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## On the decentralized provision of public goods with spillovers in the presence of household mobility

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**Wirtschaftswissenschaftliche Fakultät  
der Eberhard-Karls-Universität Tübingen**

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public goods with spillovers  
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## Abstract

When households are immobile among regions, the decentralized provision of public goods that generate interregional benefit spillovers is inefficiently low. A model of interregional migration is used to study the provision of such services in the presence of free mobility of households.

Within this model we find a surprising result: the Nash-equilibrium of competing regional governments is socially efficient. Though only maximizing the utility of their own residents, regional governments perfectly internalize the externalities associated with their provision of public goods. There is no role for a higher-level government to encourage the supply of public goods by a Pigovian subsidy.

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# On the decentralized provision of public goods with spillovers in the presence of interregional migration\*

## 1 Introduction

Traditionally, economists argue that the regional provision of a public good generating spillovers into surrounding regions should either be stimulated by a Pigovian subsidy made available by a higher-level government, or that the central government itself should provide this service. Under the latter proposal, it is suggested that the beneficiaries and the taxpayers must be located in the same jurisdiction to reach the fiscal equivalence of the public good [see, e.g., Oates (1972) and Boadway and Wildasin (1984)]. Typically, previous models on this subject ignore any mobility of households across regions.<sup>1</sup> Another approach in the literature analyzes the supply of regional (or local) public goods without spillovers in the presence of highly mobile households [see, e.g., Hartwick (1980), Boadway (1982), Boadway and Flatters (1982), Wildasin (1980) and (1986), and Myers (1990)]. Recently, Myers (1990) has demonstrated that in a Nash-equilibrium of competing regional governments not only is an optimal supply of regional public goods (without spillovers) achieved, but also an optimal distribution of mobile households across regions. Missing is an integration of the two approaches in the literature, though both phenomena often occur simultaneously.

Typical federal economies like the USA, Canada, or Germany exhibit a high degree of household mobility across states, provinces, or "Bundesländer". Revealing preferences by voting with one's feet presumably characterizes these countries. There are also many examples of public services provided by lower-level governments in the above countries that generate spillovers across jurisdictions. A few prominent cases worth mentioning are sewage treatment by an upstream city thereby reducing the need for purification by downstream cities, benefits from education provided by one jurisdiction being enjoyed by non-citizens when the latter are also granted free access to these education services, and income maintenance in one city helping eradicate poverty and so benefiting households in other places.

These phenomena also occur within the EC. On the one hand are spillovers of public goods provided by one country, and on the other, an increasing degree of labor mobility, i.e., mobility of households across member states of the EC. One important example of a public good that generates spillovers into surrounding member states is environmental quality. For instance, if France establishes higher security standards on its nuclear reactors along its common border with Germany, not only are French citizens beneficiaries of this measure, but also German residents living near the border. Germany's effort in recent years to clean the water of the Rhine provides another example. The inhabitants of the downstream country, The Netherlands,

also benefit from this effort. The increasing degree of household mobility within the EC is made possible by the fact that the EC countries are legally committed to a common labor market. According to the Treaty of Rome (Articles 48 and 51), EC member states may not exclude citizens of other member states from employment and social rights and other benefits available to their own citizens. Citizens of any EC country are legally entitled to work in any other member state and must be treated identically to native citizens with respect to taxation, transfers, access to education, and all other social benefits. While this is a rather *de jure* description of actual circumstances, it is nonetheless true that the EC member states are drawing closer to a common labor market, and that this trend continues in the future.

Hence, there are practical reasons to integrate the two approaches, i.e., to assume that there are spillovers in the provision of public services and that there is a high degree of household mobility across regions. In pursuing this idea, we will find a somewhat surprising result: in a decentralized Nash-equilibrium between regions, regional governments completely internalize external effects associated with their supply of public goods, despite the fact that they only maximize the welfare of the residents in their own jurisdiction. Given the presence of mobile households, regional authorities are concerned with the utility of non-residents indirectly via their migration responses. If they choose their policy actions non-myopically, they have to take these migration responses into consideration. This works as well as a direct concern for the utility of non-residents. If regional governments in addition have an instrument for making interregional transfers, they will provide, in their own self-interest, the socially optimal level of public goods generating spillovers. There is no need for a corrective subsidy by a central government nor for the provision of these services on a higher governmental level.

To show this, the paper is organized as follows. Section 2 presents the basic model and derives the socially efficient allocation. Section 3 analyzes the decentralized provision of regional public goods generating spillovers across regions within a Nash-equilibrium of competing regional governments. It is demonstrated that this Nash-equilibrium is socially efficient. Section 4 compares our findings with previous results and highlights possible applications to other problems. Finally, section 5 provides a summary and draws some conclusions.

## 2 Social optimum

The federal economy consists of two regions, in each of which one group of mobile households resides.<sup>2</sup> Households in the federal economy are alike, independent of their location. The total number of households is equal to  $\bar{n}$  and is allocated across both regions,  $\bar{n} = n_1 + n_2$ , where  $n_i$  ( $i = 1, 2$ ) indicates the number of households residing in region  $i$ . Household preferences are defined by a strictly quasi-concave utility function,  $u^i(x_i, G_i, G_j)$ , where  $x_i$  is the consumption of the private good,  $G_i$  denotes the consumption of the public good provided in region  $i$ , and  $G_j$  the consumption of the public good provided in region  $j$  by a household residing in  $i$ . Hence, the public good generates positive spillovers into the neighboring region. Each household inelastically supplies one unit of labor in the region of residence. We further assume a concave production function for the private good in region  $i$ ,  $f^i(n_i, T_i)$ , where  $T_i$  is the quantity of the immobile production factor in region  $i$  (e.g. land or natural resources). The private good in  $i$  can alternatively be used as a public good,  $G_i$ .<sup>3</sup> Hence,  $MRT = 1$ ; thus  $G_i$  denotes the costs of providing  $G_i$  units of the public good in region  $i$ .

The problem of a social planner is to

$$\begin{array}{ll} \text{maximize} & u^1(x_1, G_1, G_2) \\ (x_1, x_2, G_1, G_2, n_1, n_2) & \end{array} \quad (1)$$

subject to

$$u^1(x_1, G_1, G_2) = u^2(x_2, G_2, G_1), \quad (2a)$$

$$f^1(n_1, T_1) + f^2(n_2, T_2) - n_1 x_1 - n_2 x_2 - G_1 - G_2 = 0, \quad (2b)$$

$$\bar{n} - n_1 - n_2 = 0. \quad (2c)$$

To obtain the optimal allocation, the social planner has to maximize the utility of a representative household living in region 1 (1), subject to the constraints (2a) – (2c). Restriction (2a) reflects costless mobility of households, by ruling out jurisdictional utility differentials that would be incompatible with free locational choices. Thus, we are only interested in the optimal allocation that is compatible with free mobility of households.<sup>4</sup> Constraint (2b) is the feasibility constraint for the federal economy as a whole. For example, entire production in the EC must cover the consumption of private and public goods by all households. Finally, by (2c), all households must reside at some location. From the problem's first order conditions, we obtain the following conditions for an optimal provision of public goods and a socially efficient distribution of mobile households across regions:

$$n_i \frac{u_{G_i}^i}{u_x^i} + n_j \frac{u_{G_i}^j}{u_x^j} = 1 \quad \text{for } i, j = 1, 2, i \neq j, \quad (3a)$$

$$f_n^1 - x_1 = f_n^2 - x_2, \quad (3b)$$

where the subscripts indicate partial derivatives. For example,  $u_{G_i}^i = \frac{\partial u^i}{\partial G_i}$  denotes the marginal utility of  $G_i$ . The conditions set out in (3a) characterize the socially optimal supply of public goods in both regions. The sum of the *MRS* of all households in the federation between the consumption of the private good and the public good must be equal to the marginal costs (the *MRT*) of providing the public good (here unity). This is a familiar result in the theory of fiscal federalism [see, e.g., Oates (1972) and Boadway and Wildasin (1984)]. Condition (3b) describes the optimal locational pattern for mobile households. The marginal net benefits of households to regions must be equalized across regions. The marginal net benefit of a household to a region corresponds to its marginal productivity minus its consumption in that region.

### 3 Decentralized decision making by regional governments

In our decentralized setting, we assume competitive conditions for both regions. Firms in region  $i$ , producing the private good (which can also be used as a public good on a one-to-one basis), pay labor a wage,  $w_i$ , equal to its marginal product,  $f_n^i$ . Firms are assumed to earn no profits. Hence, the total income of the immobile factor corresponds to  $R_i = f^i(n_i, T_i) - n_i f_n^i$ . Homogeneity of households within the federal economy is reflected not only in identical preferences but also in identical endowments with the economy's immobile resources,  $\frac{T_1}{\bar{n}}, \frac{T_2}{\bar{n}}$  (henceforth referred to as the "equal endowment assumption").<sup>5</sup> Therefore, each household earns the same fraction of the entire rent income,  $\frac{R_1 + R_2}{\bar{n}}$ . Regional governments are assumed to provide a public good generating spillovers, to levy a head tax,  $t_i$ , on residents, and to perform direct interregional transfers,  $Z_{ij}$ . Inserting the budget restriction of the regional government into the private household restriction, the regional feasibility constraint becomes

$$x_i = \frac{f^i(n_i, T_i) + \frac{n_i R_j}{\bar{n}} - \frac{n_j R_i}{\bar{n}} - G_i - Z_{ij} + Z_{ji}}{n_i} \quad \text{for } i, j = 1, 2, i \neq j. \quad (4)$$

We should mention that it is not necessary for our results to assume that regional governments perform direct interregional transfers. If each region were able to tax land rents, then manipulation of its tax rate on these rents would enable it to increase or decrease the effective cost shares that are borne by non-residents since all households have equal ownership shares in the land rents in both regions. This tax

then serves as an indirect interregional transfer instrument. Our basic conclusions do not change using this assumption.<sup>6</sup> Most important is that regional governments have some instrument allowing them to influence the resources of the other region.

Regional governments will be assumed to maximize the welfare of their own residents in assessing policy changes. We assume a decentralized equilibrium of the Nash-Cournot type. Each regional government takes as given the policy actions of the other regional authority. Will regional governments still provide an optimal supply of public goods generating benefit spillovers to non-residents?

Rational regional governments explicitly have to take migration responses into account in choosing their preferred policy actions. This means that the migration equilibrium,  $u^1(\cdot) = u^2(\cdot)$ , is an important constraint of their maximization problem. Hence, they are concerned with non-residents to the extent that their migration responses affect the utility of residents in their own region. In choosing  $G_i$  and  $Z_{ij}$ , the problem of the regional government in  $i$  is to

$$\underset{(G_i, Z_{ij})}{\text{maximize}} \quad u^i \left[ \frac{f^i(n_i, T_i) + \frac{n_i R_j}{\bar{n}} - \frac{n_j R_i}{\bar{n}} - G_i - Z_{ij} + Z_{ji}}{n_i}, G_i, G_j \right] \quad (5)$$

subject to

$$u^1(\cdot) = u^2(\cdot), \quad G_i \text{ and } Z_{ij} \geq 0 \quad \text{for } i, j = 1, 2, i \neq j. \quad (6)$$

In assessing its policy effects, the regional government has to pay attention to migratory flows. These perceived migration responses can readily be obtained from the migration equilibrium condition set out in (6).<sup>7</sup> With respect to  $G_i$  and  $Z_{ij}$ , it follows:

$$\frac{\partial n_i}{\partial G_i} = \frac{\frac{u_x^i}{n_i} + u_{G_i}^j - u_{G_i}^i}{N} \quad \text{for } i, j = 1, 2, i \neq j, \quad (7a)$$

$$\frac{\partial n_i}{\partial Z_{ij}} = \frac{\frac{u_x^i}{n_i} + \frac{u_x^j}{n_j}}{N} \quad \text{for } i, j = 1, 2, i \neq j. \quad (7b)$$

The denominator  $N$  of these expressions is equal to  $N = u_{x_n}^1 + u_{x_n}^2$ , with  $u_{x_n}^i$  describing the change in utility resulting when the private consumption of a household in  $i$  varies as a consequence of a changed number of mobile households residing in  $i$ . The detailed expression is

$$u_{x_n}^i = \frac{u_x^i}{n_i} \left( f_n^i - x_i + \frac{R_i}{\bar{n}} + \frac{n_j n_i f_{nn}^i}{\bar{n}} + \frac{R_j}{\bar{n}} + \frac{n_i n_j f_{nn}^j}{\bar{n}} \right) \quad \text{for } i, j = 1, 2, i \neq j. \quad (8)$$

The signs of the reaction functions set out in (7) are fairly unimportant for the following results. However, we should mention that stability of the migration equilibrium



requires the denominator  $N$  to be negative,  $\frac{d(u^1 - u^2)}{dn_1} = N < 0$ . Instability arises in the case of an underpopulated federal economy [see Stiglitz (1977) and Boadway and Flatters (1982)]. If a socially efficient population distribution is achieved, stability requires that the equalized marginal net benefit of mobile households to both regions (from the viewpoint of the single region),  $f_n^i - x_i + \frac{R_i}{\bar{n}} + \frac{n_j n_i f_{nn}^i}{\bar{n}} + \frac{R_j}{\bar{n}} + \frac{n_i n_j f_{nn}^j}{\bar{n}}$ , must be negative. This means that a region must be overpopulated. Hence, if the population of a federation is too small, stability of an equilibrium is a real problem. However, we restrict our attention to the stable case, in which the migration response,  $\frac{\partial n_i}{\partial Z_{ij}}$ , is clearly negative, meaning that the population in region  $i$  decreases with increased interregional transfers from  $i$  to  $j$ . On the other hand,  $\frac{\partial n_i}{\partial G_i} > 0$  only if the regional government underspends relative to a myopic (with respect to migration responses) equilibrium,  $\frac{u_x^i}{n_i} - u_{G_i}^i < -u_{G_i}^j < 0$ .

We next turn to the first order conditions for an optimal regional policy with respect to  $G_i$  and  $Z_{ij}$ . These conditions can be derived from the regional government's maximization problem (5):

$$\frac{\partial u^i}{\partial G_i} = -\frac{u_x^i}{n_i} + u_{xn}^i \frac{\partial n_i}{\partial G_i} + u_{G_i}^i \leq 0, \quad G_i \geq 0 \quad \text{and} \quad G_i \frac{\partial u^i}{\partial G_i} = 0 \quad (9a)$$

$$\text{for } i, j = 1, 2, \quad i \neq j,$$

$$\frac{\partial u^i}{\partial Z_{ij}} = -\frac{u_x^i}{n_i} + u_{xn}^i \frac{\partial n_i}{\partial Z_{ij}} \leq 0, \quad Z_{ij} \geq 0 \quad \text{and} \quad Z_{ij} \frac{\partial u^i}{\partial Z_{ij}} = 0 \quad (9b)$$

$$\text{for } i, j = 1, 2, \quad i \neq j.$$

For example, the government in region  $i$  considers the following effects in assessing an increased supply of the public good,  $G_i$ . First, an increase in the supply by one unit decreases the consumption of the private good for each resident of region  $i$  by  $\frac{1}{n_i}$  while increasing residents' consumption of the public good. Second, this measure creates a migration response which changes residents' wage and rent income. Finally, residents are affected through a change in their tax payments due to a varying number of tax payers in the region. One can interpret the other first order conditions analogously.

Substituting the migration responses set out in (7b) into (9b), we obtain  $\frac{\partial u^i}{\partial Z_{ij}} = -\frac{\partial u^j}{\partial Z_{ji}}$ . Using this result in (9b), we find that a Nash-equilibrium is characterized by  $\frac{\partial u^i}{\partial Z_{ij}} = 0 = \frac{\partial u^j}{\partial Z_{ji}}$ . Furthermore, one region chooses a zero transfer and the other a positive transfer (if the regions are asymmetric). Combining the result that  $\frac{\partial u^i}{\partial Z_{ij}} = -\frac{\partial u^j}{\partial Z_{ji}}$  with (9b) proves this statement. Both regional governments face the equal utility constraint. Hence, both governments have the same objective (maximizing  $u^1$  in effect means maximizing  $u^2$ ), and they therefore agree upon their desired distribution of resources across regions. Agreeing in the federation's

resource distribution means agreeing in the net interregional transfer that maximizes the common utility level of all households in the federation.

Using the result that the first order condition with respect to  $Z_{ij}$  holds as an equality,  $\frac{\partial u^i}{\partial Z_{ij}} = 0$ , and inserting the migration response  $\frac{\partial n_i}{\partial Z_{ij}}$  yields

$$\frac{\partial u^i}{\partial Z_{ij}} \stackrel{!}{=} 0 = \frac{u_x^i}{n_i} \frac{u_x^j}{n_j} \{(f_n^i - x_i) - (f_n^j - x_j)\} \quad \text{for } i, j = 1, 2, i \neq j. \quad (10)$$

Therefore, the Nash-equilibrium is characterized by an optimal population distribution as a comparison of (10) and (3b) indicates.<sup>8</sup>

*Proposition 1. If regional governments have an instrument for making interregional transfers, then the decentralized Nash-equilibrium is characterized by an optimal population distribution across regions.*

We now turn to the provision of public goods generating spillovers. We will assume an interior solution. Substituting the migration responses set out in (7a) into the first order condition (9a) and rearranging yields

$$n_i \frac{u_{G_i}^i}{u_x^i} + n_j \frac{u_{G_i}^j}{u_x^j} \left( \frac{f_n^i - x_i + \frac{R_i}{\bar{n}} + \frac{n_j n_i f_{nn}^i}{\bar{n}} + \frac{R_j}{\bar{n}} + \frac{n_i n_j f_{nn}^j}{\bar{n}}}{f_n^j - x_j + \frac{R_i}{\bar{n}} + \frac{n_j n_i f_{nn}^i}{\bar{n}} + \frac{R_j}{\bar{n}} + \frac{n_i n_j f_{nn}^j}{\bar{n}}} \right) = 1 \quad (11)$$

$$\text{for } i, j = 1, 2, i \neq j.$$

As regions have an instrument for making interregional transfers, they achieve an optimal population distribution (see (10)). Therefore, the second term on the LHS of (11) reduces to the *MRS* of non-residents for providing an additional unit of the public good. It follows our basic proposition:

*Proposition 2. Suppose regional governments have an instrument for making interregional transfers, i.e., direct interregional transfers or a tax on land rents, and are explicitly concerned with migration responses to their policy actions. Then, the decentralized Nash-equilibrium is characterized by a socially optimal provision of regional public goods generating spillovers.*

Though regional governments are only concerned about the welfare of residents in their own jurisdiction, they perfectly internalize the externalities engendered by their provision of these services. Consequently, there is neither a need for central government intervention nor for the provision of such services on a higher governmental level.

Comparing the problem of the social planner (or a federal government) with the problem of regional governments, a more detailed explanation of Proposition 2 can be provided. A social planner maximizes the utility of a resident in one region and is restricted by free locational choices of households. Regional governments, maximizing the utility of a representative resident, also face the equal utility constraint. Hence, both objectives (equal utility maximizing) are the same. The social planner directly controls the entire resources within the federal economy. Regional authorities perform interregional transfers to alter the resources of the other region, thereby buying their preferred population size. As regional governments agree upon their objectives (equal utility maximizing), both regions agree upon the net interregional transfer. Therefore, regions indirectly control the resources of the federal economy too. Thus, since the objectives as well as the means of the social planner and regional governments are identical, the allocations also have to coincide.

If there are constant migration costs, our results do not alter since both regions face the same objectives up to a constant. However, our conclusions change with variable migration costs. If migration costs depend on the population size of a region [see Boadway and Flatters (1982), Mansoorian and Myers (1991), and Wellisch (1992c)], both regions, facing the migration equilibrium which depends on the population size of regions, disagree over this population size. As the population distribution is influenced by interregional transfers, at least one region would like to make negative interregional transfers. This means that this region does not indirectly control the resources of the federal economy and it therefore does not have the same means as the social planner. Consequently, the externalities of the public good provided by this region are not perfectly internalized [see Wellisch (1992c)].

Returning to perfect household mobility (without migration costs), Wildasin (1986) has provided a similar explanation for the optimal supply of regional public goods without interregional spillovers [see also Krellove (1992) for the implications of the equal utility migration equilibrium for decentralized decision-making]. He argues that due to the equal utility constraint, each jurisdiction would effectively choose policies that maximize the common level of utility throughout the entire economy. However, in previous models analyzing the decentralized provision of public goods without spillovers [see Boadway (1982) and Myers (1990)], the optimal supply can be achieved if regional governments take into account the migration responses to their provision of public goods (or even if they behave myopically), but need not have an instrument for making interregional transfers. In these models, interregional transfers are only needed to achieve an optimal population distribution, while in our model they are necessary to obtain a socially efficient provision of public goods generating spillovers. This provides one rationale for the use of interregional transfers. If some form of interregional transfer is not available on the regional level, then an interregional net transfer from the center would be optimal.

#### 4 Comparison with previous results and possible applications to other problems

As in papers investigating decentralized income redistribution in the presence of mobile households [see Wildasin (1990) and (1991) and Wellisch (1992a)], it can be concluded that mobile households are taxed by the same amount in both regions.<sup>9</sup> To see this, recall that in a decentralized equilibrium the optimal population distribution is achieved,  $f_n^i - x_i = f_n^j - x_j$ . This result, together with the private budget constraint, permits us to derive the statement,  $t_i = t_j$ . Since the incomes of residents in both regions may only differ with respect to wage rates and head taxes, an optimal population distribution is necessarily characterized by equal head taxes. Inserting the regional government constraints into this result, we can derive the optimal interregional net transfer as Myers (1990) did:

$$Z_{ij} - Z_{ji} = \frac{n_i n_j}{\bar{n}} \left( \frac{G_j}{n_j} - \frac{G_i}{n_i} \right). \quad (12)$$

Differing from Myers' analysis, ours does not aggregate a region's entire resource outflow into one interregional transfer instrument; hence, the interregional net transfer only depends on the difference in per capita spending on the public good in both regions. The jurisdiction with the larger per capita spending on the public good obtains an interregional transfer to help finance its expenditures. Therefore, as it was demonstrated in section 3, the region with lower per capita spending on the public good performs the socially optimal transfer while the other region chooses a zero interregional transfer.

It is useful to briefly compare our model with traditional approaches analyzing the provision of regional public goods generating spillovers [see, e.g., Oates (1972) and Boskin (1973)]. These authors proposed using a Pigovian subsidy to internalize the region's public goods externalities. Another approach to reach an efficient outcome is to assign the function of providing such public goods to a higher governmental level. We have argued that these proposals are rather assumptions than necessities in the presence of highly mobile households. In a competitive Nash-equilibrium, rational regional governments choose the socially optimal spending on these public goods in their own self-interest provided they have an instrument for conducting interregional transfers. Regions are concerned with mobile households and thereby take into account the welfare of non-residents. This result also applies to other policy considerations. For instance, one can demonstrate regional environmental policy to be socially efficient even if there exists negative external effects harming neighboring jurisdictions. Regions conducting environmental policy take into account their damages to non-residents due to their migration responses [see Wellisch (1992b)]. Another example is decentralized income redistribution. If mobile households are

altruistic toward immobile households and regional governments maximize the utility of mobile households, it can be demonstrated [see Wellisch (1992a)] that the outcome is socially efficient even if mobile households are altruistic toward immobile citizens of other regions. In the latter case, income redistribution appears as a regional public good [Pauly (1973)] with spillovers.

## 5 Summary and conclusions

Our analysis provides at least two conclusions. The first one, as in previous models, presupposes that the migration equilibrium can be characterized by equal utilities of households across regions [see, e.g., Stiglitz (1977), Boadway (1982), and Myers (1990)]. Then, regional governments internalize in their own self-interest the spillovers associated with their supply of regional public goods provided they have an instrument for making interregional transfers. Neither providing a Pigovian subsidy through a higher governmental level nor assigning the provision of these goods to this higher governmental level itself is necessary. The present approach is important for the broader literature concerning competing regions that generate spillovers into other regions. Given free mobility of households, the negative externalities spilling over into other regions in the case of environmental damages are also perfectly internalized [see Wellisch (1992b)]. If one assumes free mobility of households (without any restrictions) and regional governments to behave rationally with respect to migration responses, then the role for a national government (or more general for any higher-level government) must be defined in a more restricted way.

Second, this paper concludes it to be useful to analyze the implications of such constraints as the migration equilibrium condition more completely than has been done in the literature to date. We mentioned in section 3 that both regions must agree upon the net interregional transfer to achieve the efficient supply of public goods generating spillovers. If the migration equilibrium is characterized by equal utilities, this can be achieved. This also holds if imperfect household mobility can be characterized by constant migration costs. However, if migration costs instead depend on the population size in the regions, both regions disagree over this population size. In this case, at least one region would like to make negative interregional transfers [see Mansoorian and Myers (1991) or Wellisch (1992c)]. As a consequence, this region does not provide the efficient supply of the public good generating spillovers.

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## Footnotes

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- 1 Exceptions are Pauly (1970) and Boskin (1973). However, both authors conclude that regional governments inefficiently provide public goods generating spillovers as they ignore the well-being of non-residents.
  - 2 The model can be extended to include the multi-region case. The results do not alter. This extension is available from the author upon request.
  - 3 Equivalently, we can assume that the same amount of labor and immobile resources is needed to produce one unit of the public good and one unit of the private good.
  - 4 As Flatters, Henderson, and Mieszkowski (1974, p. 103) pointed out, this restriction does not prevent the attainment of a Pareto optimal allocation. However, it simply focuses the analysis on the only one of relevance in the case of free mobility.
  - 5 The equal endowment assumption is not crucial for our analysis. One can alternatively assume [as in Stiglitz (1977) or in Boadway and Flatters (1982)] that mobile households only attain rents in their region of residence due to publicly owned land. The basic conclusions about the provision of regional public goods do not alter using this assumption.
  - 6 A proof of this statement is available from the author upon request.
  - 7 The migration responses are perceived rather than actual to achieve consistency with the regional government's conjecture that the policy actions of the other government are given.
  - 8 It is often feared that there is a bit of a free-rider problem in the choice of inter-regional grants in the multi-region case [see Stiglitz (1977)]. This fear cannot be confirmed. As each regional government faces the equal utility constraint, it only withholds transfers if it makes every region better off, whether there are two or more regions. Hence, our results go through in the multi-region case, provided each region has for each other region a separate interregional transfer instrument. For instance, each EC member state needs 11 separate interregional grants.



9 This result and the formula for the optimal interregional net transfer depend on the equal endowment assumption as well as on the kind of the interregional transfer. For instance, if we assume that the rent outflow is restricted so as to choose the interregional net transfer,  $S_{ij} = Z_{ij} + n_j \frac{R_i}{\bar{n}}$ , the formula becomes [see Hartwick (1980), Boadway and Flatters (1982), and Myers (1990)]  $S_{ij} - S_{ji} = \frac{n_i n_j}{\bar{n}} (\frac{G_j}{n_j} - \frac{G_i}{n_i} + \frac{R_i}{n_i} - \frac{R_j}{n_j})$ .