the resulting budget would be higher in larger jurisdictions even in per-capita terms. This supports the practice of local fiscal equalization in several countries where cities are assumed to have a larger fiscal need per-capita than small towns.

In a setting with inefficient tax instruments, we show that additional considerations justify a different treatment of cities in fiscal equalization also with regard to the degree of fiscal redistribution. Following Bucovetsky and Smart (2006) we assume that local governments use a capital tax and equalization grants in order to finance the provision of local public services. The capital tax is assumed to be distortive even if revenue-sharing induces a tax policy that is consistent with a fully co-operative solution. In this setting, we show that an efficient fiscal equalization system would tend to treat jurisdictions differently also with regard to the rate of equalization: grants would be less responsive to the taxing capacity in jurisdictions that are hosting a relatively large share of the total tax base.

Our analysis opens up a new perspective on the special treatment of cities in systems of local fiscal equalization. While there is a general presumption that the favorable treatment of cities entails a potentially inefficient subsidy, our results suggest that an assessment of the special treatment of cities might come to a different conclusion if specific supply conditions for public services and inefficiencies from tax competition are taken into account. Thus, while cities have a cost advantage in the provision of public services and are facing lower cost of raising own funds, an efficient equalization system might actually enable cities to run larger budgets in per-capita terms and to retain a larger share of own funds than small towns.

5 Appendix

5.1 Proof of Proposition 1

Consider two jurisdictions i and j which differ in population size such that $n_i > n_j$ but which are offering the same amount of public and private goods ($z_i = z_j$ and $x_i = x_j$). With some degree of non-rivalry in public consumption

$$\frac{C_{iz}}{n_i} < \frac{C_{jz}}{n_j}.$$

As a consequence, we know from the Samuelson condition that

$$MRS_i < MRS_j,$$

where

$$MRS_i \equiv \frac{u_{iz}}{u_{ix}}$$

Now, holding constant the level of utility, MRS_i is decreasing in z_i since

$$\frac{dMRS_i}{dz_i} = \frac{1}{u_{ix}^3}\left[u_{ix}^2 u_{izz} - 2u_{ix}u_{iz}u_{ixz} + u_{iz}^2 u_{ixx}\right] < 0$$

where the term in brackets is the determinant of the Hessian bordered with the first order partial derivatives which is negative for a strictly quasi-concave utility function. Hence, in a setting with different population size it is not efficient to provide the same amount of public and private goods. Instead, the change in MRS_i implies that $z_i > z_j$ and, at the given level of utility, $x_i < x_j$. ■

5.2 Proof of Proposition 2

Let $p_i \equiv \frac{C_{iz}}{n_i}$ denote the per-capita marginal cost of public goods or services z_i. Then $z_i^\star = z^H(p_i, \overline{u})$ is the Hicksian demand for public services as a function of the marginal cost p_i and the utility level in the economy. To prove Proposition 2 we need to show that, depending on the elasticity of demand, the per-capita cost of providing public services at a level consistent with the given level of utility may be increasing in the population size. Hence, we need to show that

$$\frac{dC(n_i, z_i^\star)}{dn_i} > \frac{C(n_i, z_i^\star)}{n_i}.$$

Differentiation of the cost function yields

$$C_{iz}\frac{\partial z^H}{\partial p_i}p_{in} + C_{in} > \frac{C_i}{n_i},$$

where p_{in} gives the partial effect of the population size on the marginal per-capita cost of public good provision. If z_i is not completely rival in consumption, p_{in} is negative. Making use of $n_i p_i = C_{iz}$ we have

$$z_i n_i \underbrace{\left(-\frac{\partial z^H}{\partial p_i}\frac{p_i}{z_i}\right)}_{\zeta}(-p_{in}) > \frac{C_i}{n_i} - C_{in},$$

where ζ is the Hicksian elasticity of demand. Now let $\gamma \equiv C_{in}\frac{n_i}{C_i}$ be the elasticity of the cost of public service provision with respect to the population size – sometimes referred to as the crowding elasticity of the cost of public service provision. Hence, we obtain

$$z_i p_i \zeta \left(-p_{in}\frac{n_i}{p_i}\right) > \frac{C_i}{n_i}(1-\gamma),$$

where $-p_{in}\frac{n_i}{p_i}$ is the elasticity of the per-capita marginal cost of public good provision with regard to population size. Obviously, the condition is fulfilled for higher levels of ζ as stated in the above proposition.

If C_{iz} is constant in z_i but increasing in n_i, $p_{in}\frac{n_i}{p_i}$ is equal to $\gamma - 1$ and we can simplify this expression to obtain

$$\zeta > \frac{C_i}{z_i C_{iz}},$$

where the right hand-side is simply the ratio of total over variable cost. Thus, if, for example, the provision of public services does not involve any fixed cost, with $\zeta > 1$ the budget in per-capita terms should increase with the population size. ■

5.3 Proof of Proposition 3

Suppose the utility function allows for complete substitution between public and private consumption. Then, we can determine a lower threshold of population size such that larger jurisdictions would consume positive amounts of both the private good and the public goods whereas smaller jurisdictions would only consume the private good. To determine this threshold level, we note that there is one level of private consumption $\overline{x}_i$ that is consistent with the common level of utility and zero consumption of public goods

$$\overline{x}_i : u\left(\overline{x}_i, z_i = 0\right) = \overline{u}.$$

Now we can specify the marginal rate of substitution that is in accordance with the common level of utility and zero consumption of public goods

$$\overline{\sigma} \equiv \frac{u_z\left(\overline{x}_i, z_i = 0\right)}{u_x\left(\overline{x}_i, z_i = 0\right)}.$$

If the location-specific productivity effect γ_i declines, the population size of the jurisdiction becomes smaller and eventually goes to zero. At the same time, the marginal cost of providing the public goods in per-capita terms goes to infinity. For small jurisdictions, therefore, full specialization occurs. The threshold level of population size where full specialization occurs is obtained by setting $\overline{\sigma}$ equal to the marginal cost of providing the public goods at $z_i = 0$:

$$\overline{n} : \overline{\sigma} = \frac{C_z\left(\overline{n}, z_i = 0\right)}{\overline{n}}.$$

In the presence of indivisibilities, the threshold level of population size is higher, since with the non-convex budget set due to the fixed cost of public good provision a positive amount of consumption is characterized by two conditions. The first is the above Samuelson condition. The second requirement is that a specialization on private consumption is not preferred even if this would imply cost savings due to the fixed cost of public good provision. Consider the budget constraint for a cost function with indivisibilities

$$x_i = F_{in} + \iota s_i - h\left(n_i\right) - \frac{c_0}{n_i^{1-\gamma}} - z_i\left(\frac{c_1}{n_i^{1-\gamma}}\right).$$

The last term in brackets on the right-hand side captures the per-capita marginal cost of public good provision $\frac{c_1}{n_i^{1-\gamma}}$ that is declining in population size as discussed above. The fourth term captures possible savings from shutting down public good provision $\frac{c_0}{n_i^{1-\gamma}}$. Due to this term, the income available for private consumption at zero provision of the public goods exceeds the limit obtained by letting public good provision approach zero

$$\overline{x} > \lim_{z_i \to 0}\left[F_{in} + \iota s_i - h\left(n_i\right) - \frac{c_0}{n_i^{1-\gamma}} - z_i\frac{c_1}{n_i^{1-\gamma}}\right].$$

Therefore, if the population size is approaching $\overline{n}$ from above, where $\overline{n}$ is implied by $\overline{\sigma} = \frac{C_z(\overline{n}, z_i = 0)}{\overline{n}}$, no interior solution is obtained: fully shutting down public good provision would allow the jurisdiction to enjoy more private consumption and, thus, yield a higher level of utility. Of course, this would conflict with the equal utility constraint. At lower levels of private consumption, however, locational efficiency would be disturbed such that the central planner would reallocate population to jurisdiction i. Hence, the population size, where specialization occurs, will have to be higher than in the absence of indivisibilities. ■

5.4 Derivation of the *Social* Marginal Cost of Public Funds

The federal planner's choice maximizes the Lagrangian

$$\begin{aligned}\mathcal{L}^{fed} &= u(x_1, z_1)\\ &+\lambda\left[\sum_{i=1}\tau_{iK}K_i - \sum_{i=1}C\left(n_i, z_i\right)\right]\\ &+\sum_{i=1}^{M}\mu_i\left[n_iF_{in} + \iota s_i n_i - x_i n_i - h\left(n_i\right)n_i\right]\\ &+\sum_{j=2}^{M}\nu_j[u(x_j, z_j) - u(x_1, z_1)]\\ &+\varphi\left[N - \sum_{j=1}^{M}n_i\right].\end{aligned}$$

The FOCs with regard to the choice of public and private consumption are

$$\begin{aligned}\frac{\partial\mathcal{L}^{fed}}{\partial z_1} &= \left(1 - \sum_{j=2}^{M}\nu_j\right)u_{1z} - \lambda C_{1z} = 0\\ \frac{\partial\mathcal{L}^{fed}}{\partial z_i} &= \nu_i u_{iz} - \lambda C_{iz} = 0 \quad i = 2, ...M\\ \frac{\partial\mathcal{L}^{fed}}{\partial x_1} &= \left(1 - \sum_{j=2}\nu_j\right)u_{1x} - \mu_1 n_1 = 0\\ \frac{\partial\mathcal{L}^{fed}}{\partial x_i} &= \nu_i u_{ix} - \mu_i n_i = 0 \quad i = 2, ...M.\end{aligned}$$

The FOC with respect to the tax rate is

$$\begin{aligned}\frac{\partial\mathcal{L}^{fed}}{\partial\tau_{iK}} &= \lambda\left[K_i + \tau_{iK}\frac{dK_i}{d\tau_{iK}}\right] + \mu_i\left[n_iF_{inK}\frac{dK_i}{d\tau_{iK}} + n_is_i\frac{d\iota}{d\tau_{iK}}\right]\\ &+ \sum_{j\neq i}\left[\lambda\tau_{jK}\frac{dK_j}{d\tau_{iK}} + \mu_j\left[n_jF_{jnK}\frac{dK_j}{d\tau_{iK}} + n_js_j\frac{d\iota}{d\tau_{iK}}\right]\right] = 0.\end{aligned}$$

Since $n_i F_{in} = F_i(n_i, K_i) - K_i F_{iK}$ we know that $n_i F_{inK} = -K_i F_{iKK}$ and we can rewrite this condition to obtain the social marginal cost of public funds

$$\frac{\lambda}{\mu_i} = \frac{K_i + (K_i - n_i s_i)\frac{d\iota}{d\tau_{iK}} + \sum_{j\neq i}\frac{\mu_j}{\mu_i}(K_j - n_j s_j)\frac{d\iota}{d\tau_{iK}}}{K_i + \tau_{iK}\frac{dK_i}{d\tau_{iK}} + \sum_{j\neq i}\tau_{jK}\frac{dK_j}{d\tau_{iK}}}$$

In order to facilitate the interpretation of this expression we consider the case where all jurisdictions have a balanced capital account, such that $K_j = s_j n_j$. In this case

$$\frac{\lambda}{\mu_i} = \frac{K_i}{K_i + \tau_{iK}\frac{dK_i}{d\tau_{iK}} + \sum_{j\neq i}\tau_{jK}\frac{dK_j}{d\tau_{iK}}}.$$

5.5 Derivation of Equation (6)

Let us rewrite expression (5) in terms of elasticities

$$\vartheta_i = -\frac{\sum_{j\neq i}\tau_{jK}K_j\left(\frac{d\log K_j}{d\log\tau_{iK}}\right)}{K_i\left(\frac{d\log K_i}{d\log\tau_{iK}}\right)}.$$

The elasticities of capital demand with regard to the tax rate are

$$\left(\frac{d\log K_i}{d\log\tau_{iK}}\right) = -\frac{\tau_{iK}\epsilon_i}{\rho_i}\left(1 + \frac{d\iota}{d\tau_{iK}}\right)$$

$$\left(\frac{d\log K_j}{d\log\tau_{iK}}\right) = -\frac{\tau_{iK}\epsilon_j}{\rho_j}\left(\frac{d\iota}{d\tau_{iK}}\right),$$

where ϵ_i is the elasticity of capital demand with regard to the user cost of capital ρ_i. This allows us to describe the efficient choice of ϑ_i as

$$\vartheta_i^\star = -\left[\frac{\frac{d\iota}{d\tau_{iK}}}{1 + \frac{d\iota}{d\tau_{iK}}}\right]\left[\sum_{j\neq i}\tau_{jK}\left(\frac{K_j}{K_i}\right)\left(\frac{\rho_i\epsilon_j}{\rho_j\epsilon_i}\right)\right], \quad (7)$$

where ϵ_i, ϵ_j denote the elasticity of capital demand to the user cost of capital ρ_i, ρ_j. The first term in squared brackets captures the strength of the impact on other jurisdictions' cost of capital relative to the impact on the own cost of capital. The second term in squared brackets captures the consequence of a cost of capital increase on other jurisdictions' budgets relative to the effect on the own tax base.

To simplify the effects on the cost of capital we need to consider the capital market. The equilibrium condition can be written as

$$\sum_{j=1} K_j = K.$$

Taking account of the capital demand equation (1) total differentiation yields

$$\sum_j \frac{\partial K_j}{\partial \rho_j} d\rho_j = \frac{\partial K}{\partial \iota} d\iota.$$

Noting that in our case $d\rho_j = d\iota$ for all $j \neq i$ and $d\rho_i = d\iota + d\tau_{iK}$ we obtain

$$-\sum_j \epsilon_j \frac{K_j}{\rho_j} d\iota - \epsilon_i \frac{K_i}{\rho_i} d\tau_{iK} = \eta \frac{K}{\iota} d\iota,$$

where ϵ_i is the elasticity of capital demand and η is the elasticity of the overall capital supply. In a case where the elasticity of capital demand is equal across jurisdictions $\epsilon_i, \epsilon_j = \epsilon$ and where tax rates are identical $\tau_{iK} = \tau_K$, we can simplify this equation to

$$-\epsilon \frac{K}{\rho_i} d\iota - \epsilon \frac{K_i}{\rho_i} d\tau_{iK} = \eta \frac{K}{\iota} d\iota$$

and obtain

$$\frac{d\iota}{d\tau_{iK}} = \frac{-\epsilon K_i}{\epsilon K + \eta \frac{\rho_i}{\iota} K}.$$

The relative strength of the capital cost effects becomes

$$\left[\frac{\frac{d\iota}{d\tau_{iK}}}{1 + \frac{d\iota}{d\tau_{iK}}} \right] = \frac{-\epsilon K_i}{\epsilon \left(K - K_i \right) + \eta \frac{\rho_i}{\iota} K}.$$

Inserting in Equation (7) and noting that, under the above simplifying assumptions

$$\sum_{j \neq i} \tau_K \left(\frac{K_j}{K_i}\right)\left(\frac{\rho_i \epsilon_j}{\rho_j \epsilon_i}\right) = \tau_K \left(\frac{K - K_i}{K_i}\right),$$

we obtain a simple expression for the efficient contribution rate

$$\vartheta_i^* = \tau_K \frac{\epsilon K_i}{\epsilon \left(K - K_i\right) + \eta \frac{\rho_i}{\iota} K},$$

and, consequently, the efficient rate of equalization amounts to

$$req_i^* = \frac{\epsilon K_i}{\epsilon \left(K - K_i\right) + \eta \frac{\rho_i}{\iota} K}.$$

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