INTER-JURISDICTIONAL COST-SHARING OF PUBLIC SPENDING

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Abstract

This paper deals with the issue of how two geographically separate jurisdictions should share the cost of a centralized and uniformly provided public good. The key assumption is that jurisdictional representatives make decisions by bargaining in the centralised legislature. Results suggest that jurisdictions may reach a mutually beneficial agreement by equalising the net welfare gain produced by the provision of the public good, rather than the public good cost. The model identifies the efficiency and redistributive implications of such an agreement.

Key words: Public goods, public provided goods, cost-sharing, bargaining.

JEL Classification: C7, D3, H, H4.

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1 Introduction

This paper considers an economy with two jurisdictions where policy decisions are made through inter-jurisdictional negotiations by the jurisdictional representatives. The contentious issue in the negotiation is how jurisdictions should share the cost of a public or a publicly provided good when individuals have different income and preferences over private and public consumption. The model can be applied to the provision of either a joint public good or a common infrastructure as a bridge or a tunnel that serves both jurisdictions.

The expenditure of the jurisdictions is covered through taxes levied proportionally on the income of their citizens. The tax rates differ in the two jurisdictions and depend on the cost sharing agreement between representatives.

The results obtained do not support the idea that jurisdictions should share the cost equally. They should rather strive to equalize jurisdictions' net welfare produced by the provision of the public good. This, however, is seldom the case under either a benevolent government or under the majority voting model in which a single decision maker, the median voter of the all economy, maximizes his or her private welfare.

A redistributive consequence of splitting the net welfare gains equally between the two jurisdictions is that the tax-payers of the jurisdiction whose median voter cares more for the infrastructure should pay more. Furthermore, the results suggest that inter-jurisdictional negotiation leads to the social optimum outcome when intra-regional preferences are homogeneous.

This paper can be seen as an extension of Giuranno's (2009 and 2010) models. Giuranno developed a bargaining approach to explain the working of the centralized legislature in a multi-region economy, as that in Besley and Coate (2003). In Giuranno (2009 and 2010) the issue of the negotiation is the size of public spending under different disagreement hypothesis. Instead, here, the main focus is on the cost sharing of a public project.

The bargaining model presented in this paper has the advantage of providing an intuitive solution to the cost-sharing problem. The approach adopted here is different from that adopted by Kaneko (1977 a, b), van den Nouweland et al (2001) and Mas-Colell and Silvestre (1989) in computing the "ratio equilibrium". The latter is a cost-sharing rule in the spirit of Lindahl's (1919) original work that usually employs a voting game, but without negotiation among local representatives in the centalised legislature.

A second school of thought proposes an alternative method to share the cost of a public good, which is different from the most common mechanisms in the literature, namely average cost pricing and marginal cost pricing (Moulin and Shenker, 1992). Bag (1997) and Yu (2006) developed a class of cost-sharing rules in a non-cooperative equilibrium. They solve the free-rider problem thanks to the particular structure of the game in which the central planner undertakes the project only when the total benefit outweighs its cost.

The paper is organized as follows: Section 2 defines the framework; Section 3 presents a model of bargaining in the central legislature, determines the cost-sharing rule and its redistributive properties; Section 4 studies the social optimum and Section 5 presents the conclusions.

2 The model

In this paper, I develop the framework used by Besley and Coate (2003) and Giuranno (2009 and 2010) by explicitly addressing the cost-splitting problem.

Consider an economy with two geographically separate and equal-sized jurisdictions, each having the same number of people with a mass of unity. There are two types of goods: a public or publicly provided good g, such as pollution control or a public infrastructure, and a private good y. The private good can be thought as individual income or endowment that is used for both private consumption and to finance the provision of the public good. The incomes of citizens are the same within each jurisdiction, but different between jurisdictions. Moreover, the jurisdictions are not homogeneous because they have different tastes, λ, regarding the public good. The parameter $\lambda > 0$ tells one how much a citizen values g with respect to y. Those with higher λ value the public good more.

Jurisdictions are represented by their respective median voters. The preferences for the median voter of jurisdiction k are

$$y_k + \lambda_k H(g), \qquad \text{with } k = i, j, \tag{1}$$

where, the public good benefit function $H(g)$ shows a smooth, concave increase and satisfies the endpoint Inada condition.

Jurisdictional median voters form a central government that has to set a cost splitting rule between jurisdictions for a given level of public spending g. The cost splitting rule is used to derive the jurisdictional tax-rates, t_i and t_j. The share of the cost paid by jurisdiction i is denoted by $\gamma_i \in [0,1]$, such that $\gamma_j = 1-\gamma_i$ is the share of the cost paid by jurisdiction j. Once median voters determine the share paid by each jurisdiction, the tax rate levied by jurisdiction k, t_k, satisfies the following equation

$$\gamma_k pg = t_k y_k, \quad \text{with } k = i, j, \tag{2}$$

where, p is the price of g and the total public good cost is pg. Consequently, the budget constraint for the provision of g can be written under the form

$$t_i y_i + t_j y_j = \gamma_i pg + \gamma_j pg = pg, \tag{3}$$

which implies that $\gamma_i + \gamma_j = 1$.[1], [2]

The utility functions of the two median voters can be written under the following form:

$$u_i = y_i - \gamma_i pg + \lambda_i H(g) \tag{4}$$

for the median voter of jurisdiction i and

$$u_j = y_j + (\gamma_i - 1) pg + \lambda_j H(g) \tag{5}$$

for the median voter of jurisdiction j.

3 Legislature equilibrium policy

This section presents the legislature equilibrium policy when jurisdictional median voters make decisions by bargaining in the central legislature. I consider two analytical cases. First, I consider the case where jurisdictional representatives negotiate only on the cost splitting rule, γ_i, for a given amount of g. Second, I solve the case were the government chooses both the size of g and the inter-regional cost sharing rule.

I assume that in case of disagreement the public or publicly provided good will not be provided; that is $g = t_i = t_j = 0$. Thus, the disagreement utility of median voter k is $u_k^d = y_k$; that is, there will be only private consumption in this economy. Instead, in case of agreement median voters' utilities will be given by equations (4) and (5).

Now, I denote the net gain from providing g for median voter k by ϕ_k, such that:

$$\phi_k = u_k - u_k^d = \lambda_k H(g) - \gamma_k pg, \quad \text{with } k = i, j. \tag{6}$$

In order to reach an agreement, the net gain from providing the public good must be positive for both median voters; that is, $\phi_k > 0$.

In the following subsections, I present the legislature equilibrium policy for the two analytical cases under consideration.

3.1 The cost sharing rule

I proceed with the solution of the bargaining game between jurisdictional representatives by studying the case where the government sets the cost sharing rule for a

[1] Note that the following relations also hold: $pg = t_i \sum_{n_i=1}^{N} y_{n_i} + t_j \sum_{n_j=1}^{N} y_{n_j} = N\left(t_i y_{n_i} + t_j y_{n_j}\right)$, where $\left(\sum_{n_i} y_{n_i} + \sum_{n_j} y_{n_j}\right)$ is the sum of individual incomes in jurisdictions i and j and N the population size, which is assumed to have a mass of unity and to be the same in the two regions.

[2] Equation (2), coupled with equation (3) leads to $\gamma_i = t_i y_i / (t_i y_i + t_j y_j)$, which proves that $0 \leq \gamma_i \leq 1$, as previously assumed. This, in turn, implies that an increase in the relative cost for median voter i, γ_i, causes a decrease in the relative cost for median voter j, γ_j, and vice versa.

given level of public spending g. I solve the problem by maximising the following Nash bargaining objective function:

$$\max_{\gamma_i} \ln\left[-\gamma_i pg + \lambda_i H(g)\right] + \ln\left[(\gamma_i - 1) pg + \lambda_j H(g)\right]. \tag{7}$$

The first order condition is

$$-\frac{pg}{-\gamma_i pg + \lambda_i H(g)} + \frac{pg}{(\gamma_i - 1) pg + \lambda_j H(g)} = 0. \tag{8}$$

By rearranging, one obtains the following splitting rule: jurisdictions share the cost of a public good by equalizing their respective net gains from implementing the public good; that is, in equilibrium it must be

$$\phi_i = \phi_j. \tag{9}$$

The equilibrium equation (9) implies that total welfare may differ between jurisdictions, but the net welfare generated by the implementation of the public good has to be equally shared between jurisdictional median voters.

Equation (9) leads to the following splitting solution:

$$\left(\gamma_i^*, \gamma_j^*\right) = \left(\frac{1}{2} + (\lambda_i - \lambda_j)\frac{H(g)}{2pg}; \frac{1}{2} - (\lambda_i - \lambda_j)\frac{H(g)}{2pg}\right). \tag{10}$$

Jurisdictions share the cost equally between them only when median voters have homogeneous tastes, i.e. when $\lambda_i = \lambda_j$. When individual tastes are different, the representative with the higher preference pays a higher share of the cost. This, in turn, implies a redistribution in favor of the median voter with the lowest taste.

According to solution (10), an increase in price p causes a raise in the relative cost of the median voter who pays less; i.e.: $\frac{\partial \gamma_i}{\partial p} > 0$ if $\lambda_i < \lambda_j$. Furthermore, each representative bears a higher relative cost when his or her preference parameter λ increases or that of the other representative decreases; i.e.: $\frac{\partial \gamma_i}{\partial \lambda_i} > 0$ and $\frac{\partial \gamma_i}{\partial \lambda_j} < 0$. In addition, an increase in the size of the public good g causes a raise in the cost share of the median voter who pays less; that is, $\frac{\partial \gamma_i}{\partial g} = \frac{(\lambda_i - \lambda_j)}{2pg^2}\left(H'(g)\, g - H(g)\right) > 0$ if $\lambda_i < \lambda_j$.[3]

Once jurisdictions know their share of the public good cost, their jurisdictional tax rate can be calculated by using equality (2) to convert the gammas in (10) into tax rates. This gives

$$\left(t_i^*, t_j^*\right) = \left(\frac{pg}{2y_i} + (\lambda_i - \lambda_j)\frac{H(g)}{2y_i}; \frac{pg}{2y_j} + (\lambda_j - \lambda_i)\frac{H(g)}{2y_j}\right) \tag{11}$$

[3]Note that, here, under the assumption that $H(g)$ is strictly increasing and concave, the marginal benefit is always greater than the average benefit; that is $H'(g) > \frac{H(g)}{g}$, as proved in Chiang (1984), pp. 192-3.

In jurisdiction i, the tax rate t_i increases as p and λ_i increase and decreases as y_i and λ_j decrease. Differences in the preference parameters λ_k lead to tax income redistribution in favour of the representative with the lowest lambda; the higher the heterogeneity in the lambdas, the larger will be the redistribution. Besides, the sign of $\frac{\partial t_i}{\partial g} = \frac{p}{2y_i} + (\lambda_i - \lambda_j) \frac{H'(g)}{2y_i}$ is certainly positive when $\lambda_i > \lambda_j$ and ambiguous when $\lambda_i < \lambda_j$.

3.2 Bargaining over public spending and the cost splitting rule

So far, we have seen what happens when jurisdictions choose the cost splitting rule when the amount of public spending is taken as exogenous. In this paragraph, I study the equilibrium condition when the government decides both the amount of g and on the cost splitting rule under the threat that without an agreement on both g and γ_k the public good will not be provided. This problem can be solved hither simultaneously or in a two stage game where the government first sets the size of g and second decides the cost splitting rule. The two procedures lead to the same result in this model. Therefore, here, I present only the two stage game where the government decides one issue at a time. The problem is solved by backwards induction. In the second stage, the government sets the cost splitting rule, which is given by equation (9) that leads to solution (10). Now, we can solve the first stage of the game where the government chooses the size of g as follows:

$$g = \arg\max(-\gamma_i^* pg + \lambda_i H(g))[(\gamma_i^* - 1)pg + \lambda_j H(g)]. \tag{12}$$

After substituting solution (10) into (12) and simplifying we obtain

$$g = \arg\max[-pg + (\lambda_i + \lambda_j)H(g)].$$

The first order condition leads to the following equilibrium solution

$$(\lambda_i + \lambda_j)H\prime(g) = p. \tag{13}$$

Equation (13) states that, in equilibrium, the central government chooses the amount of g that equalises the joint marginal benefit, $(\lambda_i + \lambda_j) H'(g)$, with the joint marginal cost, p.

4 The social optimum

Here, I compare solution (13) with the social optimum outcome to understand if and, eventually, when the centralised negotiation leads to efficiency from the social point of view.

The benchmark I use to compute the social optimum is the solution of the benevolent central planner who maximises an additive social welfare function W,

$$W = \sum_i u_i + \sum_j u_j = y_i + y_j - pg + H(g) \left(\sum_i \lambda_i + \sum_j \lambda_j \right). \tag{14}$$

The benevolent central planner is indifferent to the manner in which the cost is shared between jurisdictions[4]. Sen (1973, p. 16) argues that the utilitarian approach of focusing on maximizing the sum of individual utilities is supremely unconcerned with the interpersonal distribution of that sum. This is the reason why I tackle the issue by using a bargaining approach that highlights the influence of conflicting interests among individuals of different jurisdictions on government decision-making.

The central planner would choose the size of public spending g that equalizes the social marginal cost, p, to the social marginal benefit, $H(g)' \left(\sum_i \lambda_i + \sum_j \lambda_j\right)$; i.e.:

$$H(g)' \left(\sum_i \lambda_i + \sum_j \lambda_j\right) = p. \tag{15}$$

Now, we can compare the bargaining solution (13) with the social optimum solution (15). The social marginal cost, p, equals the joint marginal cost of the two median voters. Instead, the social marginal benefit, $\left(\sum_i \lambda_i + \sum_j \lambda_j\right) H(g)'$, equals the joint marginal benefit, $(\lambda_i + \lambda_j) H'(g)$, when individual preferences are homogenous inside jurisdictions. Therefore, heterogeneous preferences lead to misallocation of public resources in a representative democracy.

5 Conclusion

In a multi-jurisdictional economy, a relevant question is how jurisdictions should share the cost of centralised public spending. The results presented here do not justify splitting the cost equally when jurisdictional median voters have heterogeneous preferences. Instead, what they should share equally is the net welfare produced by public spending.

According to this rule, the jurisdiction whose median voter has the highest preference for public goods provision should bear the highest share of the cost. Furthermore, the greater the heterogeneity, the larger is the tax-income redistribution to the jurisdiction whose median voter contributes less.

Besides, heterogeneity leads to misallocation of public resources. Specifically, the more homogenous preferences are inside jurisdictions the more efficient inter-jurisdictional government policy is.

This paper has developed a simple model of cost-sharing between jurisdictions, which can form the base for future research developments. The model can be extended to study, for example, the cost-sharing problem among a large number of jurisdictions. An application of such study could be, for example, the analysis of international negotiations on the implementation of a global public good such as the reduction of pollution, which implies a cost sharing agreement.

[4] This is also a consequence of the quasi-linear utility function commonly used in these types of models.

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