Interregional Competition between Egalitarian Regional Governments in the Presence of Interregional Spillovers and Labor Attachment

by

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Abstract: We examine the efficiency of decentralized regional policy making for a culturally diverse economy in which regional public goods generate interregional spillover benefits and labor is culturally attached to regions. Regional authorities maximize the utility of the least off residents. Unlike Wellisch (1994), we show that the Nash equilibrium for the decentralized policy game is Pareto efficient. It corresponds to the centralized optimal allocation one obtains for each of three different objective functions: Rawlsian, Utilitarian and Cobb-Douglas. Our result implies that supra-regional intervention is not necessary for efficiency in culturally diverse federations such as Canada and the European Union.

Keywords: Rawlsian, Interregional Spillovers, Labor Attachment, Decentralized Policy Making.

JEL classification numbers: C72, D78, H31, H41, H7, R5

1. Introduction

Imperfect labor mobility is an inherent characteristic of many culturally diverse federations, including Canada and the European Union. Previous works have examined the potential inefficiencies implied by labor attachment for the design of decentralized government policy making. In a setting in which there is no attachment benefit to regions, Myers (1990) demonstrates that decentralized regional policy making is Pareto efficient provided that regional governments are endowed with instruments to make income transfers to each other. He notes that regional governments' incentives are perfectly aligned in such circumstances and thus there is perfect incentive equivalence.

Mansoorian and Myers (1993) extend Myers' model to consider situations where labor is attached to regions. In their model, regional governments provide local public goods and the benefits from consumption of such goods are restricted to the residents in which the goods are provided. They show that allocations resulting from Nash behavior are socially efficient regardless of regional transfers.

Wellisch (1994) analyzes the non-cooperative provision of public goods in the presence of interregional spillovers and labor mobility. He shows that: (1) if households are perfectly mobile across regions, the Nash equilibrium is socially efficient; and (2) if households are imperfectly mobile (i.e., individuals are attached to their home region), the Nash equilibrium is socially inefficient. With regional attachment benefits, the region transfer-constrained under-provides the public good. One implication of his analysis is there is scope for a socially benevolent supra-regional authority to intervene in culturally diverse federations whenever regional governments provide regional public goods with transboundary consumption benefits.

Motivated by the implication of Wellisch's analysis that there may a rationale for considering the interplay of regional and supra-regional policy making in a federation characterized by imperfect labor mobility, Caplan *et al*. (2000) examine the decentralized provision of a pure federal public good in such a federation. The pure federal public good is a particular case of the public good generating interregional spillovers as in Wellisch. They show that in a federation characterized by decentralized leadership (i.e., regional governments are the Stackelberg leaders and the central government is a common follower), in which regional governments decide their own contributions to the public good in anticipation of the center's income transfer policies, the subgame perfect equilibrium allocation is Pareto efficient provided that both regional governments provide positive contributions to the federal public good. The result of their paper is an application of Becker's Rotten Kid Theorem to a fiscal federalism framework.

In this paper, we examine the efficiency of decentralized policy making in a setting identical to Welisch's. The sole difference between our model and Wellisch's is that here each regional authority wishes to maximize the utility of the least off resident, which then implies that each regional authority takes the least off individual's attachment benefit into account in its decision making. In Wellisch's model, each regional authority maximizes the common sub-utility of consumption of private and public goods only, thus neglecting regional attachment benefits.

We show that decentralized Nash equilibrium is Pareto efficient and that it corresponds to the optimal allocation chosen by a central authority if the center's objective function obeys any of three mutually exclusive fairness criteria: Rawlsian, Utilitarian and Cobb-Douglas. We show that with Rawlsian regional authorities, there is perfect incentive equivalence. Hence, each regional government finds it optimal to adopt regional policies that internalize all externalities. An immediate implication of our result is that decentralized policy making is not necessarily inefficient in culturally diverse federations in which regional governments provide regional public goods that generate transboundary consumption benefits.

This paper is organized as follows. Section 2 describes the basic economy. This section examines the non-cooperative game played by regional governments. In section 3, we first consider a setting where a central authority's objective function is Rawlsian. Later, we obtain the centralized optimal allocations for the center when it displays Utilitarian and Cobb-Douglas preferences over regional welfare levels. We show that the centralized optimal allocations are identical, and correspond to the Nash equilibrium for the decentralized game. Section 4 concludes the paper.

2. The basic economy

Consider an economy consisting of two politically independent and autonomous regions, indexed by i, $i = 1,2$. Let $N > 0$ denote the total population in this economy. The population of region i is n_i. Hence, $n_1 + n_2 = N$. There are two goods, one private and one public. The public good provides regional and interregional consumption benefits into another.

We assume that individuals are attached to their home region. If individual $n \in [0, N]$ resides in region 1, he derives the following utility from consumption of x_1 units of the private good, G_1 units of public good provided by region 1, and G_2 units of public good provided by region 2:

$$U^1(x_1, G_1, G_2; n) \equiv u^1(x_1, G_1, G_2) + a(N - n).$$

If this individual resides in region 2 instead, his utility from consumption of x_2 units of the private good, G_1 units of public good provided by region 1, and G_2 units of public good provided by region 2 is:

$$U^2(x_2, G_2, G_1; n) \equiv u^2(x_2, G_2, G_1) + an.$$

where the parameter a is an attachment intensity parameter. The term $a(N - n)$ denotes the individual's psychic attachment benefit from residing in region 1 and the term an denotes the psychic benefit from residing in region 2, respectively. The sub-utilities $u^1(\cdot)$ and $u^2(\cdot)$ are assumed to be increasing in each argument, twice continuously differentiable and strictly quasiconcave. The model is essentially identical to the model utilized by Wellisch (1994) to examine the efficiency of interregional competition with spillovers and labor attachment to regions.

Each individual chooses his region of residence. If both regions are populated in equilibrium, there is one individual who is indifferent between residing in region 1 and in region 2. This is the n_1 th individual for whom we have

$$u^1(x_1, G_1, G_2) + a(N - n_1) = u^2(x_2, G_2, G_1) + an_1. \quad (1)$$

An individual $n \in [0, n_1]$ is at home in region 1 and an individual $n \in [n_1, N]$ is at home in region 2.

Each individual who resides in region i is endowed with one unit of labor, which is supplied inelastically in the region. Labor endowments are assumed to be identically productive and are used to produce the private good, our numeraire. The production possibilities for the numeraire good are represented by an increasing and strictly concave function of labor, $F^i(n_i;L_i) \equiv f^i(n_i)$, where L_i denotes the fixed resource endowment of region *i*. To guarantee that each region is populated in equilibrium, we assume that the regional production functions satisfy $\lim_{n_i \to 0} f_n^i = \infty$, $i = 1,2$. As it is customary in the literature, we postulate that each individual's total return from work in region i is $f^i(n_i)/n_i$. This is equivalent to postulating that each worker in region i gets a wage w_i, which equals the marginal product of labor, plus an equal share of the regional profit, $\pi^i/n_i = \left[f^i(n_i) - n_i w_i\right]/n_i$.

The numeraire good may be used for consumption, as input in the provision of public goods and as a source of funds to finance interregional transfers. For simplicity, we assume that it takes one unit of the numeraire good to produce one unit of the public good. Region i may utilize t_{ij} units of the numeraire good to make an income transfer to region j, $i, j = 1,2$, $i \neq j$. Hence, the total cost incurred by region $i's$ government is simply $G_i + t_{ij} - t_{ji}$, where t_{ji} represents the non-negative transfer received from region j. Since there are n_i residents in region i, this region's resource constraint is

$$n_i x_i + G_i + t_{ij} - t_{ji} = f^i(n_i), \qquad i = 1,2. \tag{2}$$

We assume that region $i's$ welfare function is Rawlsian. This egalitarian regional objective is present in constitutional statements of many federations, including the European Union. According to these statements, every citizen should be treated equally and be given equal opportunities in spite of his or her individual characteristics and of his or her residential location. Although one does not typically observe perfect equality in such federations, their governments exert considerable effort in reducing inequities. In terms of the standard attachment model, which we adopt here, this ideal is better captured by assuming a regional objective function in which the utility of the least off resident is maximized. This objective function minimizes the differences in residential utilities.

In the standard attachment model, the least off individual in region 1 is individual n_1 th, namely, the individual who is indifferent between regions. This is also the individual who gets the lowest utility in region 2. Hence, the individual who is indifferent between residing in region 1 and region 2 is the one whose utility is maximized by each regional government.

The regions play a simultaneous non-cooperative game in full anticipation of how their choices influence migration decisions. Region 1 chooses $\{G_1, t_{12}\}$ to maximize

$$u^1\left(\frac{f^1(n_1)-G_1-t_{12}+t_{21}}{n_1}, G_1, G_2\right)+a(N-n_1) \tag{3a}$$

s.t.: $n_1 = n^1(G_1, G_2, t_{12}, t_{21})$, $G_1 \in \left[0, f^1(n_1)+t_{21}\right]$, $t_{12} \in \left[0, f^1(n_1)+t_{21}\right]$, taking $\{G_2, t_{21}\}$ as given. Region 2 chooses $\{G_2, t_{21}\}$ to maximize

$$u^2\left(\frac{f^2(n_2)-G_2-t_{21}+t_{12}}{n_2}, G_2, G_1\right)+an_1 \tag{3b}$$

s.t.: $n_2 = n^2(G_1, G_2, t_{12}, t_{21})$, $G_2 \in \left[0, f^2(n_2)+t_{12}\right]$, $t_{21} \in \left[0, f^2(n_2)+t_{12}\right]$, $n^2(\cdot) = N - n^1(\cdot)$, taking $\{G_1, t_{12}\}$ as given. The migration response function, $n^1(\cdot)$, is implicitly defined by the migration equilibrium condition

$$u^1\left(\frac{f^1(n_1)-G_1-t_{12}+t_{21}}{n_1},G_1,G_2\right)+a(N-n_1)$$
$$=u^2\left(\frac{f^2(n_2)-G_2-t_{21}+t_{12}}{n_2},G_2,G_1\right)+an_1, \tag{4}$$

which follows from solving the resource constraints for x_i, $i=1,2$, letting $n_2=N-n_1$ and then plugging all the results into the migration equilibrium equation (1).

Let us derive the resource allocation resulting from interregional competition. Assuming that $G_1 \in \left(0, f^1(n_1)+t_{21}\right)$ and $t_{12} \in \left(0, f^1(n_1)+t_{21}\right)$, we obtain

$$U^1_{n_1}n^1_{G_1}-\frac{u^1_x}{n_1}\left(1-n_1\frac{u^1_{G_1}}{u^1_x}\right)=0, \tag{5a}$$

$$\left(U^1_{n_1}n^1_{t_{12}}-\frac{u^1_x}{n_1}\right)\le 0,\ t_{12}\ge 0,\ t_{12}\left(U^1_{n_1}n^1_{t_{12}}-\frac{u^1_x}{n_1}\right)=0, \tag{5b}$$

where $U^1_{n_1}=\left(u^1_x/n_1\right)\left(f^1_n-x_1\right)-a.$[1]

Close inspection of equations (5a) and (5b) reveal that we need to obtain the migration response functions in order to find clear-cut first order conditions. Differentiating equation (4) with respect to the strategic variables yields

$$n^1_{G_1}=\left[\left(u^1_x/n_1\right)-u^1_{G_1}+u^2_{G_1}\right]/D, \tag{6a}$$

$$n^1_{G_2}=\left[-u^1_{G_2}-\left(u^2_x/n_2\right)+u^2_{G_2}\right]/D, \tag{6b}$$

$$n^1_{t_{12}}=\left[\left(u^1_x/n_1\right)+\left(u^2_x/n_2\right)\right]/D, \tag{6c}$$

$$n^1_{t_{21}}=-\left[\left(u^1_x/n_1\right)+\left(u^2_x/n_2\right)\right]/D. \tag{6d}$$

[1] Throughout this paper, we use superscript to denote functions and subscript to denote variables, parameters and partial derivatives of functions.

where $D \equiv U_{n_1}^1 + U_{n_2}^2$ and $U_{n_2}^2 = \left(u_x^2 / n_2\right)\left(f_n^2 - x_2\right) - a$. Since we wish to examine situations where the migration equilibrium is stable, we shall assume that $D < 0$ throughout this paper.

Substituting equations (6a) and (6c) into (5a) and (5b) respectively gives us

$$n_1 \frac{u_{G_1}^1}{u_x^1} + n_2 \frac{u_{G_1}^2}{u_x^2} \left(\frac{\left(f_n^1 - x_1\right) - a\left(n_1 / u_x^1\right)}{\left(f_n^2 - x_2\right) - a\left(n_2 / u_x^2\right)} \right) = 1, \tag{7a}$$

$$\left(f_n^1 - x_1\right) - \left(f_n^2 - x_2\right) \geq a\left(\frac{n_1}{u_x^1} - \frac{n_2}{u_x^2} \right), t_{12} \geq 0,$$

$$t_{12}\left(\left(f_n^1 - x_1\right) - \left(f_n^2 - x_2\right) - a\left(\frac{n_1}{u_x^1} - \frac{n_2}{u_x^2} \right) \right) = 0. \tag{7b}$$

Adopting similar reasoning for the conditions that solve the problem faced by regional government 2, we have

$$n_1 \frac{u_{G_2}^1}{u_x^1} \left(\frac{\left(f_n^2 - x_2\right) - a\left(n_2 / u_x^2\right)}{\left(f_n^1 - x_1\right) - a\left(n_1 / u_x^1\right)} \right) + n_2 \frac{u_{G_2}^2}{u_x^2} = 1, \tag{8a}$$

$$\left(f_n^1 - x_1\right) - \left(f_n^2 - x_2\right) \leq a\left(\frac{n_1}{u_x^1} - \frac{n_2}{u_x^2} \right), t_{21} \geq 0,$$

$$t_{21}\left(\left(f_n^1 - x_1\right) - \left(f_n^2 - x_2\right) - a\left(\frac{n_1}{u_x^1} - \frac{n_2}{u_x^2} \right) \right) = 0. \tag{8b}$$

Conditions (7b) and (8b) imply that the regions make interregional transfers to each other in equilibrium. Combining conditions (7b) and (8b), we obtain

$$\left(f_n^1 - x_1\right) - \frac{an_1}{u_x^1} = \left(f_n^2 - x_2\right) - \frac{an_2}{u_x^2} < 0, \tag{9a}$$

where we know that each side of equation (9a) is negative because this equation implies that $D = \left[\left(u_x^1/n_1\right) + \left(u_x^2/n_2\right)\right]\left[\left(f_n^2 - x_2\right) - a\left(n_2/u_x^2\right)\right]$ and $D < 0$ by the stability condition for the migration equilibrium. Plugging equation (9a) into equations (7a) and (8a), respectively, gives us

$$n_1 \frac{u^1_{G_1}}{u^1_x} + n_2 \frac{u^2_{G_1}}{u^2_x} = 1, \tag{9b}$$

$$n_1 \frac{u^1_{G_2}}{u^1_x} + n_2 \frac{u^2_{G_2}}{u^2_x} = 1. \tag{9c}$$

The Nash equilibrium is characterized by equations (2), (4), (9a)-(9c). Equation (9a) is the efficient population distribution condition (See, e.g., Mansoorian and Myers 1993, Wellisch 1994, and Caplan *et al*. 2000). It informs us that the net marginal regional cost of population size should be equated across regions. Equations (9b) and (9c) are the familiar Samuelson conditions for optimal provision of the public good in each region. Each condition states that the sum of the marginal rates of substitution between the public good and the private good, where the sum includes marginal rates of substitution for residents and non-residents, should be equal to the marginal rate of transformation between the public good and the private good.

Let $\{G_1^*, G_2^*, t_{12}^*, t_{21}^*\}$ be the solution to equations (9a)-(9c). From equation (4) we have $n_1^* = n^1(G_1^*, G_2^*, t_{12}^*, t_{21}^*)$ and $n_2^* = n^2(G_1^*, G_2^*, t_{12}^*, t_{21}^*) \equiv N - n^1(G_1^*, G_2^*, t_{12}^*, t_{21}^*)$.

3. Centralized Allocations

Our main objective in this section is to show that the Nash equilibrium allocation derived in the previous section is Pareto efficient. We will demonstrate that it corresponds to the optimal allocation implemented by a central authority for each of three different objective functions: Rawlsian, Utilitarian and Cobb-Douglas.

3.1 Rawlsian Preferences

In this section, we characterize the center's optimal allocation when the center's preferences over regional welfare levels are Rawlsian. We shall assume that the center implements interregional income transfers across regions denoted by τ_i, where $\sum_i \tau_i \equiv 0$. If it is positive (negative), region i receives the transfer from (pays the transfer to) the center. The region's constraint is:

$$n_i x_i + G_i = f^i(n_i) + \tau_i, \qquad i = 1,2. \tag{10}$$

We assume that the center wishes to maximize the following function:

$$\begin{aligned} W^R(U_1, U_2) = Min\Bigg\{ & \left[u^1\left(\frac{f^1(n_1) - G_1 + \tau_1}{n_1}, G_1, G_2 \right) + a(N - n_1) \right], \\ & \left[u^2\left(\frac{f^2(n_2) - G_2 + \tau_2}{n_2}, G_2, G_1 \right) + a n_1 \right] \Bigg\}. \end{aligned} \tag{11}$$

We shall assume that each individual chooses his or her residential location after knowing the policy decisions made by the center. Hence, the migration equilibrium is characterized by

$$\begin{aligned} & u^1\left(\frac{f^1(n_1) - G_1 + \tau_1}{n_1}, G_1, G_2 \right) + a(N - n_1) \\ & = u^2\left(\frac{f^2(N - n_1) - G_2 + \tau_2}{N - n_1}, G_2, G_1 \right) + a n_1. \end{aligned} \tag{12}$$

Equation (12) implicitly defines n_1 as a function of $\{G_1, G_2, \tau_1, \tau_2\}$, $\hat{n}^1(G_1, G_2, \tau_1, \tau_2)$.[2] For future reference, we obtain the following migration responses.

$$\hat{n}^1_{G_1} = \left[(u^1_x / n_1) - u^1_{G_1} + u^2_{G_1} \right] / D_1, \tag{13a}$$

$$\hat{n}^1_{G_2} = \left[-u^1_{G_2} - (u^2_x / n_2) + u^2_{G_2} \right] / D_1, \tag{13b}$$

$$\hat{n}^1_{\tau_1} = -(u^1_x / n_1) / D_1, \tag{13c}$$

[2] The implicit function possess an upper hat " ^ " in this section in order to distinguish them from the implicit functions derived in the other sections.

$$\hat{n}^1_{\tau_2} = \left(u^2_x / n_2\right) / D_1 , \tag{13d}$$

where $D_1 \equiv U^1_{n_1} + U^2_{n_2} = \left(u^1_x / n_1\right)\left(f^1_n - x_1\right) + \left(u^2_x / n_2\right)\left(f^2_n - x_2\right) - 2a < 0.$

The center chooses $\{G_1, G_2, \tau_1, \tau_2\}$ to maximize $u^1(\cdot) + a(N - n_1)$ subject to $\sum_i \tau_i \equiv 0$ and $\hat{n}^1(G_1, G_2, \tau_1, \tau_2)$. Let λ be the Lagrange multiplier associated with the income transfer constraint. Assume that $G_1 \in \left(0, f^1(n_1) + \tau_1\right)$, $G_2 \in \left(0, f^2(n_2) + \tau_2\right)$. Then, we have the following first order conditions:

$$U^1_{n_1} \hat{n}^1_{G_1} - \frac{u^1_x}{n_1}\left(1 - n_1 \frac{u^1_{G_1}}{u^1_x}\right) = 0, \tag{14a}$$

$$U^1_{n_1} \hat{n}^1_{G_2} + u^1_{G_2} = 0, \tag{14b}$$

$$U^1_{n_1} \hat{n}^1_{\tau_1} + \left(\frac{u^1_x}{n_1}\right) - \lambda = 0, \tag{14c}$$

$$U^1_{n_1} \hat{n}^1_{\tau_2} - \lambda = 0. \tag{14d}$$

Combining equations (14c) and (14d), inserting equations (13c) and (13d) into the equation derived and rearranging its equation yields,

$$\left(f^1_n - x_1\right) - \left(f^2_n - x_2\right) = a\left(\frac{n_1}{u^1_x} - \frac{n_2}{u^2_x}\right). \tag{15a}$$

Given equation (15a), substitute equations (13a) and (13b) into (14a) and (14b) respectively to obtain

$$n_1 \frac{u^1_{G_1}}{u^1_x} + n_2 \frac{u^2_{G_1}}{u^2_x} = 1, \tag{15b}$$

$$n_1 \frac{u^1_{G_2}}{u^1_x} + n_2 \frac{u^2_{G_2}}{u^2_x} = 1. \tag{15c}$$

The center's optimal allocation is the solution to equations (10), (12), (15a)-(15c). Comparing this efficient allocation with the decentralized Nash equilibrium allocation derived in the previous section, we find that they are identical. We gather this important result in Proposition 1 below.

Proposition 1. *Suppose that each regional government maximizes the utility of the least off resident. Suppose also that the central government's objective function is Rawlsian in the sense that the center maximizes the lowest regional utility. Then, the allocation resulting from the Nash equilibrium corresponds to the center's most preferred allocation.*

Wellisch (1994) shows that in the presence of interregional spillovers and labor attachment to regions at least one region is transfer-constrained and the constrained region under-provides its public good. Regional objective functions disagree because each regional government wishes to maximize the common component of each resident's utility function, namely, the sub-utility function that expresses the utility from consumption of private and public goods. Each resident's utility is given by the sum of this sub-utility and the idiosyncratic utility from attachment. As each regional government neglects their residents' utilities from attachment, their objective functions coincide only when the attachment intensity parameter is zero; that is, when there is perfect mobility. Incentive equivalence fails in his model because of his assumption regarding regional objective functions. [3] As a result, the decentralized Nash equilibrium is inefficient.

Our paper contributes to the literature by demonstrating that decentralization is not necessarily inefficient in the standard regional attachment model. If the regional governments' objective functions are Rawlsian, their incentives are perfectly aligned in the

[3] See e.g., Myers (1990), Mansoorian and Myers (1993) and Wellisch (1994).

decentralized equilibrium. Hence, they optimally choose the allocation that maximizes the sum of both regions' payoffs. The implied Nash equilibrium allocation is Pareto efficient.

3.2 Utilitarian Preferences

Let us now suppose that the center is Utilitarian. For this, we assume that the center has the following modified Benthamite objective over the regional welfare levels:

$$\begin{aligned} W^B(U_1, U_2) = \theta &\left[u^1\left(\frac{f^1(n_1) - G_1 + \tau_1}{n_1}, G_1, G_2 \right) + a(N - n_1) \right] \\ &+ (1-\theta)\left[u^2\left(\frac{f^2(n_2) - G_2 + \tau_2}{n_2}, G_2, G_1 \right) + an_1 \right], \end{aligned} \tag{16}$$

where $\theta \in [0,1]$. For a fixed θ, the center chooses $\{G_1, G_2, \tau_1, \tau_2\}$ to maximize its objective (16) subject to $\sum_i \tau_i \equiv 0$ and $\overline{n}^1(G_1, G_2, \tau_1, \tau_2)$.[4]

Assuming that $G_1 \in (0, f^1(n_1) + \tau_1)$ and $G_2 \in (0, f^2(n_2) + \tau_2)$, the first order conditions are

$$\left(\theta U_{n_1}^1 - (1-\theta)U_{n_2}^2\right)\overline{n}_{G_1}^1 - \frac{\theta u_x^1}{n_1}\left(1 - n_1 \frac{u_{G_1}^1}{u_x^1}\right) + \frac{(1-\theta)u_x^2}{n_2}\left(n_2 \frac{u_{G_1}^2}{u_x^2}\right) = 0, \tag{17a}$$

$$\left(\theta U_{n_1}^1 - (1-\theta)U_{n_2}^2\right)\overline{n}_{G_2}^1 + \frac{\theta u_x^1}{n_1}\left(n_1 \frac{u_{G_2}^1}{u_x^1}\right) - \frac{(1-\theta)u_x^2}{n_2}\left(1 - n_2 \frac{u_{G_2}^2}{u_x^2}\right) = 0, \tag{17b}$$

$$\left(\theta U_{n_1}^1 - (1-\theta)U_{n_2}^2\right)\overline{n}_{\tau_1}^1 + \frac{\theta u_x^1}{n_1} - \mu = 0, \tag{17c}$$

$$\left(\theta U_{n_1}^1 - (1-\theta)U_{n_2}^2\right)\overline{n}_{\tau_2}^1 + \frac{(1-\theta)u_x^2}{n_2} - \mu = 0, \tag{17d}$$

[4] The implicit function possess an upper bar " - " in this section.

where μ is the Lagrangian multiplier associated with the income transfer constraint. Combining equations (13c), (13d), (17c) and (17d) and then rearranging the equation yields condition (15a). Given equation (15a), substitute equations (13a) and (13b) into (17a) and (17b) respectively to obtain equations (15b) and (15c). Hence, the Utilitarian optimum corresponds to the Rawlsian optimum characterized in the previous section: it is the solution to equations (10), (12), (15a)-(15e).

3.3 Cobb-Douglas Preferences

Suppose now that the center exhibits Cobb-Douglas preferences over regional welfare levels. The planner chooses $\{G_1, G_2, \tau_1, \tau_2\}$ to maximize

$$\begin{aligned} W^{CD}(U_1,U_2) &= \left[u^1\left(\frac{f^1(n_1) - G_1 + \tau_1}{n_1}, G_1, G_2 \right) + a(N - n_1) \right] \\ &\times \left[u^2\left(\frac{f^2(n_2) - G_2 + \tau_2}{n_2}, G_2, G_1 \right) + a n_1 \right], \end{aligned} \tag{18}$$

subject to $\sum_i \tau_i \equiv 0$ and $\tilde{n}^1(G_1, G_2, \tau_1, \tau_2)$.[5]

The first order conditions are characterized by the following equations provided that $G_1 \in (0, f^1(n_1) + \tau_1)$ and $G_2 \in (0, f^2(n_2) + \tau_2)$.

$$\left(U_2 U^1_{n_1} - U_1 U^2_{n_2}\right)\tilde{n}^1_{G_1} - \frac{u^1_x}{n_1}\left(1 - n_1 \frac{u^1_{G_1}}{u^1_x}\right)U_2 + \frac{u^2_x}{n_2}\left(n_2 \frac{u^2_{G_1}}{u^2_x}\right)U_1 = 0, \tag{19a}$$

$$\left(U_2 U^1_{n_1} - U_1 U^2_{n_2}\right)\tilde{n}^1_{G_2} + \frac{u^1_x}{n_1}\left(n_1 \frac{u^1_{G_2}}{u^1_x}\right)U_2 - \frac{u^2_x}{n_2}\left(1 - n_2 \frac{u^2_{G_2}}{u^2_x}\right)U_1 = 0, \tag{19b}$$

$$\left[\left(U_2 U^1_{n_1} - U_1 U^2_{n_2}\right)\tilde{n}^1_{\tau_1} + \left(u^1_x / n_1\right)U_2\right] - \delta = 0, \tag{19c}$$

[5] The implicit function possess an upper wave line “ ~ “ in this section.

$$\left[\left(U_2 U_{n_1}^1 - U_1 U_{n_2}^2\right)\tilde{n}_{\tau_2}^1 + \left(u_x^2 / n_2\right) U_1\right] - \delta = 0, \tag{19d}$$

where δ is the Lagrangian multiplier associated with the transfer constraint.

By using the same method as in the previous section, it is now straightforward to show that this efficient allocation corresponds to the Rawlsian solution. Combining equations (13c), (13d), (19c) and (19d) yields equation (15a). We can find equations (15b) and (15c) by inserting equations (13a) and (13b) into equations (19a) and (19b) respectively and using equation (15a). Hence, the Cobb-Douglas efficient allocation corresponds to the Rawlsian solution: it is given by equations (10), (12), (15a)-(15e). We gather the efficiency results in Proposition 2.

Proposition 2. *Suppose that each regional government maximizes the utility of the least off resident. Then, the allocation resulting from the Nash equilibrium is Pareto efficient and corresponds to the central authority's most preferred allocation if the center's objective function is Rawlsian, Utilitarian or Cobb-Douglas.*

4. Conclusion

We examine decentralized regional policy making in the presence of interregional spillovers and labor attachment to their home regions. We utilize the standard regional attachment model, which in the presence of spillovers is identical to Wellisch's model. The critical difference between our approach and Wellisch's is that we consider a situation in which regional welfare functions account for the utility of attachment. In our setting, each regional government wishes to maximize the utility of the least off resident, which in the standard regional attachment model implies that each regional government wishes to maximize the utility of the resident who is indifferent between regions. Hence, in accordance with this regional Rawlsian criterion, the Nash equilibrium for the decentralized game is Pareto efficient and corresponds to the centralized optimal allocation for various objective functions, including Rawlsian, Utilitarian and Cobb-Douglas. An immediate implication of our analysis is that regional policy decentralization is not necessarily inefficient in federations characterized by regional attachment benefits, such as Canada and the European Union.

References

Caplan, A.J., Cornes, R.C. and Silva, E.C.D., 2000. Pure public goods and income redistribution in a federation with decentralized leadership and imperfect labor mobility. *Journal of Public Economics 77*, 265-284.

Mansoorian, A. and Myers, G.M., 1993. Attachment to home and efficient purchases of population in a fiscal externality economy. *Journal of Public Economics 52*, 117-132.

Myers, G.M., 1990. Optimality, free mobility, and the regional authority in a federation. *Journal of Public Economics 43*, 107-121.

Wellisch, D., 1994. Interregional spillovers in the presence of perfect and imperfect household mobility. *Journal of Public Economics 55*, 167-184.