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An Efficiency Case for
Cost Equalisation in a
Regional Economy with
Migration Externalities

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An efficiency case for cost equalisation in a regional economy with migration externalities

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Abstract

Cost equalisation, which redistributes income from low to high cost sub-national regions, is practised in many unitary and federal countries as part of broader schemes designed to equalise fiscal capacities. While these policies are motivated by equity, in this paper I show that under plausible circumstances cost equalisation enhances economic efficiency. The rationale for this striking result has to do with the way that cost differences across regions interact with externalities caused by migration and the role of inter-regional transfers as a corrective instrument. By providing an efficiency rationale for cost equalisation, the paper builds a more effective bridge between the theory and practice of fiscal equalisation.

Key Words: federalism, intergovernmental relations, inter-governmental differentials and their effects, federal state relations.

JEL: H73, H77.

1 Introduction

A survey of fiscal equalisation by Blochliger and Charbit (2008) identified eighteen countries undertaking cost equalisation between sub-national regions. Of these, ten are unitary states which include the United Kingdom, Sweden, Japan and Norway.¹ The rest are federal/regional countries such as Germany, Canada, Australia, Italy and Mexico. Most countries operate schemes of vertical cost equalisation whereby the central government adjusts the provision of sub-national services to account for higher cost, though in some -Australia, Norway and Sweden - it is overtly horizontal.

Conceptually, cost equalisation can arise from two sources. One takes account of differences across jurisdictions in the per unit cost of providing local public goods due to economies of scale, production technology and input costs. For example, the Australian system takes into account inter-regional differences in wage rates for public servants and scale economies. Another source adjusts for inter-regional public good cost differences arising from expenditure needs caused by socio-demographic features of local populations, density/dispersion or remoteness. In practice, equalisation schemes often include both aspects of cost equalisation using a costed

¹See Table 4, page 13, of their paper.

norms approach to estimating inter-jurisdictional cost differences (see Reschovsky (2007)). With this approach, only those cost differences outside of local control are subject to cost equalisation.

Generally speaking, cost equalisation is conducted as part of broader fiscal capacity equalisation schemes which include revenue equalisation. Fiscal equalisation aims to equalise the fiscal capacity of disparate regions. If full equalisation is achieved, each region is able to provide the same standard of services to its citizens while imposing the same tax burden. Therefore, traditionally cost equalisation has its rationale in notions of inter-regional equity, not efficiency.

The net effect of cost equalisation, whether it derives from regional differences in input costs or expenditure needs, or takes a horizontal or vertical form, is to redistribute income *from* low to high cost jurisdictions. Its redistributive effect is often as large in numerical terms as the redistribution resulting from revenue equalisation and can make up one to two percent of a sub-national region's output. This makes the question of whether cost equalisation has efficiency costs (or benefits) an important one. As economists, we might reasonably conjecture that it has efficiency costs. A policy which transfers income and encourages migration from low to high cost jurisdictions would seem to be inefficient since it encourages more output of relatively high cost local services. Surely, on economic efficiency grounds the preferred policy is to encourage labour and capital to locate in low cost regions? This view prevails in the fiscal federalism literature. It is nicely summarized by Albouy (2012) who writes that with regard to local public good prices '...variations in these prices due either to factor costs or production efficiency are to be ignored. When prices are set efficiently, they represent the opportunity cost of scarce factors for producing tradeable output. Subsidising households to live in areas where providing local services costs more ignores these opportunity costs and leads to inefficient use of scarce factors'².

In this paper, I seek to convince the reader that in a world of labour migration externalities, which call for corrective inter-regional transfers, the opposite is, in fact, true. Specifically, I set out to show that there are highly plausible circumstances under which cost equalisation in favour of high cost regions, as we see in the practice of equalisation, is efficiency enhancing. This striking and apparently counter-intuitive result contrasts with the dominant view that cost equalisation in favour of high cost states is inefficient. It also provides theoretical support for what we see in practice - cost equalisation programs which redistribute income from low to high cost regions to equalise fiscal capacities. In this sense, I hope my results provide something of a firmer bridge between the theory of equalisation and its practice. If, indeed, my result is correct, then I have a case where efficiency and equity goals are one and the same - equalising fiscal capacities is also efficiency enhancing.

To explain the idea, I develop an efficiency-in-migration model of a federation which is entirely standard (see Boadway (2004) for a survey). An important feature of these models is that, in contrast to a Tiebout world, free migration creates externalities which can be corrected for by an inter-state transfer. Within this framework, I suppose two states and a federal agency play a three stage game with Nash conjectures. The timing of moves is the same as in Caplan

²See Albouy (2012) page 827.

et al. (2000). Hence, states move first as Stackleberg leaders to choose provision of congested local public goods to maximise within-state welfare subject to feasibility and an equal utility constraint arising from free labour migration. In stage 2 the federal agency chooses the corrective inter-regional transfer to maximise national social welfare. This maximisation is also subject to feasibility and the equal utility condition. Mobile labour chooses its location in the final stage conditional on state and federal policies. When making their choices states play Nash, make their choices simultaneously and correctly anticipate the federal transfer and labour location choices. In choosing its transfer, the federal agency takes state policies as given and correctly anticipates labour location choices.

A sub-game perfect equilibrium to the game is then characterised and explained. It is important for the reader to know that up to this point my analysis is standard and tells us nothing new about how corrective transfers work in a world of migration externalities. However, what follows is, I believe, novel, and does advance our knowledge of corrective inter-state transfers, especially of how they respond to region-specific price shocks. In particular, I examine the effects of an exogenous increase in the price of local public goods in each region on the equilibrium transfer chosen by the federal agency. This I do by using the implicit function theorem to derive an expression which shows how the equilibrium transfer changes in response to increases in the local public good price in a region. I then show that if two restrictions are satisfied, a region's corrective transfer is *increasing* in its local public good cost, for a given cost in the neighbouring region. What is more, I am able to demonstrate that these restrictions are automatically satisfied if a free migration equilibrium exists, is unique and stable. Finally, I provide an explanation of what are essentially mathematical results on the transfer response to exogenous price shocks. My explanation exposes the unique role of migration externalities in causing the directional relationship between the corrective transfer and changes in regional local public good costs.

The outline is as follows. Section 2 below sets up the efficiency-in-migration model of a federation. Section 3 solves the Pareto efficient problem for this federation and establishes the benchmark conditions that must be satisfied for efficiency. Section 4 develops the state-federal equalisation game and looks at its equilibrium properties, focussing on the transfer chosen by the federal agency. Section 5 shows, as a backdrop for the results, that the equilibrium transfer is non-zero since it corrects for various migration externalities. Section 6 develops the key result in relation to transfers in favour of high cost states while the discussion in Section 7 concludes. Mathematical details are placed in Annex A and B.

2 Model of a federation

Consider a federal economy with $i = 1, 2$ states each with a benevolent government providing a single local public good denoted as G_i . The federation also has a benevolent central agency which chooses a lump sum inter state transfer, ρ . A given labour supply, N , migrates freely across states. On the assumption that citizens have homogeneous preferences the analysis is conducted in terms of a representative person from each state. A citizen also supplies one unit of labour so N is the (given) labour supply for the federation. Denoting n_i as the population

(labour supply) of state i , for $i = 1, 2$, the following labour supply constraint must hold:

$$N = n_1 + n_2. \quad (2.1)$$

The production process in each state uses three inputs. One is the mobile labour defined above. Assuming a competitive labour market it receives a wage, w_i , equal to its marginal product. The second input is foreign-owned capital denoted as k_i for $i = 1, 2$. This input is assumed to be in fixed supply within each state. It has the same price across states which is equal to some given world return, r . The remaining input - an un-priced natural resource - is also in fixed supply within each state. States produce a numeraire using a continuous, increasing and quasi-concave production technology. Since labour supply is the only variable input this can be expressed as

$$f_i(n_i) \quad i = 1, 2. \quad (2.2)$$

Supposing the price of the numeraire is one, $f_i(n_i)$ also defines the value of output. With diminishing returns to labour:

$$\frac{\partial f_i(n_i)}{\partial n_i} = w_i > 0, \quad \frac{\partial w_i}{\partial n_i} < 0 \quad i = 1, 2. \quad (2.3)$$

where $\partial w_i / \partial n_i$ is the change in the wage rate (marginal product) as labour supply varies. The total economic rent generated in state i ,

$$R_i = f_i(n_i) - w_i n_i - r k_i, \quad i = 1, 2. \quad (2.4)$$

is the difference between the value of output and the payments to mobile labour and foreign-owned capital.

The total income accruing to citizens in state i is equal to their wage income and some share, determined by the parameter $0 \leq \beta_i \leq 1$, of the economic rent generated within the state. This parameter captures the degree of rent capture in state i for $i = 1, 2$. This can vary across states with $\beta_i = 0$ implying no rent capture - all rents accrue to foreigners - and $\beta_i = 1$ meaning there is full rent capture. As shown by Wildasin and Wilson (1998) the burden of local rent capture is exported to foreigners so one would expect $\beta_i = 1$. Citizen income in state i is $I_i = w_i n_i + \beta_i R_i$ which, using (2.4), is

$$I_i = (1 - \beta_i) w_i n_i + \beta_i (f_i(n_i) - r k_i) \quad i = 1, 2. \quad (2.5)$$

In the event that $\beta_i = 1$ citizens of the state are residual claimants with $I_i = f_i(n_i) - r k_i$. At the other extreme, if $\beta_i = 0$ there is no rent capture in state i and citizens earn only their wage income so that $I_i = w_i n_i$.

A representative citizen of state i has a continuous, quasi concave direct utility function,

$$u_i = x_i + v(g_i) \quad i = 1, 2. \quad (2.6)$$

where x_i is per capita consumption of a pure private good and g_i is the benefit received from each unit of the public good produced in state i . It is supposed that the private good price is given and the same in each state. This can be rationalised by supposing that x_i is a traded good with a given world supply price. For convenience this price is set equal to one. The price of the local public good is assumed to be given and denoted by c_i where $i = 1, 2$.

Public good output and the benefit received by citizens are linked by the relationship

$$g_i = \frac{G_i}{n_i^\alpha} \quad i = 1, 2, \quad (2.7)$$

where α is a congestion parameter assumed to be the same across states. If $\alpha = 0$, then $g_i = G_i$ and state i provides a pure local public good while if $\alpha = 1$ we have $g_i = G_i/n_i$ and state i provides a pure private good. For alpha between zero and one the state-provided good is mixed. Note that g_i is the choice variable of state i , not G_i .

Define the state government strategy set as $g = \{g_1, g_2\}$. The strategy set for all decision makers in the federation is then

$$s = \{g, \rho\}. \quad (2.8)$$

Free mobility implies that the following equal utility condition must also be satisfied:

$$x_1 + v(g_1) = x_2 + v(g_2). \quad (2.9)$$

One can allow for migration costs, but if symmetric, as assumed here, they can be ignored. Attachment to place can also be incorporated (see Mansoorian and Myers (1993)) though this does not change the conclusions. Therefore, I proceed without allowing for migration costs or attachment. This enables the results to be presented with minimal complexity.³

Denote the given per unit cost of the public good as c_i where $i = 1, 2$. The per unit public good cost can differ across states. This is justified on the basis that local public goods are not traded goods. Hence, one would not expect price equalisation across states or that local public good prices would equal some world supply price.

The budget constraint for a state can now be defined as

$$x_i n_i \pm \rho - c_i G_i = f_i(n_i) \quad i = 1, 2. \quad (2.10)$$

Per capita private good consumption for state i becomes

$$x_i = \left\{ \frac{(1 - \beta_i)w_i n_i + \beta_i [f_i(n_i) - r k_i] \pm \rho - c_i G}{n_i} \right\} \quad i = 1, 2. \quad (2.11)$$

³Results with attachment to place are available on request.

Using this, together with $n_2 = (N - n_1)$ to eliminate n_2 , the equal utility condition is:

$$\left\{ \frac{(1 - \beta_1)w_1n_1 + \beta_1[f_1(n_1) - rk_1] - \rho - c_1G}{n_1} \right\} + v(g_1) = \left\{ \frac{(1 - \beta_2)w_2n_2 + \beta_2[f_2(N - n_1) - rk_2] + \rho - c_2G_2}{n_2} \right\} + v(g_2). \quad (2.12)$$

From the equal utility condition, implicitly, n_1 is a function of $s = (g, \rho)$ and one can define

$$n_1 = n_1(s). \quad (2.13)$$

Using the constraint $n_1 + n_2 = N$ labour supply to state 2 is also, implicitly, a function of state and federal policies, that is, $n_2 = n_2(s)$.

3 Pareto efficiency

In this section I explore the first order necessary conditions that support a Pareto optimal outcome for the federation postulated above. These conditions allow me to assess the efficiency properties of the policy game between states and the federal agency developed in the next section. This, in turn, is important for establishing the results of the paper.

The conditions necessary for optimality are derived by invoking the assumption, common in the fiscal federalism literature, that a mythical central planner can directly choose per capita private good consumption, local public good provision and the labour supply in each state in order to maximise utility in either state 1 or state 2, subject to the equal utility constraint, feasibility and the total labour supply condition. Formally, the planner chooses x_i , g_i and n_i , for $i = 1, 2$, to maximise

$$u_1 = \left\{ \frac{(1 - \beta_1)w_1n_1 + \beta_1[f_1(n_1) - rk_1] - c_1n_1^\alpha g_1}{n_1} \right\} + v(g_1) \quad (3.1)$$

subject to the following constraints:

$$(i) \quad x_1 + v(g_1) = x_2 + v(g_2) \quad (3.2)$$

$$(ii) \quad n_1x_1 + n_2x_2 - c_1n_1^\alpha g_1 - c_2n_2^\alpha g_2 = (1 - \beta_1)w_1n_1 + \beta_1(f_1(n_1) - rk_1) + (1 - \beta_2)w_2n_2 + \beta_2(f_2(n_2) - rk_2) \quad (3.3)$$

$$(iii) \quad n_1 + n_2 = N. \quad (3.4)$$

This is in large part similar to the formulation in Myers (1990), except that in my set up the planner is constrained to find a solution on the utility possibilities frontier defined between a citizen of state 1 and her counterpart in state 2 consistent with free migration (equal per capita utilities). By contrast, in Myers (1990) the equal utility condition is replaced by a constraint which holds utility in state 2 at some particular level, that is, $u_2 = \bar{u}_2$. With either formulation the same set of first order necessary conditions for local public good provision and the spatial

allocation of labour are obtained but my planner solution is constrained to be at the point where the 45 degree line from the origin intersects with the utility possibilities frontier. In contrast, a solution which holds state 2 utility at some particular level while maximising per capita utility in state 1 finds a solution on the frontier consistent with this constraint.

The Lagrangian for the maximisation problem is:

$$\begin{aligned} Z = & u_1(x_1, g_1) + \lambda[x_1 + v(g_1) - x_2 - v(g_2)] \\ & + \lambda_2 \{(1 - \beta_1)w_1n_1 + \beta_1(f_1(n_1) - rk_1) + (1 - \beta_2)w_2n_2 + \beta_2(f_2(n_2) - rk_2) \\ & - n_1x_1 - n_2x_2 - c_1n_1^\alpha g_1 - c_2n_2^\alpha g_2\} + \lambda_3[N - n_1 - n_2]. \end{aligned} \quad (3.5)$$

Solving yields the following first order necessary conditions for local public good provision and the supply of labour to each state:

$$n_i^{1-\alpha}v_{g_i} = c_i \quad (3.6)$$

$$\mu_1 = \mu_2, \quad (3.7)$$

where

$$\mu_1 = \left\{ w_1 - x_1 + (1 - \beta_1)n_1 \frac{\partial w_1}{\partial n_1} - \alpha \frac{c_1 G_1}{n_1} \right\}; \quad \mu_2 = \left\{ w_2 - x_2 + (1 - \beta_2)n_2 \frac{\partial w_2}{\partial n_2} - \alpha \frac{c_2 G_2}{n_2} \right\}$$

are the social marginal benefits of adding a unit of labour to states 1 and 2 respectively. For state 1 the social marginal benefit is equal to the marginal product of an extra worker, w_1 , less their per capita consumption, x_1 , plus their impact on the wage income of all citizens captured by $(1 - \beta_1)n_1(\partial w_1/\partial n_1)$, less their congestion adjusted contribution to the cost of providing the state's local public good, $\alpha c_1 G_1/n_1$. The same interpretation applies to state 2.

I conclude here that Pareto optimality requires local public goods to be provided according to the Samuelson condition, (3.6), and that mobile labour is allocated across states to equate social marginal benefits, as given by (3.7). In addition, constraints (3.2) to (3.4) must be satisfied. If these conditions hold the planner's maximisation yields a solution on the utility possibilities frontier defined between a representative citizen of state 1 and her counterpart in state 2 where per capita utilities are equal, output is exhausted by private good and public service consumption and the federation's labour force is allocated to each of the two states.

4 State-federal equalisation game

Having established what is necessary for Pareto optimality I now set up a three stage game which captures the essence of a federation with centrally mandated equalisation and semi-independent states. In this game, the two states move first to choose their local public good provision simultaneously while holding Nash conjectures. States correctly anticipate the migration and inter-state transfer responses to their policies. Hence, they have an incentive to distort their policies to influence both the transfer and their supply of mobile labour. The federal agency moves in stage 2 to choose its inter-state transfer for given state policies. It correctly anticipates

migration responses to its policy choice. Finally, in stage 3 mobile labour makes its location choice to equate per capita utility conditional on state and federal policies. The game also has complete information. The following discussion starts with labours' location choice.

4.1 Stage 3: settlement patterns

For given local public good provision and inter-state transfer the only decision facing citizens in the final stage is their location consistent with equal per capita utilities. This choice determines the pattern of settlement for the federation conditional on equilibrium state and federal policies, $s^* = \{g^*, \rho^*\}$. It is well known that existence of a unique and stable migration equilibrium is guaranteed if (i) social marginal benefit, μ_i , is negative for each state; and (ii) social marginal benefit in a state is decreasing in its labour supply. These restrictions are consistent with the standard diagram of a free migration equilibrium with N on the horizontal axis and two concave indirect utility (maximum) value functions intersecting at a unique migration equilibrium with equal per capita utilities.

4.2 Stage 2: inter-state transfer

Consideration of the federal agency's problem in stage 2 begins by noting that the equal utility constraint is also a social welfare function for the federation. With strong incentive equivalence imposed by free mobility social welfare is maximised by the central agency if it chooses ρ to maximise per capita utility in *either* state 1 or 2, for given g_1 and g_2 , subject to the equal utility constraint, feasibility and the implicit labour supply function. Formally, the agency solves:

$$\underset{\rho}{Max} \quad u_1 = \left\{ \frac{(1 - \beta_1) + \beta_1[f_1(n_1) - rk_1] - \rho - C_1G_1}{n_1} \right\} + v(g_1) \quad (4.1)$$

subject to (2.1), (2.12) and (2.13).

The reader might wish to compare the federal agency and planner maximisation problems. Both decision-makers maximise per capita utility in state 1 conditional on feasibility, the equal utility condition and the total labour supply constraint. However, unlike the planner, the federal agency cannot directly choose local public good provision or labour supply in each state. Rather, it is states that now choose the provision of local public goods while mobile labour makes its own location choices in stage 2 for given state and federal policies. Of course, while the agency does not directly choose settlement patters, from the relationship at (2.13) it does so indirectly by manipulating the transfer instrument to achieve a population distribution which maximises social welfare. As we shall see below, this is sufficient for the agency to replicate, using its indirect instrument, the spatial efficiency achieved by the planner.

The solution drops out naturally by differentiating (4.1) with respect to ρ and setting the result equal to zero. This yields:

$$\mu_1 \frac{\partial n_1}{\partial \rho} = 1. \quad (4.2)$$

where μ_1 is the social marginal benefit in state 1 from an additional worker and $\partial n_1 / \partial \rho$ is the

labour supply response to a change in the transfer. Hence, (4.2) equates the social marginal benefit (to state 1) of an increase in the transfer (to state 2) with the marginal cost which is equal to one.

From the equal utility constraint,

$$\frac{\partial n_1}{\partial \rho} = \frac{A}{D}, \quad (4.3)$$

where

$$(i) \quad A = \left\{ \frac{1}{n_2} + \frac{1}{n_2} \right\} > 0; \quad (ii) \quad D = \left\{ \frac{1}{n_1} \mu_1 + \frac{1}{n_2} \mu_2 \right\}.$$

In general, one cannot sign $\partial n_1 / \partial \rho$. However, in proposition 1 presented later in the paper, I impose the restriction that the federation is over-populated, namely, $\mu_i < 0$ for $i=1,2$. This implies that $D < 0$ which means that $\partial n_1 / \partial \rho < 0$; as the inter-state transfer from state 1 to 2 increases labour migrates out of state 1 to state 2. In other words, workers follow the transfer.

Combining (4.2) and (4.3) yields the first order necessary condition for the inter-state transfer to be $\mu_1 = \mu_2$ where μ_1 and μ_2 are the social marginal benefits for states 1 and 2 from the solution to the central planner problem. The social marginal benefit in state 1 can be defined as a function of the state's labour supply, that is, $\mu_1(n_1)$, and similarly define $\mu_2(n_2)$. Given this, the first order necessary condition can be expressed as

$$F(s) = \mu_1(n_1(s)) - \mu_2(n_2(s)) = 0. \quad (4.4)$$

Although the federal agency cannot directly choose labour supply to each state it uses its transfer instrument to achieve the same outcome as the planner - equality of social marginal benefits across states, or spatial efficiency. If it chooses a transfer consistent with (4.4) the agency maximises (4.1) subject to the set of constraints, for given state policies.

The first order necessary condition is a best response $\hat{\rho} = \hat{\rho}(g)$ with a solution $\rho^* = \hat{\rho}(g^*)$ where $g^* = \{g_1^*, g_2^*\}$ are the levels of local public good provision chosen by states in a Nash equilibrium to stage 1 of the equalisation game. A solution exists if $F(s)$ is concave in the inter-state transfer. A set of sufficient conditions which ensure this are provided in Annex A.

4.3 Stage 1: local public good supply

In stage 1 states simultaneously choose their supply of local public goods while correctly anticipating the impact of their choices on labour location and the inter-state transfer. Specifically, state 1 solves:

$$Max_{g_1} \quad u_1 = \left\{ \frac{(1 - \beta_1) + \beta_1[f_1(n_1) - rk_1] - \rho - c_1 G_1}{n_1} \right\} + v(g_1) \quad (4.5)$$

subject to (2.1), (2.12), (2.13) and (4.4), the first order necessary condition adopted by the federal agency. Differentiating the objective function with respect to g_1 yields:

$$n_1^{1-\alpha} v_{g_1} = c_1 - \frac{1}{n_1^\alpha} \left\{ \mu_1 \frac{\partial n_1}{\partial g_1} - \frac{\partial \rho}{\partial g_1} \right\}. \quad (4.6)$$

This is analogous to the efficiency condition, (3.6), except for the presence of two terms, $\partial n_1/\partial g_1$ and $\partial \rho/\partial g_1$, which capture the migration and inter-state transfer responses to the choice of g_1 . The transfer response term is present because the state takes account of the impact of its choice of public good on the inter-state transfer; that is, the state acts strategically with respect to the transfer.

From the equal utility constraint and the first order necessary condition for the inter-state transfer it is possible to obtain two expressions that show how the labour supply to state 1 and the inter-state transfer it makes to state 2 change in response to changes in the state's local public good provision. The expressions are as follows

$$\frac{\partial n_1}{\partial g_1} = \frac{v_{g_1} - \alpha c_1 n_1^{\alpha-1}}{-(H + D)} \quad (4.7)$$

$$\frac{\partial \rho}{\partial g_1} = \frac{(c_1 n_1^{\alpha-1} - v_{g_1})H + (1 - \alpha)c_1 n_1^{\alpha-1} D}{-A \{H + D\}} \quad (4.8)$$

where

$$H = \left\{ \frac{\partial \mu_1}{\partial n_1} + \frac{\partial \mu_2}{\partial n_2} \right\}$$

and D and A are as previously defined.

State 2 chooses g_2 to maximise u_2 subject to the same set of constraints. This yields

$$n_2^{1-\alpha} v_{g_2} = c_2 - \frac{1}{n_2^\alpha} \left\{ \mu_2 \frac{\partial n_2}{\partial g_2} + \frac{\partial \rho}{\partial g_2} \right\}. \quad (4.9)$$

Using the same approach to the constraint set yields the migration and transfer responses

$$\frac{\partial n_2}{\partial g_2} = \frac{v_{g_2} - \alpha c_2 n_2^{\alpha-1}}{-\{H + D\}} \quad (4.10)$$

$$\frac{\partial \rho}{\partial g_2} = \frac{(c_2 n_2^{\alpha-1} - v_{g_2})H + (1 - \alpha)c_2 n_2^{\alpha-1} D}{A(H + D)}. \quad (4.11)$$

Absent any restrictions, the signs of the migration and transfer response terms are ambiguous for both states. What is more, when substituted into (4.6) and (4.9) it is not possible to obtain the public good efficiency condition, (3.6). It can be concluded that in a Nash equilibrium to the first stage of the game both states provide their local public goods inefficiently with over or under provision possible. States manipulate their policies in order to influence the federation's settlement patterns and the inter-state transfer chosen by the federal agency and this leads to inefficient policies. For my purposes, it does not matter whether states provide their local public goods efficiently, only that some Nash equilibrium exists. Therefore, though interesting in its own right, this aspect of the problem is not pursued further.

The first order necessary conditions together with the labour supply and transfer responses are best response functions, $\hat{g}_1 = \hat{g}_1(g_2)$ and $\hat{g}_2 = \hat{g}_2(g_1)$. A Nash equilibrium to stage 1 of the game is a solution, $g^* = \{g_1^*, g_2^*\}$, such that $g_1^* = \hat{g}_1(g_2^*)$ and $g_2^* = \hat{g}_2(g_1^*)$. It is well known that existence of a Nash equilibrium is assured in this game if the player payoffs are concave in their

strategies (see Mas-Colell et al. (1995)). Annex A derives sufficient conditions ensuring this.

4.4 Equilibrium and efficiency

A sub-game perfect equilibrium (SPE) is a solution $s^* = \{g^*, \rho^*\}$ such that $g^* = \{g_1^*, g_2^*\}$ is a Nash equilibrium to stage 1, $\rho^* = \hat{\rho}(g^*)$ is the optimal inter-state transfer from the second stage and $n_1^* = \hat{n}_1(s^*)$ and $n_2^* = \hat{n}_2(s^*)$ are optimal labour supplies to states 1 and 2 (respectively) chosen in the final stage. A SPE exists if the sufficient conditions for the existence of a Nash equilibrium to stage 1, an optimal transfer in stage 2, and a migration equilibrium in stage 3, hold.

What efficiency properties characterise a SPE for this game? From the planner problem, local public goods must be provided according to the Samuelson rule and labour should be allocated across states to equate social marginal benefits if a SPE is to be on the utility possibilities frontier defined between a representative citizen of state 1 and her counterpart in state 2. We know the federal agency chooses a transfer that achieves an equality of social marginal benefits but local public services are, as noted previously, over or under-provided. Hence, a SPE is inside the utility possibilities on the 45 degree line from the origin. For this reason, henceforth the corrective transfer chosen by the federal agency in stage 2 is referred to as constrained optimal.

5 Migration externalities

The corrective inter-state transfer in a SPE is non-zero because some redistribution of income across states is required to offset the externalities related to free migration. In their presence, a SPE is not Pareto optimal without a non-zero inter-state income transfer. Two migration externalities, one relating to the fiscal effects of a migrant and the other to their impact on economic rents, are very well known. However, in my model there is also a migration externality related to the impact of mobility on wage income via changes in the wage rate.

It is useful for the reader to know how and why the constrained optimal transfer is determined by the inter-state pattern of these transfers. The results in Section 6 cannot be readily understood without this background. That said, readers familiar with the arguments about migration externalities and the corrective transfer may wish to proceed directly to Section 6, without any loss of understanding of the results there.

Proceed by using the definitions of social marginal benefit at (3.7) and per capita consumption at (2.11) in (4.4) to derive the following expression for the equilibrium transfer:

$$\rho^* = -\frac{n_1 n_2}{N} \left\{ (1 - \alpha) \left(\gamma_1 \frac{c_1 G_1}{n_1} - \gamma_2 \frac{c_2 G_2}{n_2} \right) - \left(\beta_1 \frac{R_1}{n_1} - \beta_2 \frac{R_2}{n_2} \right) + \left((1 - \beta_1) n_1 \frac{\partial w_1}{\partial n_1} - (1 - \beta_2) n_2 \frac{\partial w_2}{\partial n_2} \right) \right\} \quad (5.1)$$

From this, the constrained optimal transfer is a function of three externalities. First of all there is the well-known (positive) fiscal externality created by a migrant to a state, $(c_i G_i / n_i)$, for $i = 1, 2$. This is their contribution to the cost of providing the local public good. The constrained

optimal transfer is a function of the difference between this externality across states: $(c_1G_1/n_1) - (c_2G_2/n_2)$, adjusted for congestion. When $\alpha = 1$ the public good is fully congested and this difference has no influence on the optimal transfer. However, when $\alpha < 1$ the constrained optimal transfer corrects for the difference. If the fiscal externality in state 2 exceeds that in state 1, then $(c_1G_1/n_1) - (c_2G_2/n_2) < 0$. If local public goods are not fully congested, this exerts a positive influence on ρ ; thus, the transfer redistributes income *towards* states with relatively large fiscal externalities. From the migration responses derived earlier we know that the constrained optimal transfer will also encourage migration to high fiscal externality states.

The second (negative) externality is the per capita economic rent consumed by a migrant to a state, R_i/n_i , for $i = 1, 2$, adjusted by the local rent capture parameter. When $\beta_i = 1$, for $i = 1, 2$, there is full rent capture, but when $\beta_i = 0$ locals capture no economic rent and earn only their wage income. In this latter case, the difference between per capita rents, $(R_1/n_1 - R_2/n_2)$ exerts no influence whatever on the optimal transfer. If local rent capture is non-zero then the constrained optimal transfer must correct for inter-state differences between per capita rents. One can see from (5.5) that if state 2 generates higher per capita rent then $(R_1/n_1 - R_2/n_2) < 0$; this exerts a negative influence on ρ . Hence, the optimal transfer redistributes income *away* from relatively high rent states.

The remaining externality is new and enters the optimal transfer expression because I have allowed for variable local rent capture which splits out the effect of a migrant to a state into its wage income and economic rent effects. The wage income externality only operates when $\beta_i < 1$ otherwise the impact of migration on labour income is captured by the rent externality term. Therefore, let us suppose $\beta_i < 1$, where $i = 1, 2$. This means there is less than full rent capture in both states. Since $\partial w_i / \partial n_i < 0$, the wage externalities are negative. If the negative wage income externality in state 2 exceeds that in state 1, this difference exerts a negative effect on ρ , redistributing income in favour of state 1. Thus, the transfer redistributes income *away* from states with a comparatively high negative wage income externality.

One might reasonably argue that in practice the need for a corrective transfer is over-stated since it is likely that locals capture none of their state's economic rent and state services are fully congested pure private goods.⁴ If this is so, $\beta_i = 0$ for $i=1,2$ and $\alpha = 1$. However, even then one does not enter a Tiebout world in my model as the equilibrium transfer is still non-zero and defined by

$$\rho = -\frac{n_1 n_2}{N} \left\{ (1 - \beta_1) n_1 \frac{\partial w_1}{\partial n_1} - (1 - \beta_2) n_2 \frac{\partial w_2}{\partial n_2} \right\}. \quad (5.2)$$

The transfer must correct for inter-state differences in the wage income externality. This is why my results in the next Section apply even when there is no local rent capture and state services are pure private goods.

⁴See Oates (1988) for a discussion of empirical estimates of public good congestion.

6 Transfer response to a public good cost increase

A SPE to the game is conditional on the parameter set $\varphi = \cup_i \varphi_i$ where $\varphi_i = \{\alpha, k_i, r, N, \beta_i, c_i\}$ is the set of parameters in state i for $i=1,2$. It is possible to analyse how equilibrium choices respond to changes in any of these parameters. In this Section I focus on two, c_1 and c_2 . In particular, I wish to see how the equilibrium choices made by players respond to exogenous increases in local public good prices. Since my focus is on the transfer and labour location responses to cost increases I ignore the impact on local public good provision. That said we know states will respond to any cost increase in stage 1 by changing provision of their local public goods. However, given the timing of moves the federal agency will take these responses and the resulting levels of public good provision as given. Thus, one can focus on the transfer best response since any adjustments made by the states to price changes occur in stage 1 and the agency optimises conditional on these choices. I also assume the federal agency correctly anticipates how labour location choices respond to changes in the cost of local public goods. As we shall see, this anticipation plays an important part in determining how the agency changes its transfer when the prices of local goods change.

The analysis proceeds by considering, first, the effects of an increase in the local public good cost in state 1 on the constrained optimal transfer. From (4.4) the implicit function theorem allows one to derive (see Annex B for mathematical details):

$$\frac{\partial \rho^*}{\partial c_1} = - \left\{ H \frac{\partial n_1}{\partial c_1} \right\} / \left\{ H \frac{\partial n_1}{\partial \rho} + A \right\} \quad (6.1)$$

where $\partial n_1 / \partial \rho$ and A are given to us at (4.3) and H is defined at (4.8). From the equal utility condition one can derive

$$\frac{\partial n_1}{\partial c_1} = \frac{c_1 G_1}{D n_1}. \quad (6.2)$$

This expression tells us how the labour supply to state 1 changes when the cost of the local public good in state 1 changes. It is present in (6.1) because as noted previously the federal agency correctly anticipates how labour location choices respond to changes in the prices of local public goods. In general this migration response cannot be signed. However, as is shown in proposition 1 below it can be signed if one of the restrictions in the proposition holds, namely, that $\mu_i < 0$ for $i=1,2$. In this case labour supply to state 1 is decreasing in c_1 since D is negative. With N fixed a decrease in n_1 can only occur if there is migration from state 1 to 2. Thus, an increase in the cost of the local public good in state 1 leads to migration from state 1 to 2 as labour moves to the relatively lower cost state.

Similarly, for state 2:

$$\frac{\partial \rho^*}{\partial c_2} = \left\{ H \frac{\partial n_2}{\partial c_2} \right\} / \left\{ H \frac{\partial n_1}{\partial \rho} + A \right\} \quad (6.3)$$

The equal utility condition yields

$$\frac{\partial n_2}{\partial c_2} = \frac{c_2 G_2}{D n_2}. \quad (6.4)$$

The expression is analogous to (6.2) and tells us how the labour supply to state 2 changes in response to an increase in the cost of the local public good in that state. This too is negative if $\mu_2 < 0$ as supposed in proposition 1. That is, an increase in the cost of the local public good in state 2 causes outward migration to state 1 as labour seeks the lower cost jurisdiction. As with a cost increase in state 1, the federal agency correctly anticipates this labour supply response to a cost increase in state 2.

Expressions (6.1) and (6.3), together with the labour supply responses, (6.2) and (6.4), tell us how the constrained optimal transfer chosen by the federal agency in stage 2 changes as the cost of the local public good increases in states 1 and 2 respectively. The following proposition can now be stated and proved:

Proposition 1. If social marginal benefit, μ_i , in state i is *negative* and *decreasing* in labour supply, for $i = 1, 2$, the inter-state transfer received by the state is *increasing* in its local public good cost. Thus, as a state's relative local public good cost increases so too does its transfer.

Proof. Suppose:

$$(i) \quad \mu_i < 0; \quad (ii) \quad \frac{\partial \mu_i}{\partial n_i} < 0 \quad i = 1, 2.$$

Restriction (i) implies that $D < 0$. This, in turn, means that $\partial n_i / \partial c_i < 0$, for $i = 1, 2$, and $\partial n_1 / \partial \rho < 0$. The second restriction (ii) implies that $H < 0$. Combined, these signs imply:

$$\frac{\partial \rho^*}{\partial c_1} < 0, \quad \frac{\partial \rho^*}{\partial c_2} > 0.$$

and the proposition is proved. □

Are these restrictions plausible from an economic perspective? It turns out they automatically hold if a unique and stable free migration equilibrium exists. To see this, note that the indirect utility (maximum value) function for a representative citizen in state i in stage 3 of the game is $V_i(n_i) = \text{Max}_{s^*} u_i$, for $i = 1, 2$, where s^* are equilibrium state and federal policies from stages 1 and 2. The envelope theorem tells us that $dV_i/dn_i = \partial u_i / \partial n_i$ at an optimum. The utility function yields:

$$\frac{\partial u_i}{\partial n_i} = \frac{\mu_i}{n_i}. \tag{6.5}$$

Differentiating again with respect to labour supply and rearranging one is able to form the following relationship:

$$\frac{\partial \mu_i}{\partial n_i} = \frac{\partial^2 u_i}{\partial n_i^2} n_i + \mu_i. \tag{6.6}$$

It is well known that for a stable free migration equilibrium to exist requires (i) $\partial^2 u_i / \partial n_i^2 < 0$ and (ii) $\mu_i < 0$ for $i=1,2$. Per capita indirect utility in each state must be strictly concave in labour supply and the social marginal benefit of an additional migrant must be negative. This latter restriction implies the federation is over-populated. If these conditions hold then from (6.6) it is clear social marginal benefit will also be decreasing in labour supply, that is, $\partial \mu_i / \partial n_i < 0$ for $i=1,2$. Hence, if the sufficient conditions for existence and stability are satisfied

so too are the restrictions which are sufficient for the transfer to a state to be increasing in its public good cost. In this sense, the restrictions are highly plausible⁵.

The mathematical result in proposition 1 is at first sight counter-intuitive for it tells us that efficiency requires a transfer of income *from* low to high cost jurisdictions. The following explanation seems to capture the essence of the idea in the proposition. Consider what happens to labour location decisions in stage 3 with a higher c_1 , conditional on some value of c_2 . For given state-federal policies and allocation of labour across states, an increase in c_1 reduces per capita (indirect) utility in state 1 relative to state 2. This means that compared to a free migration equilibrium at the old public good price for state 1, $V_1(n_1)$ is less than $V_2(n_2)$. Assuming the restrictions in proposition 1 hold, a free migration equilibrium can be re-established if labour migrates from state 1 to 2 until $V_1(n_1) = V_2(n_2)$. This is why the sign of $\partial n_1 / \partial c_1$ at (6.2) is negative. As we would expect, labour will wish to migrate out of the state which has experienced the cost increase.

However, relative to an equilibrium at the old local public good price for state 1, such a labour supply response in stage 3 to a higher c_1 will also increase μ_2 and decrease μ_1 . Without a change in the transfer we will have $\mu_1 < \mu_2$ and any resulting free migration equilibrium will not be Pareto optimal. Hence, in response to a cost increase in state 1 the agency must choose a smaller ρ , that is, transfer income *from* state 2 to 1 as a partial offset for the local public good price increase in state 1. This stops any inefficient migration that would otherwise take place in response to the cost increase in state 1 - that part related to the migration externalities identified in the discussion above - but preserves the efficient component. Migration from state 1 to 2 in response to the cost increase in state 1 still occurs in net terms. However, the increased transfer of income to the state which has experienced the cost increase corrects for that part of the migration response related to locational externalities. This is why the transfer to state 1 is increasing in c_1 as shown in the proposition. An analogous (reverse) argument applies to an increase in c_2 for a given c_1 .

There is an alternative way of thinking about this. The cost of providing local public goods in a state can be thought of as a location specific negative externality just like, say, air pollution or traffic congestion. When a migrant enters a state they must pay their contribution for the provision of local services. If the price of providing local services goes up then this negative externality increases and drives labour out of the jurisdiction. However, because of migration-related fiscal, rent and wage income externalities, too many migrants leave the state and this necessitates an increased transfer in favour of the state which has experienced an increase in its local public good cost. The transfer acts as compensation for higher cost to encourage an optimal number of people to live in the high cost region. Otherwise, labour supply to the high cost region would be less than is optimal.

Thus, on efficiency grounds the constrained optimal transfer must respond to changes in local public good prices and in such a way that jurisdictions experiencing cost increases receive a larger transfer. In this sense the proposition provides an efficiency rationale for inter-state

⁵Even with the restrictions it is not possible to determine whether local public goods are under or over provided in equilibrium

transfers to high cost states to deter inefficient migration in response to exogenous price shocks. In contrast to the traditional view that such transfers are inefficient, this provides an efficiency rationale for the direction of transfers one sees in real world equalisation schemes, namely, transfers from low to high cost regions.

It should also be noted that the result holds even if there is no local rent capture - so rents do not distort location choices - and local public goods are fully congested - meaning there are no fiscal externalities. Even in this case a Tiebout world does not emerge as wage income externalities still distort migration choices requiring a non-zero corrective transfer to achieve a Pareto optimal outcome. With only this externality distorting migration choices a region's transfer is still increasing in its local public good cost.

Finally, proposition 1 applies regardless of the reason *why* local public good costs increase. In principle, there could be an exogenous increase in c_1 or c_2 due to changes in technology, input prices or factors such as the dispersion, density or remoteness of populations and socio-demographic features which lead to greater expenditure needs. The result is general in that it applies to cost increases arising from *all* of these potential sources.

7 Conclusion

Cost equalisation is a feature of grant design in many countries, including unitary states with regions, and federations. Most often it is vertical in nature though sometimes it is overtly horizontal. Regardless, cost equalisation results in the redistribution of income from low to high cost jurisdictions, usually in the name of equalising fiscal capacities, an equity goal. As economists, we might view this at first sight as being inefficient: indeed, this seems to be the prevailing view.

In this paper, I have argued the situation is more complex in a world where free migration is associated with externalities and a corrective inter-state transfer is required on efficiency grounds. My contribution has been to show that if a stable, unique, free migration equilibrium exists, the corrective transfer received by a region is, in fact, *increasing* in the cost of its local public good, for a given cost in neighbouring regions. As explained, this result arises because a part of any migratory response to a cost increase in one region is inefficient and needs to be corrected for by an increased (compensatory) transfer to the region experiencing higher cost. It should be pointed out that this would not happen in a Tiebout world where there are no externalities and the migration response to a cost increase is fully efficient. However, as I have shown it is difficult for a Tiebout world to emerge in my model. Even when fiscal and rent externalities are zero there is still a wage income externality to distort migration decisions.

So far as I am aware, this result is also the first efficiency rationale *for* cost equalisation, particularly in favour of high cost regions. As discussed in the Introduction, this is exactly what we see in the practice of fiscal equalisation in a large number of countries. Thus, my paper provides a bridge between the practice and theory of equalisation and is good news for unitary and federal countries that operate schemes of cost equalisation embedded within broader fiscal equalisation programs, or inter-governmental grants.

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Annex A: Second order conditions

The second order condition for ρ is:

$$\frac{\partial^2 u_1}{\partial \rho^2} = \frac{\partial \mu_1}{\partial n_1} \left(\frac{\partial n_1}{\partial \rho} \right)^2 + \mu_1 \frac{\partial^2 n_1}{\partial \rho^2}$$

The following set of sufficient conditions ensure this is negative:

$$(i) \mu_i < 0 \quad i = 1, 2 \quad (ii) \frac{\partial \mu_i}{\partial n_i} < 0 \quad i = 1, 2 \quad (iii) \frac{\partial^2 n_1}{\partial \rho^2} > 0$$

The second order condition for the local public good in state 1 is:

$$\frac{\partial^2 u_1}{\partial g_1^2} = \frac{\partial \mu_1}{\partial n_1} \left(\frac{\partial n_1}{\partial g_1} \right)^2 + \mu_1 \frac{\partial^2 n_1}{\partial g_1^2} - \frac{\partial^2 \rho}{\partial g_1^2} + \frac{\partial n_1}{\partial g_1} \left\{ \frac{u_{1,g_1}}{u_{1,x_1}} - \alpha \gamma_1 p_1 n_1^{\alpha-1} [1 - G_1] \right\} + a_1 - \gamma_1 n_1^{2\alpha} p_1$$

where

$$a_1 = n_1 \left\{ \frac{u_{1,g_1,g_1} u_{1,x_1} - u_{1,g_1} u_{1,x_1,g_1}}{(u_{1,x_1})^2} \right\} < 0$$

The following set of sufficient conditions ensure this is negative:

$$(i) \quad \mu_i < 0 \quad i = 1, 2 \quad (ii) \quad \frac{\partial \mu_i}{\partial n_i} < 0 \quad i = 1, 2; \quad (iii) \quad \frac{\partial n_i}{\partial g_i} < 0 \quad i = 1, 2$$

$$(iv) \quad \frac{\partial^2 n_i}{\partial g_i^2} > 0 \quad i = 1, 2 \quad (v) \quad \frac{\partial^2 \rho}{\partial g_1^2} > 0 \quad (vi) \quad \frac{\partial^2 \rho}{\partial g_2^2} < 0 \quad (vii) \quad G_1 > 1$$

An analogous second order condition and set of sufficient conditions hold for state 2.

Annex B: Derivations for section 5

From (4.4) in the main text the implicit function theorem implies

$$\frac{\partial \rho}{\partial c_1} = - \frac{F_{c_1}}{F_\rho}$$

where

$$F_{c_1} = \left\{ \frac{\partial \mu_1}{\partial c_1} - \frac{\partial \mu_2}{\partial c_1} \right\}, \quad F_\rho = \left\{ \frac{\partial \mu_1}{\partial \rho} - \frac{\partial \mu_2}{\partial \rho} \right\}.$$

From the definition of social marginal benefit for state 1

$$\frac{\partial \mu_1}{\partial c_1} = \frac{\partial \mu_1}{\partial n_1} \frac{\partial n_1}{\partial c_1}$$

where

$$\frac{\partial \mu_1}{\partial n_1} = \left\{ (1 - \beta_1) \frac{\partial^2 w_1}{\partial n_1^2} n_1 + \frac{\partial w_1}{\partial n_1} (2 - \beta_1) - \frac{\mu_1}{n_1} - \frac{\alpha c_1 G_1}{n_1^2} (\alpha - 1) \right\}.$$

The equal utility condition yields:

$$\frac{\partial n_1}{\partial c_1} = \frac{c_1 G_1}{D n_1}.$$

Similarly

$$\frac{\partial \mu_2}{\partial c_1} = - \frac{\partial \mu_2}{\partial n_2} \frac{\partial n_1}{\partial c_1}$$

where

$$\frac{\partial \mu_2}{\partial n_2} = \left\{ (1 - \beta_2) \frac{\partial^2 w_2}{\partial n_2^2} n_2 + \frac{\partial w_2}{\partial n_2} (2 - \beta_2) - \frac{\mu_2}{n_2} - \frac{\alpha c_2 G_2}{n_2^2} (\alpha - 1) \right\}.$$

Combining these results it is possible to define F_{c_1} from (5.1) as

$$F_{c_1} = H \frac{\partial n_1}{\partial c_1}$$

where

$$H = \left\{ \frac{\partial \mu_1}{\partial n_1} + \frac{\partial \mu_2}{\partial n_2} \right\}.$$

Next, from the definition of social marginal benefit in state 1 obtain the following expression

$$\frac{\partial \mu_1}{\partial \rho} = \left\{ \frac{\partial \mu_1}{\partial n_1} \frac{\partial n_1}{\partial \rho} + \frac{1}{n_1} \right\}.$$

Similarly, the definition of social marginal benefit in state 2 yields

$$\frac{\partial \mu_2}{\partial \rho} = - \left\{ \frac{\partial \mu_2}{\partial n_2} \frac{\partial n_1}{\partial \rho} + \frac{1}{n_2} \right\}.$$

It is now possible to express F_ρ as

$$F_\rho = \left\{ H \frac{\partial n_1}{\partial \rho} + \frac{1}{n_1} + \frac{1}{n_1} \right\}$$

It is now possible to express the inter-state transfer response to a change in the local public good cost in state 1 as

$$\frac{\partial \rho}{\partial c_1} = - \left\{ H \frac{\partial n_1}{\partial c_1} \right\} / \left\{ H \frac{\partial n_1}{\partial \rho} + A \right\}.$$

The inter-state transfer response to a change in the local public good cost in state 2 is

$$\frac{\partial \rho}{\partial c_2} = - \frac{F_{c_2}}{F_\rho}.$$

Using the approach adopted for state 1 obtain

$$\frac{\partial \rho}{\partial c_2} = \left\{ H \frac{\partial n_2}{\partial c_2} \right\} / \left\{ H \frac{\partial n_1}{\partial \rho} + A \right\}$$

where

$$\frac{\partial n_2}{\partial \gamma_2} = \frac{c_2 G_2}{D n_2}.$$



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