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LEVIATHAN AND PURE PUBLIC GOODS IN A FEDERATION WITH MOBILE POPULATIONS

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This paper investigates properties of the second best allocation in a federation where regional governments provide a pure public good non-cooperatively and policy makers are neither entirely benevolent nor wholly self-serving. A high degree of household mobility across regions forces the governments to raise the efficiency of the public good, however, it also helps to waste resources. It is shown that regional Leviathans not only under-provide the public good but also decrease the amount of wasteful expenditures as households become less mobile. Central government's intervention can enhance efficiency if households are attached to particular regions.

JEL classification codes: H70, H77
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I. Introduction

There are numerous examples of transboundary spillover problems. Regional pollutants deteriorate, for example, the stratospheric ozone shield, the atmosphere, rivers, lakes, and forests in the federation. The spillover should be subjected to a Pigouvian subsidy determined by a higher-level government, namely, the central government (see, for example, Oates, 1972). In fact, transboundary pollution control has been implemented within federal

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environmental systems or by cooperative treaties where the pollution problems involve politically independent nations. In the United States (US), the central government (Environmental Protection Agency) generally works with the states in the control of environmental policy. Similarly, the center of the European Union (EU), outlined by the Maastricht Treaty of 1991 (Treaty on the European Union), implements environmental policy among the member nations.

In a recent study, however, Wellisch (1994) demonstrates that competing regional governments fully internalize such externalities associated with the provision of public goods if households are perfectly mobile. That is, each regional government will have an incentive to internalize all externalities, including interregional spillovers, if it chooses policy variables in order to maximize the utility of its representative resident in anticipation that utilities will be equalized in the migration equilibrium. Such a 'perfect incentive equivalence' reasoning, shown by Boadway (1982) and developed by Myers (1990), implies that there is no efficiency role for the central government in an economy where all households are freely mobile across regions. Wellisch also exhibits, however, that in the case of imperfect mobility, decentralized control is inefficient since the migration equilibrium can no longer be characterized by equal utilities in each region. In his analysis, each household is imperfectly mobile because she or he derives a psychic regional attachment benefit. These benefits are likely to be very important in a federation such as the EU and Canada where residents are culturally heterogeneous. More recently, Caplan et al. (2000) examine the efficient scheme for imperfect mobile households with a game where regional governments are policy leaders and the central government is a policy follower. These efficiency results depend on the behavior of perfectly benevolent governments.

There are two extremes on how to describe government. One, founded on the theory of welfare economics, takes governments as benevolent maximisers of its residents' welfare, which is based on the fact that politicians want to be re-elected and hence must bear in mind the utility of residents. The other view, based on public choice, takes governments instead as Leviathans, which pursue their own interests. Some empirical evidences, for example, demonstrate that regional governments, including politicians and bureaucrats, lead more resources to public expenditures than representative residents prefer, as in Filimon et al. (1982) and Wyckoff (1988). We can find this dichotomy throughout all areas of public economics. However, these two theories need not be mutually exclusive. Edwards and Keen (1996) present an approach which reconciles these views by assuming that regional governments are moderate Leviathans who are neither entirely benevolent nor fully self-interested. They use the model to investigate whether capital income tax competition among regions is beneficial. Recently, Rauscher (1998) extends the model to include benefit taxation. These models ignore any household mobility across regions though.

It is our purpose to integrate both models, i.e., to investigate the regional Leviathan's provision of a pure public good, called a federal public good; that is, a good whose economic benefit is available for an entire federation, in an environment of imperfectly mobile households.[1] One important example of such a public good is environmental quality. We can observe this situation in the EU. Although one nation's efforts to abate emissions of pollutants in the atmosphere (e.g., carbon dioxide) contribute to the clean air within the EU, the abatement costs as well as the Leviathan's wasteful expenditures compel residents in the nation to cut down their private consumptions simultaneously. This nation's action motivates the population to emigrate to other nations since the Treaty of Rome (Article 48) guarantees that all EU citizens are entitled to work in any other member nations and are treated identically as native residents with respect to taxation, transfers and all other social benefits. However, the degree of household mobility is much lower than within the US since the EU consists of culturally diverse regions.

The federal regime in this paper is hierarchical like the EU economy. However, if decentralization of government functions can yield an efficient allocation, there is no need to introduce a central government in the spirit of the Maastricht Treaty. This implies that only functions which cannot satisfactorily be fulfilled by the member nations should be assigned a center and those should be subsidiary. Therefore, we will first analyze the Nash equilibrium for the decentralized provision of the federal public good.

[1] In the case of perfectly mobile households, Wrede (1998) synthesizes both models without interregional spillovers.

The difference in household mobility will prove to be quite important since the conclusions differ in both cases. The regional Leviathans provide the federal public good efficiently and the socially efficient population distribution holds in an environment of perfect household mobility. Furthermore, perfect mobility requires them to waste resources until the marginal costs of their expenditures are equalized. If households move across regions imperfectly, however, the Leviathans have no incentive to provide the federal public good efficiently. But they decrease the amount of wasteful expenditures as households become less mobile. Later, we analyze whether a central government's intervention can enhance efficiency by utilizing a regime similar to the Structural and Cohesion Funds in the EU, where regional governments have precommitted to their policies and the center has been endowed with an instrument to redistribute income among regions after it observes regional contributions to the federal public good.

This paper is organized as follows. Section II presents the basic model of a federal public good in a federal economy and derives the social optimum. Section III demonstrates the decentralized decision-making of regional Leviathan governments. It examines whether household mobility can tame Leviathan governments and hence improve social welfare. Section IV investigates the implications of a central government's intervention in a setting similar to the EU. Section V summarizes and concludes.

II. The Basic Structure of the Model

The federation consists of two regions denoted by i = 1, 2. The size of the national population is normalized to unity. The population of region i is indexed by n_i. Obviously, $n_i + n_2 = 1$, as all households must reside at some location in the federation. Households in region i are assumed to derive utility from consumption of x_i units of numeraire goods and G units of the federal public good, with the utility function: $U(x_i, G)$, where $U_x^i > 0$, $U_G^i > 0$, $U_{xx}^i < 0$, $U_{GG}^i < 0$ and $U_{xG}^i \geq 0$. Furthermore, we introduce imperfect mobility for households by supposing heterogeneous preferences with respect to home attachment as in Mansoorian and Myers (1993) and in Wellisch (1994). Each type of household, denoted by n, is assumed to be distributed uniformly on the interval [0, 1]. Then, the utility function of type n household is:

$$U(x_1, G) + a(1 - n)$$

if the household lives in region 1, and

$$U(x_2, G) + an,$$

if she or he lives in region 2. The parameter n measures the non-pecuniary benefit the household derives from living in region 2, the parameter $(1 - n)$ the benefit from living in region 1 and the constant parameter $a \geq 0$ denotes the attachment intensity. For $a = 0$, households are perfectly mobile across regions. As a increases, households become less mobile, since the psychic benefit each household derives from a region is idiosyncratic, a migration equilibrium can be characterized by the marginal household, indexed by n_1, who is just indifferent between locating in either region.

$$U(x_1, G) + a(1 - n_1) = U(x_2, G) + an_1 \tag{1}$$

Households with $n < n_1$ reside in region 1 and those with $n > n_1$ live in region 2. It is obvious that the marginal household n_1 also indicates the population of households residing in region 1.

Each household supplies inelastically one unit of homogeneous labor in the region of residence. Perfectly competitive firms produce numeraire goods with a constant-returns-to-scale production function $F^i(n_i, T_i) \equiv f^i(n_i)$. T_i is the fixed resource endowment of region i, say land. Numeraire goods can be used in the production of the federal public good G with $\mathrm{MRT}_{Gx} = 1$. The feasibility constraint for the federation is

$$f^1(n_1) + f^2(n_2) - n_1 x_1 - n_2 x_2 - G = 0. \tag{2}$$

For a fixed $\theta \in [0, 1]$, an efficient allocation can be obtained as a solution to the following problem:

$$\underset{\{x_i,\, G,\, n_i \mid i = 1, 2\}}{\text{Maximize}} \ \theta U(x_1, G) + (1 - \theta) U(x_2, G),$$

subject to (1), (2), $n_1 + n_2 = 1$, $x_i \geq 0$, $G \geq 0$ and $n_i \geq 0$.[2] Assuming the solution is interior, the efficient allocation is determined by (1), (2) and (3) through (5) below:

$$n_1 \frac{U_G^1}{U_x^1} + n_2 \frac{U_G^2}{U_x^2} = 1, \tag{3}$$

$$\left(f_n^1 - x_1\right) - \left(f_n^2 - x_2\right) = 2a\left(\frac{(1-\theta)n_1}{U_x^1} - \frac{\theta n_2}{U_x^2}\right), \tag{4}$$

$$n_1 + n_2 = 1 \tag{5}$$

Eq. (3) is the familiar Samuelson condition for the optimal provision of the federal public good; the regional sum of the marginal benefits on the LHS must be equal to the marginal costs on the RHS. Eqs. (4) and (5) give the optimal population distribution between the two regions. If households are perfectly mobile: $a = 0$, then the net social benefits of an additional mobile household to a region must be equalized across regions in the unique efficient equilibrium: $f_n^1 - x_1 = f_n^2 - x_2$. If households are imperfectly mobile: $a > 0$, there must be a range of efficient population distributions, which depend on the center's weight parameter $\theta \in [0, 1]$.

III. The Regional Government

In a decentralized setting, each regional government is assumed to behave as a moderate Leviathan which derives utility from public expenditures C_i as well as from the utility of a representative resident U^i. Following Edwards

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[2] Although this maximization problem ignores locational tastes, it can characterize an efficient allocation for a given weight θ as in Mansoorian and Myers (1997). To see this, assume ω^n to be the welfare weight on household n where $\int_0^1 \omega^n dn = 1$, then the problem becomes: $\int_0^{n_1} \omega^n \left[U\left(x_1, G\right) + a\left(1-n\right)\right] dn + \int_{n_1}^1 \omega^n \left[U\left(x_2, G\right) + an\right] dn.$ Given the value of other variables, the effect of marginal change in n_1 is:

$$\theta \frac{\partial U^1}{\partial n_1} + \left(1-\theta\right)\frac{\partial U^2}{\partial n_1} + \omega^{n_1}\left[U\left(x_1, G\right) + a\left(1-n_1\right)\right] - \omega^{n_1}\left[U\left(x_2, G\right) + an_1\right],$$

where $\theta \equiv \int_0^{n_1} \omega^n dn.$ Combining with (1) implies that the above is equivalent to our problem.

and Keen (1996), the Leviathan's utility function is assumed to be a quasi-concave function for $i = 1, 2$: $V(C_i, U(x_i, \mathrm{G}))$, where the ordinary demands for C_i and U^i are both normal. Competitive firms pay a labor a wage equal to marginal product. We assume that land in a region is owned solely by the residents of the region on an equal per capita basis. Since firms are assumed to earn no profits, the total land rent accrues to the residents. Firms' production in region i can be used not only in the regional provision of federal public good G_i but also as wasteful expenditures C_i, which benefit only politicians, on a one-to-one basis. The regional government collects a residence-based head tax to finance these public expenditures and a non-negative interregional transfer from i to j: $Z_{ij} \geq 0$. We assume that the regional government i takes $\{Z_{ji}, G_j, C_j\}$ as given in choosing $\{Z_{ij}, G_i, C_i\}$. Using these assumptions, the feasibility constraint for region i becomes

$$f^i(n_i) - n_i x_i - G_i - C_i - \left(Z_{ij} - Z_{ji}\right) = 0 \text{ for } i, j = 1, 2, i \neq j. \tag{6}$$

Inserting (6) for x_i into (1) gives the migration equilibrium condition, which determines n_i as an implicit function of the regional control variables:

$$n_i = n\left(Z_{ij}, Z_{ji}, G_i, G_j, C_i, C_j\right). \tag{7}$$

A straightforward exercise in comparative statics yields the following migration responses for $i, j = 1, 2, i \neq j$.

$$\frac{\partial n_i}{\partial Z_{ij}} = \frac{U_x^i / n_i + U_x^j / n_j}{D}, \; \frac{\partial n_i}{\partial G_i} = \frac{U_x^i / n_i - U_G^i + U_G^j}{D} \; \text{ and } \; \frac{\partial n_i}{\partial C_i} = \frac{U_x^i / n_i}{D}, \tag{8}$$

where $D \equiv U_x^i\left(f_n^i - x_i\right)/n_i + U_x^j\left(f_n^j - x_j\right)/n_j - 2a < 0.$[3] The regional government i's problem is to

$$\underset{\{Z_{ij},\, G_i,\, C_i \,|\, i=1,2\}}{\text{maximize}} V\left(C_i, U\left(x_i, G\right)\right),$$

[3] Stability of the migration equilibrium requires D to be negative. (See Boadway, 1982, and Stiglitz, 1977). We implicitly assume stable equilibria with populated regions, i.e., $f_n^i - x_i < 0$.

subject to (6), (7), $Z_{ij} \geq 0$, $G_i \geq 0$, $C_i \geq 0$ and $G_i + G_j = G$.

The first-order conditions for $i, j = 1, 2, i \neq j$ are

$$\frac{1}{V_U^i}\frac{\partial V^i}{\partial Z_{ij}} = \frac{U_x^i}{n_i}\left(\left(f_n^i - x_i\right)\frac{\partial n_i}{\partial Z_{ij}} - 1\right) \leq 0, \quad Z_{ij} \geq 0 \text{ and } Z_{ij}\frac{\partial V^i}{\partial Z_{ij}} = 0, \tag{9}$$

$$\frac{1}{V_U^i}\frac{\partial V^i}{\partial G_i} = \frac{U_x^i}{n_i}\left(\left(f_n^i - x_i\right)\frac{\partial n_i}{\partial G_i} - 1 + n_1\frac{U_G^i}{U_x^i}\right) \leq 0, \; G_i \geq 0 \text{ and } G_i\frac{\partial V^i}{\partial G_i} = 0, \tag{10}$$

$$\frac{\partial V^i}{\partial C_i} = V_C^i + V_U^i\frac{U_x^i}{n_i}\left(\left(f_n^i - x_i\right)\frac{\partial n_i}{\partial C_i} - 1\right) \leq 0, \quad C_i \geq 0 \text{ and } C_i\frac{\partial V^i}{\partial C_i} = 0. \tag{11}$$

Inserting the migration response (8) into (9) and rearranging yields

$$\left(f_n^j - x_j\right) - \left(f_n^i - x_i\right) \leq 2a\,n_j / U_x^j \text{ for } i, j = 1, 2, i \neq j. \tag{12}$$

These first-order conditions for both regions together indicate that decentralized decisions of regional governments always achieve the socially efficient population distribution condition (4) regardless of whether governments are malevolent or benevolent. Assuming an interior solution for G_i, combining (8) and (10) gives

$$n_i\frac{U_G^i}{U_x^i} + n_j\frac{U_G^j}{U_x^j}\left(\frac{f_n^i - x_i}{f_n^j - x_j - 2a\,n_j / U_x^j}\right) = 1 \text{ for } i, j = 1, 2, i \neq j. \tag{13}$$

Comparing (3) with (13), it is clear that the Samuelson condition can only be achieved if the region makes a strictly positive interregional transfer. Hereafter we say the region is "not transfer-constrained" since in this case (12) holds as an equality, as in Wellisch (1994). Furthermore, substituting (8) into (11), the first-order conditions for choosing C_i become

$$\frac{n_i}{U_x^i} + \frac{n_j}{U_x^j}\left(\frac{f_n^i - x_i}{f_n^j - x_j - 2a\,n_j / U_x^j}\right) \leq \frac{V_U^i}{V_C^i} \text{ for } i, j = 1, 2, i \neq j. \tag{14}$$

These inequalities characterize how tax revenues are distributed between government expenditures and outlays on the federal public good. We focus our attention on situations where both regional governments are malevolent: $C_i > 0$ for $i = 1, 2$, since Wellisch (1994) analyzes the case of purely benevolent governments: $C_i = 0$ for $i = 1, 2$. Needless to say, each government chooses wasteful expenditures in line with equality (14), which states that the MRS in government i's preference for increasing in a representative resident's utility, in terms of wasteful expenditures, V_U^i / V_C^i, must equal the marginal costs. The marginal costs are caused by incrementing the utility of households measured in units of the numeraire good.

In the perfect mobility case: $a = 0$, inequalities (12) indicate that both regions are not transfer-constrained. This implies that both governments must have the correct incentive to attain not only the efficient population distribution condition (4), but also the Samuelson condition (3). Furthermore, equalities (14) indicate that, for given amounts of wasteful expenditures, the MRSs must coincide across the Leviathan governments: $n_i / U_x^i + n_j / U_x^j = V_U^i / V_C^i = V_U^j / V_C^j$. This implies that $C_i = C_j$, since the migration equilibrium $U^i = U^j$ means $V_C^i = V_C^j$. Thus, the following proposition holds:

Proposition 1: *If households are perfectly mobile and regions provide a federal public good, then the Leviathan governments lead to an efficient allocation for the populations and the federal public good but wasteful expenditures. They choose the same amount of wasteful expenditures in the equilibrium.*

Perfect mobility implies the equal utility migration equilibrium. That is, non-myopic governments must decide on their policies taking account of the utilities of non-residents as well as those of residents. Hence, both governments have to provide the public good according to the Samuelson condition and to agree upon a population distribution that attain a common utility level for all households in the federation. At the same time, these governments agree upon wasteful expenditures as well as net interregional transfers. In other words, each Leviathan increases wasteful expenditures until the marginal benefits are equalized. Obviously, comparing (2) with the sum of (6) for both regions demonstrates that this equilibrium, called the second best, is not the socially optimum because of the amount of wasteful expenditures.

When households are imperfectly mobile: $a > 0$, the equilibrium allocation is inefficient even if $C_i = 0$ for both regions, since at least one region must fail to provide the federal public good in accordance with the Samuelson condition.[4] Now we are interested in whether high degrees of household mobility reduce Leviathans' wasteful expenditures. In order to obtain the impact of an increase in the attachment parameter a on C_i, we have to apply the implicit function theorem on the entire set of first-order conditions of both regions; i.e., eqs. (12), (13) and (14). Instead, it is useful to focus on symmetric cases so as to make the result clear. If there is no difference across regions, then both regions are transfer-constrained since the first-order conditions (12) hold as inequalities: $\tilde{Z} = 0$, where tildes above variables denote values in the environment of identical regions. In a symmetric equilibrium, each region has no incentive to provide the federal public good according to the Samuelson condition.[5] However, each region reduces wasteful expenditures compared to the case where there is no attachment to regions. This can be derived by the following system, which simply restates the first-order conditions (13) and (14):

$$\Phi\left(\tilde{G},\tilde{C},a\right) \equiv n\frac{U_G}{U_x} + n\frac{U_G}{U_x}\left(\frac{f_n - x}{f_n - x - 2a\,n/U_x}\right) - 1 = 0, \tag{15}$$

$$\Psi\left(\tilde{G},\tilde{C},a\right) \equiv \frac{n}{U_x} + \frac{n}{U_x}\left(\frac{f_n - x}{f_n - x - 2a\,n/U_x}\right) - \frac{V_U}{V_C} = 0. \tag{16}$$

The appendix in Section A.I provides an explicit solution to this problem. Here, we summarize the results in

[4] Wellisch proved that at least one region must be transfer-constrained in the case of imperfect household mobility. See Proposition 2 and 3 in Wellisch (1994). If the production functions are the same in both regions, then interregional differences can only be attributed to different land endowments. The greater the interregional differences, the more likely it is that the region with the higher land endowment will make a strictly positive transfer.

[5] Wellisch (1994) demonstrates that a transfer-constrained region always undersupplies the public goods generating trans-boundary externality relative to the Samuelson criterion.

Proposition 2: *If households are imperfectly mobile and identical regions provide a federal public good, then the transfer constrained Leviathan has no incentive to provide the federal public good efficiently but it reduces wasteful expenditures as the intensity of attachment benefit to regions becomes larger.*

Proposition 2 implies that the sum of Leviathans' wasteful expenditures become the maximum in the case of perfect mobility. In this case, the marginal cost of the wasteful expenditures in the whole federation is $n_i/U_x^i + n_j/U_x^j = \left(V_U^i/V_C^i + V_U^j/V_C^j\right)/2$. If households are immobile, the marginal cost is $n_i/U_x^i + n_j/U_x^j = V_U^i/V_C^i + V_U^j/V_C^j$. This is the minimum level of wasteful expenditures. Namely, if households are more mobile across regions, then the opportunity costs of wasteful expenditures shrink and hence the Leviathan governments increase their own expenditures strategically in order to lead part of the populations to emigrate to the other region, since the assumption $f_n^i - x_i < 0$ implies that each region is better off the less inhabitants it has. Note that $f_n^i - x_i = 0$ can happen in a stable equilibrium when $a > 0$. In this limit case, the degree of household mobility a is independent of $\tilde{G}$ and $\tilde{C}$.[6] The allocation is just same as the preceding result at $a \to \infty$ except that the governments have no incentive to get rid of excess population and hence respond to a change on a.

Since imperfectly mobile households prevent the Leviathan governments from providing the federal public good according to the Samuelson condition, although they cut down their wasteful expenditures in comparison with the case of perfect mobility, for taxpayers the equilibrium is worse than the second best allocation. There are some possibilities for a central government to overcome the problem. The following section examines the intervention of the central government and its implications for the allocation of resources in the federation.

IV. The Central Government

Let us now consider a situation whereby there are one central government

[6] I thank the co-editor for suggesting this explanation for the limit case.

and two regional governments in the federation. Since we are basically interested in whether households benefit from the central government's intervention, it is useful to assume that the center is benevolent in order to compare the results with the decentralized setting in the previous section. Furthermore, we assume that the right to choose both the provision of the federal public good and wasteful expenditures is left in the hands of regional governments and that the center only controls the net interregional transfer. Although there are several ways for the central government to control the federation, this indirect method seems to be more appropriate in the EU case, since it's difficult to imagine that member nations would be willing to give up their responsibility to the supranational institution. The center cannot interfere with the locational choices of households and has to face the migration equilibrium (1) and the following budget constraint:

$$S_1 + S_2 = 0, \tag{17}$$

where S_i for i, j = 1, 2 is the federal tax (subsidy if negative). Then, the budget constraint (6) can be rewritten as

$$f^i(n_i) - n_i x_i - G_i - C_i - S_i = 0 \text{ for } i, j = 1, 2. \tag{18}$$

Combining (1), (17) for S_2 and (18) determines n_i as an implicit function of the center and regional control variables:

$$n_i = n'(S_1, G_i, G_j, C_i, C_j). \tag{19}$$

Differentiation of (19) gives the following migration responses for i, j = 1, 2, $i \neq j$:

$$\frac{\partial n_1}{\partial S_1} = \frac{U_x^1/n_1 + U_x^2/n_2}{D}, \quad \frac{\partial n_i}{\partial C_i} = \frac{U_x^i/n_i}{D}, \quad \frac{\partial n_i}{\partial G_i} = \frac{U_x^i/n_i - U_G^i + U_G^j}{D}. \tag{20}$$

The central government's problem is to

$$\underset{\{S_1\}}{\text{maximize}}\ \delta U(x_1, G) + (1-\delta) U(x_2, G),$$

subject to (17) through (19) and $G_i + G_j = G$, where δ and 1-δ indicate the subjective weights of the center for respective regions.[7] The behavior of the center is characterized by the following first-order condition:

$$\frac{\delta U_x^1}{n_1}\left(\left(f_n^1 - x_1\right)\frac{\partial n_1}{\partial S_1} - 1\right) - \frac{(1-\delta)U_x^2}{n_2}\left(\left(f_n^2 - x_2\right)\frac{\partial n_1}{\partial S_1} - 1\right) = 0. \tag{21}$$

Inserting the migration response (20) into the first-order condition and rearranging yields the efficient population distribution condition (4) with δ acting in θ 's place. We can use this equation to define the implicit function:

$$S_1 = s\left(G_i, G_j, C_i, C_j\right). \tag{22}$$

Differentiation of the implicit function yields the following partial derivatives:

$$\frac{\partial S_1}{\partial G_i} = \frac{1}{\Delta}\left[\frac{(-1)^i}{n_i} + 2a\left(\frac{(-1)^{1+i}\,\delta_j U_{xx}^i}{\left(U_x^i\right)^2} - \frac{(1-\delta)n_1 U_{xG}^1}{\left(U_x^1\right)^2} + \frac{\delta n_2 U_{xG}^2}{\left(U_x^2\right)^2}\right)\right],$$

$$\frac{\partial S_1}{\partial C_i} = \frac{(-1)^i}{\Delta}\left(\frac{1}{n_i} - 2a\frac{\delta_j U_{xx}^i}{\left(U_x^i\right)^2}\right) \text{ for } i, j = 1, 2,\ i \neq j. \tag{23}$$

where $\delta_1 = \delta$, $\delta_2 = 1 - \delta$ and the derivative with respect to S_1 is

$$\Delta \equiv \frac{1}{n_1} + \frac{1}{n_2} - 2a\left(\frac{(1-\delta)U_{xx}^1}{\left(U_x^1\right)^2} + \frac{\delta U_{xx}^2}{\left(U_x^2\right)^2}\right) > 0.$$

Both regional governments determine their policies, taking the reaction functions: $n_i = n'\left(S_1, G_i, G_j, C_i, C_j\right)$ and $S_1 = s\left(G_i, G_j, C_i, C_j\right)$ into account.

[7] This description for the representative utility in politician's preference fits the electoral system used, e.g., to elect members of the US House of Representatives, where candidates are elected in local districts by plurality rule and each district receives a number of seats roughly proportional to its share of the total population. Alternatively, under a system of proportional representation, $U(x_i, G)$ would represent the expected fraction of seats for the region.

Then, the regional government i's problem is to

$$\underset{\{G_i,\, C_i\}}{\text{maximize}}\; V\left(C_i, U\left(x_i, G\right)\right),$$

subject to (17) through (19), (22), $G_i \geq 0$, $C_i \geq 0$ and $G_i + G_j = G$. Assuming interior solutions, the Nash equilibrium is characterized by the following first-order conditions:

$$\frac{1}{V_U^1}\frac{\partial V^1}{\partial G_1} = \frac{U_x^1}{n_1}\left[\left(f_n^1 - x_1\right)\left(\frac{\partial n_1}{\partial G_1} + \frac{\partial n_1}{\partial S_1}\frac{\partial S_1}{\partial G_1}\right) - 1 - \frac{\partial S_1}{\partial G_1} + n_1\frac{U_G^1}{U_x^1}\right] = 0, \tag{24}$$

$$\frac{1}{V_U^2}\frac{\partial V^2}{\partial G_2} = \frac{U_x^2}{n_2}\left[-\left(f_n^2 - x_2\right)\left(\frac{\partial n_1}{\partial G_2} + \frac{\partial n_1}{\partial S_1}\frac{\partial S_1}{\partial G_2}\right) - 1 + \frac{\partial S_1}{\partial G_2} + n_2\frac{U_G^2}{U_x^2}\right] = 0, \tag{25}$$

$$\frac{\partial V^1}{\partial C_1} = V_C^1 + V_U^1\frac{U_x^1}{n_1}\left[\left(f_n^1 - x_1\right)\left(\frac{\partial n_1}{\partial C_1} + \frac{\partial n_1}{\partial S_1}\frac{\partial S_1}{\partial C_1}\right) - 1 - \frac{\partial S_1}{\partial C_1}\right] = 0, \tag{26}$$

$$\frac{\partial V^2}{\partial C_2} = V_C^2 + V_U^2\frac{U_x^2}{n_2}\left[-\left(f_n^2 - x_2\right)\left(\frac{\partial n_1}{\partial C_2} + \frac{\partial n_1}{\partial S_1}\frac{\partial S_1}{\partial C_2}\right) - 1 + \frac{\partial S_1}{\partial C_2}\right] = 0. \tag{27}$$

Inserting the migration responses (20) and the center's responses (23) into (24) and (25) yields the Samuelson condition (3). We demonstrate the detailed derivation in Section A.II. This allows us to state

Lemma 1: *If the central government controls the interregional transfer, then both regional Leviathans supply the federal public good efficiently regardless of imperfect household mobility across regions.*

The result above makes it clear that the decentralized provision of the federal public good with the interregional transfer mechanism implemented by the center induces the regional Leviathans to behave efficiently. That is, each regional Leviathan is endowed with the correct incentive to fully internalize the spillover effect associated with the provision of the federal public good. Furthermore, as demonstrated in Section A.III, eqs. (26) and (27) imply the equalization of the MRS across regional Leviathans in the Nash equilibrium: $n_i/U_x^i + n_j/U_x^j = V_U^i/V_C^i = V_U^j/V_C^j$.

Lemma 2: *If the central government controls the interregional transfer, then both Leviathans' marginal benefits are equated even if households are imperfectly mobile across regions.*

The center's interregional transfer mechanism forces regions to equate their marginal costs of wasteful expenditures and hence to increase the total amount of wasteful expenditures in the federation as much as those which are chosen in the case of perfect household mobility. Nevertheless, the central intervention is valid in the sense of the Samuelson efficiency. Needless to say, the intervention scheme can attain the second best allocation. Then, we can summarize these findings as follows:

Proposition 3: *If regional policy makers waste resources and households are imperfectly mobile, then the interregional transfer mechanism implemented by the center attains the second best allocation. If households are perfectly mobile, however, there is no efficient role for the central government.*

This is good news for federations such as the EU. The results suggest that the efficiency of a federal public good is contingent on the redistributive mechanism of the central government (e.g., Structural and Cohesion Funds in the EU).

V. Conclusions

This paper analyzes the decentralized provision of a public good by governments who are neither entirely benevolent nor wholly self-serving in a federation, such as the EU, characterized by imperfect household mobility. We show that in the decentralized Nash equilibrium, Leviathan governments not only under-supply the federal public good but also under-waste resources as households become immobile across regions. We also demonstrate that the center's intervention with the interregional transfer enhances efficiency if households are imperfectly mobile.

The result derived in this paper may be applied to many situations where governments are neither purely benevolent nor purely malevolent and regional public goods cause interregional spillovers in the federation. Consider, for instance, the bovine spongiform encephalopathy (BSE) tests in the EU. Each regional BSE test contributes to safety of the food (cow) market, as a pure public good, in the EU. Defense forces for the peace and health services to reduce infectious diseases can also be the examples of the federal public good. The central government can induce regions to contribute in line with the Samuelson efficiency despite the intensity of household attachment to regions. However, our result also implies that there is no efficient role for the central government in the case of perfect household mobility as well as when regional Leviathans provide regional public goods with no transboundary externality; in this case, since the Samuelson efficiency always holds regardless of household attachment benefit, the center's intervention only maximize the amount of wasteful expenditures in the federation.

It is important, however, to discuss a few restrictions in the analysis. First, the introduction of imperfect household mobility is done in a rather restrictive form. Following Mansoorian and Myers (1993) and Wellisch (1994), we assume that only the psychic attachments to regions are different among households. Different formulations of the imperfect mobility might bring different characteristics in the second best of this paper. Second, our efficiency result crucially depends on the benevolentness of the central government. If it were malevolent, the outcome would be changed.[8] Furthermore, the result implies that it's necessary for efficiency to pay the maximum costs of regional wasteful expenditures. Hence, it is important for the efficiency enhancing transfer system in a federation to monitor behaviors of governments and to check the costs-benefits analysis by taking the Leviathan costs into account. Finally, we have abstracted from capital mobility. Introducing two sorts of imperfect mobility might lead new insight on the analysis.

Appendix

A.I. Responses to the Degree of Household Mobility

The basic purpose of this appendix is to derive the response $d\tilde{C}/da$ to prove Proposition 2. Total differentiation of (15) and (16) yields

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[8] If the center's utility function is also moderate Leviathan type: $V(C, \delta U^1 + (1 - \delta)\, U^2)$, the center's intervention will never enhance efficiency.

$$\begin{pmatrix} \Phi_G & \Phi_C \\ \Psi_G & \Psi_C \end{pmatrix} \begin{pmatrix} d\tilde{G} \\ d\tilde{C} \end{pmatrix} = -\begin{pmatrix} \Phi_a \\ \Psi_a \end{pmatrix} da, \tag{28}$$

with

$$\Phi_G = \frac{(U_G U_{xx} - U_x U_{xG}) + 2n(U_x U_{GG} - U_G U_{xG})}{(U_x)^2} + \frac{(2nU_{GG} - U_{xG}) f_{nx}}{U_x (f_{nx} - 2an/U_x)}$$

$$+ \frac{(U_{xx} - 2nU_{xG})(f_{nx})^2 - 2an}{(U_x)^2 (f_{nx} - 2an/U_x)^2} U_G \ ,$$

$$\Phi_C = \frac{(U_G U_{xx} - U_x U_{xG})}{(U_x)^2} - \frac{U_{xG} f_{nx}}{U_x (f_{nx} - 2an/U_x)} + \frac{U_{xx} (f_{nx})^2 - 2an}{(U_x)^2 (f_{nx} - 2an/U_x)^2} U_G,$$

$$\Psi_G = \frac{U_{xx} - 2nU_{xG}}{(U_x)^2} + \frac{(U_{xx} - 2nU_{xG})(f_{nx})^2 - 2an}{(U_x)^2 (f_{nx} - 2an/U_x)^2} + \frac{2anU_G (V_C V_{UU} - V_U V_{CU})}{U_x (f_{nx} - 2an/U_x)(V_C)^2},$$

$$\Psi_C = \frac{U_{xx}}{(U_x)^2} + \frac{U_{xx} (f_{nx})^2 - 2an}{(U_x)^2 (f_{nx} - 2an/U_x)^2}$$

$$+ \frac{(V_U V_{CC} - V_C V_{CU}) + U_x (V_C V_{UU} - V_U V_{CU})/n}{(V_C)^2},$$

$$\Phi_a = 2U_G \left(\frac{n}{U_x}\right)^2 \frac{f_{nx}}{(f_{nx} - 2an/U_x)^2}, \ \Psi_a = 2\left(\frac{n}{U_x}\right)^2 \frac{f_{nx}}{(f_{nx} - 2an/U_x)^2},$$

where $f_{nx} \equiv f_n - x < 0.$

Let Γ denote the 2×2 matrix on the LHS of (28). It follows that $\Phi_G < 0$ and $\Psi_C < 0$ with the normality assumption. We assume that $|\Gamma| > 0$ to ensure stability of the system of equations (15) and (16). Solving (28) with Cramer's rule yields

$$\frac{d\tilde{G}}{da} = \frac{1}{|\Gamma|}\left(-2\left(\frac{n}{U_x}\right)^2 \frac{f_{nx}}{\left(f_{nx} - 2an/U_x\right)^2}\right)$$

$$\times\left[\frac{\left(V_U V_{CC} - V_C V_{CU}\right) + U_x\left(V_C V_{UU} - V_U V_{CU}\right)/n}{\left(V_C\right)^2} U_G + \frac{2U_{xG}\left(f_{nx} - an/U_x\right)}{U_x\left(f_{nx} - 2an/U_x\right)}\right].$$

$$\frac{d\tilde{C}}{da} = \frac{1}{|\Gamma|}\left(-2\left(\frac{n}{U_x}\right)^2 \frac{f_{nx}}{\left(f_{nx} - 2an/U_x\right)^2}\right)$$

$$\times\left[\frac{2\left(2nU_{GG} - U_{xG}\right)\left(f_{nx} - an/U_x\right)}{U_x\left(f_{nx} - 2an/U_x\right)} - \frac{2an^2 U_G\left(f_{nx} - an/U_x\right)\left(V_C V_{UU} - V_U V_{CU}\right)}{\left(U_x\right)^2\left(f_{nx} - 2an/U_x\right)}\right].$$

The sign of $d\tilde{G}/da$ is ambiguous in general and depends on the sign of the square bracket; e.g., if U_{xG} = 0, then $d\tilde{G}/da < 0$. However, it is clear that $d\tilde{C}/da < 0$. That is, each Leviathan decreases wasteful expenditures in a symmetric equilibrium as households become less mobile.

A.II. Efficiency of the Federal Public Good

In this appendix, we show that both regional Leviathans supply the federal public good in accordance with the Samuelson condition. From the migration responses (20), it obtains the following result:

$$\frac{\partial n_1}{\partial G_1} - \frac{\partial n_1}{\partial G_2} = \frac{\partial n_1}{\partial S_1}. \tag{29}$$

Furthermore, the center's responses to regions (23) imply that

$$\frac{\partial S_1}{\partial G_1} - \frac{\partial S_1}{\partial G_2} = -1. \tag{30}$$

Combining (29) with (30) yields

$$\frac{\partial n_1}{\partial G_1} + \frac{\partial n_1}{\partial S_1}\frac{\partial S_1}{\partial G_1} = \frac{\partial n_1}{\partial G_2} + \frac{\partial n_1}{\partial S_1}\frac{\partial S_1}{\partial G_2}. \tag{31}$$

Subtracting (25) from (24) and using (30) and (31) gives

$$\left[\frac{U_x^1}{n_1}\left(f_n^1 - x_1\right) + \frac{U_x^2}{n_2}\left(f_n^2 - x_2\right)\right]\left(\frac{\partial n_1}{\partial G_1} + \frac{\partial n_1}{\partial S_1}\frac{\partial S_1}{\partial G_1}\right) = \frac{U_x^1}{n_1} + \left(\frac{U_x^1}{n_1} + \frac{U_x^2}{n_2}\right) - U_G^1 + U_G^2.$$

Dividing this equation by D and using (20), it obtains

$$\frac{2a}{D}\left(\frac{\partial n_1}{\partial G_1} + \frac{\partial n_1}{\partial S_1}\frac{\partial S_1}{\partial G_1}\right) = 0. \tag{32}$$

It is clear that the expression in the parenthesis of (32) equals zero because $2a/D < 0$. Given the result above, the first-order conditions (24) and (25) reduce to

$$n_1\frac{U_G^1}{U_x^1} = 1 + \frac{\partial S_1}{\partial G_1},\ \ n_2\frac{U_G^2}{U_x^2} = 1 - \frac{\partial S_1}{\partial G_2}.$$

Add these equations and utilize (30) to obtain the Samuelson condition (3).

A.III. Equalization of MRS across Leviathans

Here we demonstrate that in the Nash equilibrium, the regional Leviathans choose their wasteful expenditures so that the marginal benefits are equated across governments. The procedure is quite similar to A.II. From the migration responses (20), and the center's responses (23), it obtains:

$$\frac{\partial n_1}{\partial C_1} - \frac{\partial n_1}{\partial C_2} = \frac{\partial n_1}{\partial S_1},\ \ \frac{\partial S_1}{\partial C_1} - \frac{\partial S_1}{\partial C_2} = -1. \tag{33}$$

Hence,

$$\frac{\partial n_1}{\partial C_1} + \frac{\partial n_1}{\partial S_1}\frac{\partial S_1}{\partial C_1} = \frac{\partial n_1}{\partial C_2} + \frac{\partial n_1}{\partial S_1}\frac{\partial S_1}{\partial C_2}. \tag{34}$$

Subtracting (27) from (26) and using (20), (33) and (34) yields

$$\frac{V_C^1}{V_U^1} - \frac{V_C^2}{V_U^2} + 2a\left(\frac{\partial n_1}{\partial C_1} + \frac{\partial n_1}{\partial S_1}\frac{\partial S_1}{\partial C_1}\right) = 0. \qquad (35)$$

Assume that $V_U^1 / V_C^1 = V_U^2 / V_C^2$. Then the expression in the parenthesis of (35) equals zero because $a > 0$. Given these results and the assumption above, the first-order conditions (26) and (27) reduce to: $V_U^1 / V_C^1 = V_U^2 / V_C^2 = n_1 / U_x^1 + n_2 / U_x^2$. Hence, the assumption is self-confirmed as the Nash equilibrium.

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