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Evaluating the efficiency and equity of federal fiscal equalization ☆

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ABSTRACT

Theoretically, federal transfers that make household location decisions efficient should ignore local cost differences, subsidize positive externalities, and offset differences in federal-tax payments and local taxes levied on non-residents, but not local tax revenues from residents. Transfers that redistribute resources equitably across regions will likely target areas with individuals of low earnings potential or low real incomes. Applying these criteria empirically, Canadian equalization policy appears neither efficient nor equitable, but exacerbates pre-existing inefficiencies and underfunds minorities. Locational inefficiencies cost Canada 0.41% of income annually and cause over-funded provinces to have populations of 30% beyond their efficient long-run levels.

1. Introduction

Many federal governments – including those of Canada, Germany, Australia, and Japan – make fiscal equalization payments to local governments, with the stated goal of equalizing the fiscal capacity of local governments to provide public services. Most equalization systems provide unconditional grants that are negatively related to an estimate of local fiscal capacity. Often, the federal government estimates fiscal capacity from a weighted average of local tax bases, where the weight of each base is determined by its representative share of revenue across all localities. These weights are generally independent of whether the tax has a *source* or *residence* base — i.e., levied on incomes earned locally or received locally. For example, corporate income taxes, which may be paid by non-residents, receive the same treatment as personal income taxes, paid only by residents.

The merits of equalization systems have been heavily debated by economists such as Buchanan (1950, 1951, 1952), Scott (1950, 1952), Jenkins (1951), Musgrave (1961), Feldstein (1970), Buchanan and Wagner (1970), Courchene (1981), Ladd and Yinger (1994), Oakland (1994), and Usher (2007). These debates typically focus on how equalization may affect efficient migration or steer public resources equitably toward needy communities. Such discussions are closely tied to those on similar place-based policies (e.g. Bartik, 1991; Courant, 1994; Glaeser and Gottlieb, 2008; Busso et al., 2010) that are of great interest to the European Union, the United States, and other countries.

In this paper, I clarify these debates using a theoretical framework similar to the previous literature, with mobile heterogeneous households who live, work, and consume local public services in the same region. Unlike influential work by Buchanan (1950) and Boadway and Flatters (1982a), I argue that, when properly interpreted, this same framework actually only supports the equalization of source, and not residence-based revenues. In addition, I expand the traditional framework to incorporate federal taxes, residential land, and inter-regional differences in amenities and private and public productivities. This

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expanded framework establishes that it is efficient for federal grants to refund higher federal-tax payments caused by higher local wage levels. Uncorrected, federal taxes discourage households from working in high-wage areas, where labor productivity is high (Albouy, 2009a). Otherwise, efficiently-set transfers should ignore differences in local costs-of-living or input costs for providing public services.

The framework also provides a richer context for how grants may be distributed to promote equity goals, expanding on Buchanan (1950), who compares households based on their realized nominal incomes. Since incomes depend on where households choose to locate, I argue that it is more sensible to compare households on the potential incomes they would earn if they lived in the same region. Even if we abandon this insight, it may make more sense to compare households based on their realized incomes adjusted for local costs-of-living, especially when quality-of-life differences across regions are small. The theoretical framework implies that federal transfers can be both efficient and equitable if the redistributive portion is targeted and spent on households according to their location-independent characteristics, e.g., they are made to lower-paid people, not lower-paying areas.

The expanded framework is empirically compatible with observed inter-regional differences in wages, costs-of-living, and population. Therefore, it allows researchers to use real-world data to evaluate whether existing equalization systems are efficient or equitable based on the criteria presented here. I perform such an evaluation of Canada's equalization system. Over recent history, the highest per-capita equalization payments were made to the Atlantic provinces – Newfoundland, Prince Edward Island, Nova Scotia, and New Brunswick – and to two Prairie provinces, Manitoba and Saskatchewan. These payments inefficiently incentivize Canadians to move to these six provinces, as they have considerable source-based revenues and low federal-tax burdens. Similar incentives exist for Alberta, the remaining Prairie province, albeit in a different form. It collects enormous source-based revenues from oil and other resources, which the federal government does not redistribute because of asymmetry in its equalization formula. As these revenues are offered only to those who reside within Alberta's borders, they too create inefficient incentives. According to simulations below, equalization's failure to eliminate fiscal imbalances causes the Atlantic and Prairie provinces to be populated by 30% beyond their efficient levels, leading to inefficiency costs of 0.41% of income, or C$4.3 billion per year. Furthermore, grants and other benefits do not appear to be equitably targeted, as they go disproportionately toward provinces with high skill levels and real incomes.

Section 2 presents the theoretical model used to determine efficient grant levels, and Section 3 discusses equity criteria in greater detail. The measurable net fiscal benefits of residing in each Canadian province are calculated in Section 4, which involves estimating how much provincial wage differences are due to location or to worker characteristics. Section 5 examines the externality and equity justifications for net fiscal benefit differences empirically. The long-run effects of fiscal distortions on provincial price levels, wages, employment and welfare are simulated in Section 6. Section 7 concludes and discusses possible applications outside of Canada. The Appendices contain details on the theory and data.

2. Federal location model with grants

2.1. Model set-up

Here, I develop a model to characterize when long-run household location choices are efficient and how federal transfers may ensure this efficiency. The model is set within a competitive economy with heterogeneous households who are mobile across jurisdictions, with governments that provide a local good. This follows the mainstream literature on fiscal federalism by Flatters et al. (1974), Stiglitz (1977), Boadway and Flatters (1982a), Wildasin (1980, 1986), and Mieszkowski and Zodrow (1989). I expand this literature by incorporating regional differences in productivity and quality of life, as in Rosen (1979) and Roback (1982), and federal taxes, as in Albouy (2009a), making the framework more empirically viable. The framework here resembles that of Albouy et al. (in press) – who use wage and cost-of-living data to estimate productivity and quality-of-life differences across Canadian cities – except that it incorporates local public sectors that vary in productivity, similar to Yinger (1986).

Households each supply one unit of labor and belong to one of E types, indexed by $e=1,\ldots,E$, where types may characterize skills or tastes. The number of households of each type is fixed in the federation. Households may locate in any of J regions, $j=1,\ldots,J$, where they live and work; I do not consider location decisions within regions. The population composition of region j is described by the vector $\mathbf{N}^j=(N_1^j,\ldots,N_E^j)$ and the scalar $N^j=\sum_e N_e^j$ for region j's total population.

Household preferences for each type are represented by the utility function

$$U_e\left(x,y,g^j;Q^j\right),$$

which depends on three goods: (i) a tradable private good, x, (ii) a non-tradable (home) private good, y, and (iii) a non-tradable publicly-provided good (or public service), $g^j=G^j(N^j)^{-\alpha}$. G^j is the aggregate level of public production, which is congested according to the parameter $\alpha\in[0,1]$: $\alpha=0$ corresponds to a pure public good, and $\alpha=1$, a publicly-provided private good. Private consumption bundles in region j may vary by type e, but G^j is uniformly provided across all types within the population, and each household contributes equally to congesting it, although tastes for g^j may differ. The local public sector does not provide services to capital or firms.

Each location j is characterized by exogenous levels of (i) quality of life, Q^j, determined by consumption amenities; (ii) productivity in the tradable sector, A_X^j; (iii) productivity in the non-tradable sector, A_Y^j; (iv) productivity in the public sector, A_G^j; and (v) land supply, L^j. All final goods are produced from land, labor, and mobile capital, K^j. Factor markets and output markets are perfectly competitive. Factors are fully mobile within each region and so command the same regional price in all sectors, including the public sector.[1] Land is immobile across regions and earns a local price r^j. Capital is fully mobile across regions and earns a gross price i^j: the national supply of capital may be fixed or determined internationally. Each household type owns a portfolio of capital and land, which earn incomes I_e and R_e independent of where the household lives.

Households are fully mobile across regions and earn the local wage w_e^j, which varies to compensate workers for differences in costs-of-living, p_Y^j, quality of life, Q^j, and the local-government good, g^j. In equilibrium, regions with high quality of life, Q^j, or public-productivity, A_G^j, have local costs that are high relative to local wage levels. Thus, lower wage levels compensate workers for local non-market benefits. Regions with high private-sector productivity, A_X^j or A_Y^j, have wage and cost-levels that are high relative to output prices, either 1 or p_Y^j, as the ratio of input to output prices reflect the marginal productivity of those inputs.[2] As described in Albouy (2009b), the degree to which local wages and prices capitalize these attributes depends on the proportions of land and labor in tradable

[1] Results would not change significantly if another fixed factor used only in the production sector, such as a natural resource reserve, is introduced. Land may also proxy for capital that is immobile.

[2] If multiple output goods are produced then it seems possible that factor-price equalization will force factor prices to converge across areas. However, productivity differences should still lead to higher wages for workers in more productive areas. With free mobility, cities differing in amenities are likely to specialize in the production of a subset of goods, putting them outside of the cone of diversification in which factor-price equalization holds.

production and federal-tax rates. The results below apply regardless of these capitalization effects.[3]

To pay for local-government goods, local governments levy linear taxes.[4] Source (or origin)-based taxes on land and capital are levied at rates τ_L^j and τ_K^j. Residence (or destination)-based taxes on income from wages, rents, and interest are given by τ_w^j, τ_R^j, and τ_I^j. The budget constraint of local governments requires that expenditures equal revenues:

$$p_G^j G^j = \left(\tau_L^j L^j + \tau_K^j K^j\right) + N^j\left(\tau_w^j \bar{w}^j + \tau_R^j \bar{R}^j + \tau_I^j \bar{I}^j\right), \tag{1}$$

where $p_G^j G^j$ are expenditures on the local government good and $\bar{w}^j = (1/N^j)\sum_e N_e^j w_e^j$, $\bar{R}^j = (1/N^j)\sum_e N_e^j R_e$, and $\bar{I}^j = (1/N^j)\sum_e N_e^j I_e$ are the per-capita values of the three residence bases, labor, rents, and interest. Following standard assumptions, local governments pay factors their marginal product and produce and allocate G^j efficiently, so that it obeys the following Samuelson rule, generalized to handle congestion (Stiglitz, 1977):

$$\left(N^j\right)^{1-\alpha}\overline{MRS}_{gx}^j = MRT_{GX}^j. \tag{2}$$

$\overline{MRS}_{gx}^j$ and MRT_{Gx}^j are the average marginal rates of substitution and transformation between the local-government good and the private tradable good. The condition reflects that households decide how to allocate resources between private and public consumption locally. It is for local, not federal, agents to decide between buying, say, a better car or a better roadway. As α increases, Eq. (2) more closely resembles the rule for the efficient provision of private goods than for public goods. Notice that it applies regardless of cost differences due to factor prices or public-productivity, A_G^j.[5]

The federal government levies taxes τ_w^F, τ_R^F, and τ_I^F to raise revenue. Besides making its own purchases, valued at G^F, the federal government provides transfers, or grants, to households, F_e^j, based upon their type e and region j.[6] The sign of F_e^j is unrestricted: a negative value represents a non-distortionary head tax. Having transfers target households rather than local governments follows the previous literature and allows the federal government to attain "first-best" efficient allocations. An interesting "second-best" scenario would occur when regional grants are fixed across types, i.e., $F_e^j = F_{e'}^j$, for each j and all e. This is a more difficult problem, better-suited for future research, although in Section 2.4 I discuss what may happen when transfers are instead made to local governments.[7] The federal government obeys the budget constraint:

$$G^F + \sum_j \sum_e N_e^j F_e^j = \sum_j \sum_e N_e\left(\tau_w^F w_e^j + \tau_R^F R_e + \tau_I^F I_e\right). \tag{3}$$

[3] The Boadway and Flatters (1982a, 1982b) model, discussed in Appendix A.4, has no non-tradable sector and only allows areas to differ in land supply. As a result, provinces with more land have greater population and provision of G^j, which causes them to have lower wages. This makes the model empirically unworkable, as wage levels are higher in more populated areas, and vary for many other reasons.

[4] Linear taxes are without loss of generality as progressive tax rates lead to similar conclusions. Whether tax rates are set endogenously is not important to the locational distortions modeled here. Inefficiencies in local public-sector spending policies or taxes may have an effect on the quality of life or public or private productivity of the community.

[5] Condition (2) generally rules out the case where G is provided equally across areas, e.g. $G^j = \bar{G}$, which could lead to inefficiently high or low levels of public consumption in different areas. The results below are largely unaffected if local governments tax or provide G^j inefficiently, as this is usually equivalent to lowering A_G^j or Q^j.

[6] G^F may enter the utility function, but since it benefits all households equally, there is no purpose in modeling it. This may be violated if, for instance, households on the coasts benefit more from national defense than those in the interior.

[7] Considerations such as the "flypaper effect" are ignored here, as this paper focuses on efficient location decisions, not public-service provision. In addition, this treatment does not consider how equalization programs affect the incentives of local governments in raising revenues; see Smart (1998).

The average grant to region j is denoted $\bar{F}^j = (1/N^j)\sum_e N_e^j F_e^j$. With all of these definitions in place it is possible to write the household budget constraint as

$$x_e^j + p_Y^j y_e^j + T_e^j = w_e^j + R_e + I_e + F_e^j \tag{4}$$

where $T_e^j = (\tau_w^j + \tau_w^F)w_e^j + (\tau_R^j + \tau_R^F)R_e + (\tau_I^j + \tau_I^F)I_e$ is the total amount of local and federal taxes paid by resident e in region j.

2.2. Efficient transfer policy to households across regions

From the above set up, Appendix A derives the set of Pareto efficient transfers as the solution to a benevolent planner's problem. The solution characterizes efficient levels of population, production, and consumption across regions. These conditions combine with market conditions to determine efficient transfer levels to each household type e by region j.

The planner's problem assumes that households are fully mobile. Each household type receives the same utility regardless of where it resides, but utility varies across types. Thus, a regional planner would enact the same efficient transfers as a federal planner (Myers, 1990). Mobility makes the most sense in a long-run setting: when mobility costs are amortized over longer time periods, they become small relative to the potential gains from moving.[8]

To characterize efficiency, the planner's problem maximizes the utility of one household type in one region, say $e = 1$ and $j = 1$, subject to the mobility constraint that type 1 receives the same utility in other occupied regions, $j \neq 1$. As with other planner's problems, the utility of other types are set at arbitrary, feasible levels $\bar{u}_e$, $e \neq 1$. Mobility constrains $\bar{u}_e$ to be constant across regions for each type. The problem is also subject to standard production and resource constraints, including those fixing total population numbers.

According to the solution, households are located efficiently if the following first-order condition is satisfied for each type e and region j:

$$\frac{\partial F_X^j}{\partial N_{Xe}} - x_e^j - MRT_{YX}^j y_e^j - \alpha MRT_{GX}^j \frac{G^j}{N^j} = \nu_e^*, \ \text{if} \ N_e^j > 0. \tag{5}$$

The first term on the left is the marginal productivity of labor in tradable goods, the second and third reflect the resource cost of private consumption, and the last, the resource cost of public consumption through congestion. On the right is a type-specific Lagrange multiplier, which decreases in the implicit weight type e would receive in a social welfare function compatible with the Pareto optimum. Condition (5) implies that it is efficient for households to locate where labor productivity is high relative to the resource cost needed to achieve a nationally-fixed level of utility. Households need fewer resources where quality of life is high.

The efficient federal transfer for type e in region j is derived from Eq. (5) after substituting in market conditions, which describe efficient prices – $\partial F_X^j/\partial N_{Xe} = w_e^j$, $MRT_{YX}^j = p_Y^j$ and $MRT_{GX}^j = p_G^j$ – and household and government budget constraints, (1), (3), and (4). The result is

$$F_e^{j*} = \tau_w^F\left(w_e^j - \bar{w}_e^F\right) + \left(T_e^{jR} - \frac{p_G^j G^j}{N^j}\right) + (1-\alpha)\frac{p_G^j G^j}{N^j} + F_e, \ \text{if} \ N_e^j > 0. \tag{6}$$

[8] The conclusions below may hold even when some households are immobile, so long as there is a sufficiently large number of mobile households of each type.

$\bar{w}_e^F = \left(1/N_e^{TOT}\right)\sum_j N_e^j w_e^j$ is the average wage of type e across locations; T_e^{jR} is the residence-based tax paid by type e in location j.[9] Each term in Eq. (6) requires an explanation:

1. *Federal-tax differential*. The term $\tau_w^F\left(w_e^j - \bar{w}_e^F\right)$ is the federal tax that a household of type e in region j pays relative to the national average for type e. It can be positive or negative, and encourages workers to locate in low-wage areas, as this lowers their federal-tax burdens without lowering their federal benefits from G^F. Federal grants can undo this effect by increasing benefits to highly-taxed areas. This term isolates the dependence of a household's income on its location, apart from its type. Thus, efficient grants undo redistribution across identical households in different regions.
2. *Residence-based taxes net of per-capita expenditures*. $T_e^{jR} - p_G^j G^j/N^j$ expresses Buchanan's (1949) "fiscal residuum" and equals the cost of residence-based taxes borne by type e minus the average per-capita cost. This should be set to zero so that local residence-based taxes exactly reflect local costs, and there is only one local tax price for residing in region j. Substituting in the local government budget constraint (1) yields an additional insight:

$$T_e^{jR} - \frac{p_G^j G^j}{N^j} = \left[\tau_w^j\left(w_e^j - \bar{w}^j\right) + \tau_R^j\left(R_e - \bar{R}^j\right) + \tau_I^j\left(I_e - \bar{I}^j\right)\right] - \frac{\tau_L^j r^j L^j + \tau_K^j i^j K^j}{N^j}. \tag{7}$$

The first right-hand term in Eq. (7), in brackets, breaks down the residence-based taxes paid by type e relative to the average local resident. Households paying more than the average should have excess taxes refunded to them by the federal government, insuring that local taxes operate as user fees. Because households are perfectly mobile, any local attempts at income redistribution are inefficient and are undone by efficient transfers. The second term in Eq. (7) expresses that local source-based revenues, whether on mobile (capital) or immobile (land) factors, need to be taxed away and redistributed nationally. Otherwise, households have distorted incentives to live where valuable land and capital are taxed.[10]

3. *Public-good externality*, $(1-\alpha)p_G^j G^j/N^j$ is the net externality that members of region j receive when a migrant arrives. It results from the non-rivalness of the public good when $\alpha<1$. By paying taxes, a new resident increases public expenditures by $p_G^j G^j/N^j$, while only consuming $\alpha p_G^j G^j/N^j$ in resources. An efficient transfer internalizes this externality with a subsidy proportional to per-capita public expenditures (Buchanan and Goetz, 1972). Most empirical estimates of α are close to one (e.g. Bergstrom and Goodman, 1973), meaning this externality is likely small, although Oates (1988) argues that these estimates of α are biased upward.[11]
4. *Location-independent transfer*: F_e is a lump-sum transfer to households of type e, regardless of where they live. This term accomplishes redistributive goals federally: the greater utility type e receives the higher is F_e. Since there is an F_e for each type, the federal authority can achieve any feasible distribution of utilities, precluding any need for less efficient local redistribution.

The federal transfer, F_e^j minus the first three terms in Eq. (6) reflects the total *net fiscal benefits, or NFB*, of residing in region j for type e. Differences in these NFBs across regions distort migration incentives, and thus efficient transfer policy negates these differences by setting F_e^j so that the *NFB* facing households are the same everywhere.

The transfer formula implies that it is inefficient to subsidize a household's location based on the cost of private or public goods. Neither p_Y^j, and p_G^j appear in Eq. (6) independently of total expenditures $p_G^j G^j$, which matters only for the public-good externality. Thus 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 tradable output. Subsidizing households to live in areas where providing local services costs more ignores these opportunity costs and leads to inefficient use of scarce factors.

According to Eqs. (6) and (7), the average per-capita amount sent to region j is

$$\bar{F}^{j*} = \tau_w^F\left(\bar{w}^j - \bar{w}^{j,F}\right) - \frac{\tau_L^j r^j L^j + \tau_K^j i^j K^j}{N^j} + (1-\alpha)\frac{p_G^j G^j}{N^j} + \bar{F}_e^j \tag{8}$$

where $\bar{w}^{j,F} = (1/N^j)\sum_e N_e^j \bar{w}_e^F$ is the average wage level in region j that would prevail at the national wage level, and $\bar{F}_e^j = (1/N^j)\sum_e N_e^j F_e$ is the average location-independent grant by type. The key result from this aggregation is that the residence-based tax terms in Eq. (7) add up to zero, as discussed below.[12]

2.3. Discussion and relationship to the existing literature

The analysis above is the first to propose that federal transfers may offset location distortions caused by higher federal-tax burdens in higher-wage areas, examined in Hochman and Pines (1993) and Albouy (2009a).[13] Without such offsets, indexing transfers to local costs may improve efficiency if these costs are strongly correlated with local wage levels, as they often are. Otherwise, it is efficient for transfers to ignore differences in local costs, both private and public. This does not preclude categorical transfers to households with special needs, e.g., with handicapped children. Such transfers are handled through the location-independent transfer, F_e. These insights clarify the debate for (e.g., Ladd and Yinger, 1994; Reschovsky, 1994) and against (e.g., Oakland, 1994; Glaeser, 1998) indexing transfers to local costs.

The literature establishes that it is generally efficient and equitable for federal governments to equalize differences in fiscal capacity from source bases (Usher, 1977; Boadway and Flatters, 1982a; Mieszkowski and Toder, 1983; Mckenzie, 2006), unless these taxes fund services to the factors they are levied on. The case for equalizing differences in residence bases has been less clear. In the Tiebout (1956) model, equalization policy breaks the Wicksellian link between residence taxes and local benefits, causing households to locate inefficiently. However, the model requires households to sort perfectly into communities so that each pays the same tax. This seems inapplicable to large jurisdictions, where labor markets tie different household types together.

[9] This condition characterizes efficiency assuming that there are no other distortions in the economy. Most importantly, capital tax rates τ_K^j must be equal across regions for this equation to hold exactly.

[10] It may be efficient to tax capital and particularly land, but the revenues from these taxes need to be distributed equally across regions to prevent inefficient migration. Some may see publicly redistributing oil revenues locally as compensation for negative local externalities associated with oil drilling. Compensating payments of this kind counteract the correct incentives to live away from polluted areas. It is inefficient to pay households yearly to live on top of a toxic waste dump as it encourages them to live there. It is more sensible to make a one-time payment to households on a waste dump when it opens, and not penalize them for moving away.

[11] Oates' critique applies to estimates of α based on the elasticity of $p_G G$ to community size N. Demand for local goods may increase with N, as larger communities may exploit economies of scale for certain hard-to-divide public goods, such as zoos. This implies that expenditures may rise quickly with population size, even when congestion is low, as communities increase the number of subfunctions of local governments.

[12] A version of the "Henry George Theorem" (Stiglitz, 1977) applies when $\alpha=0$, $\tau_w^F = \tau_K^j = 0$ and $\tau_L^j = 1$, in which case $p_G^j G^j = r^j L^j + N^j\left(\bar{F}^{j*} - \bar{F}_e^j\right)$. When local public expenditures equal local land values, net fiscal benefits are zero, and location decisions are efficient.

[13] Poschmann (1998) also considers provincial inequalities in federal taxation, but he does not distinguish amounts due to differences in local wage levels apart from differences in local worker composition.

Without perfect sorting, Buchanan (1950) and Boadway and Flatters (1982a) conclude that equalizing differences in residence-based tax capacities prevents inefficient migration toward high-income communities. This conclusion appears widely accepted in the academic and policy literature on fiscal federalism (e.g., Inman and Rubinfeld, 1997; Musgrave, 1997; Boadway, 2004). It is based on the observation that the efficient transfer formula, seen through Eqs. (6) and (7), is decreasing in the average income level, $\bar{w}^j + \bar{I}^j + \bar{R}^j$. The intuition is that all households want to move to areas with richer types, who contribute greatly to local public services.

Yet, the corrective transfers that turn residence-based taxes into benefit taxes average out to zero in Eq. (8). This happens since each correction depends on household deviations from the local average. Locally, the poor are taxed and the rich are subsidized in equal amounts. In areas with richer types, fiscal residua are eliminated by imposing higher dues on the poor, and giving smaller grants to the rich. Providing greater subsidies to live in areas with poorer types will overcrowd them. Penalizing areas that collect greater revenues from richer types causes richer types to inefficiently seek out areas where tax rates and public services are low.

Buchanan's reasoning is consistent with Eq. (8) but produces interregional transfers because he requires the location-independent transfers, F_e, to be set so that transfers produce no net redistribution across types, i.e. $\sum_j N_e^j F_e^j = 0$. He considers only correcting the fiscal residuum, $T_e^{jR} - p_G^j G^j / N^j$. Since poorer types pay corrective taxes, they need to be refunded more through F_e, implying that areas with more poor types receive a higher $\bar{F}_e^j$. But this refunding is unnecessary, as first explained by Jenkins (1951). Other rules may be set to make grants more or less redistributive, without hindering efficiency. In an example with two types and two regions, Boadway and Flatters (1982b) implicitly impose $F_1^j = F_2^j$, although this constraint is generally incompatible with Eq. (6) when there are more than two types and regions with different tax rates.[14]

2.4. Grants to local governments instead of households

The framework above assumes that federal grants are made to households, when they are actually made to local governments. Such transfers are coarser and filtered through another decision-making body. This makes it more difficult for grants to accomplish the goals that they would in the traditional framework. First, it becomes difficult to correct for type-specific differences in federal-tax burdens when regional wage differentials vary by household type. Second, interregional grants are coarse instruments for redistributing income, as local governments are not required to spend additional funds disproportionately on their poorest residents. Perhaps more importantly, if local governments redistribute federal grants in equal-sized payments, they do not eliminate fiscal residua, $T_e^{jR} - p_G^j G^j / N^j$ (Musgrave, 1961). Eliminating these residua with one grant per region seems unlikely as the number of possible fiscal residua is $J \times E$.

According to Bradford and Oates (1971a, 1971b), the local political process may cause federal grants to lower local tax rates as they reduce the need for local revenues. Such a process redistributes grants according to each household's local tax share. Lowering tax rates shrinks fiscal residua, but may also break the link between local taxes and public expenditures. To illustrate, suppose local governments use only linear taxes. Then, federal grants can reduce fiscal residua simply by lowering local tax rates in Eq. (7). But once the size of these grants exceeds the expenditures in the lowest-spending area, driving tax rates there to zero, complications arise. If tax rates must be non-negative, then as grants increase and more localities levy no taxes, areas with higher public expenditures will receive greater federal payments, distorting location decisions toward those areas. If public expenditures are limited to be equal, then provision levels will not match local tastes, as idealized by the Samuelson rule (2), undermining a core benefit of federalism.[15]

3. Equity criteria

The location-independent transfers, F_e, in the efficient transfer formula (6) imply that equity goals are compatible with efficiency goals, so long as equitable transfers are based on household characteristics other than location. Deciding what types of transfers are equitable involves contestable normative judgments. Keeping with the previous literature, I propose criteria based on measures of income, but which take into account how income depends on location choices. The first criterion, based on earnings potential, is fully consistent with the assumption that households are mobile and that observed data reflect equilibrium outcomes. The second criterion, based on realized incomes adjusted for cost-of-living, may apply out of equilibrium.

3.1. Earnings potential

When households are mobile, equalization policy may aim to direct funds toward households who have relatively low incomes regardless of where they live. Such a policy would depend on earnings potential, which depends on household characteristics. For instance, in any region, less-educated and minority groups earn on average less than others. Potential income differs from realized income, which depends on the workplace. In equilibrium, areas with low private productivity offer lower nominal wages, but these are offset by lower costs-of-living, so that real incomes are equal. Areas with low real-wage levels compensate households with greater quality-of-life or more efficient public services.

Buchanan's (1950) criterion for horizontal equity treats two households with the same nominal incomes in different regions as equals. Instead, the earnings-potential criterion treats the two as equals if they earn the same income in the same region. This is consistent with the above framework, since two households of the same type e, have the same potential income. Earnings potential also provides a criterion for vertical equity. It suggests a single metric for comparing households who differ in race, education or other

[14] In Buchanan's (1950) example $j \in \{A, B\}$ and $e \in \{s, u\}$ where s is skilled and u is unskilled, all income is from labor $w_s^A = w_s^B = 10000$, $w_u^A = w_u^B = 1000$ $N_s^A, N_u^A, N_s^B, N_u^B = (2, 1, 1, 2)$ with $\tau_w^A = \tau_w^B = 0.1$. No externalities are considered. This implies efficient transfers are $(F_s^{A^*}, F_u^{A^*}, F_s^{B^*}, F_u^{B^*}) = (F_s + 300, F_u - 600, F_s + 600, Fu - 300)$ where F_s and F_u are unspecified, implying aggregate transfers to region A and region B should differ by $F_u - F_s$. In the name of equity, Buchanan imposes the rule that no transfers are made across types, meaning $\sum_j N_e^j F_e^j = 0$, and proposes the solution $(F_s^A, F_u^A, F_s^B, F_u^B) = (-100, -200, 200, 100)$, which is consistent with $(F_s, F_u) = (-400, 400)$. The redistribution from the high wage region to the low-wage regions is not needed for efficiency, i.e. correcting the "fiscal residua" that Buchanan emphasized, but only to satisfy Buchanan's rule. The supporting statement by Boadway and Flatters (1982a, pp. 629-30), translated in the notation here uses the same tax rate for all income sources, $\tau_I^j = \tau_R^j = \tau_w^j = \tau$, with total personal income termed $PI^j = w^j + I + R$ Suppose, for instance, that both provinces levied the same personal tax rates $(\tau^1 = \tau^{2'})$. The NFB difference due to residence-based taxes would simply be $\tau(\overline{PI}^1 - \overline{PI}^2)$ and would represent the difference in per capita public sector benefits arising solely from differences in residence-based tax bases. Notice that the NFB difference is identical over all income groups. Therefore the equalization program that is called for on efficiency grounds is one that fully equalizes per capita revenues from both source-based taxes and residence-based taxes. This argument appears to make the most sense if we assume that $F_1^j = F_2^j$, in which case $(F_s^A, F_u^A, F_s^B, F_u^B) = (-150, -150, 150, 150)$, which is consistent with $(F_s, F_u) = (-450, 450)$. However, it cannot apply to more than 2 regions. Mieszkowski and Musgrave (1999) explore how Buchanan's criterion produces smaller cross-provincial transfers than Boadway and Flatters'.

[15] If local tax rates can be negative, then large uniform lump-sum grants could cause local governments to pay out subsidies proportional to resident incomes, creating distortionary fiscal residua that benefit the rich relative to the poor. This seems strange, since lump-sum payments would not be distortionary. But then there is a question of why local governments do not resort to using efficient lump-sum taxes without federal grants.

characteristics, depending on how each affects earnings. Some characteristics may be purposefully excluded. Measuring potential income raises practical issues in applications, since the earnings process may depend on unobservable characteristics and may differ by region because of comparative advantage.

There is also the question of how potential earnings across households should be aggregated. One candidate is the average, since this measures overall per-capita buying power. A dollar difference in average earnings potential may be compensated for by up to a dollar in higher transfers, depending on the redistributive preferences of society. Transferring more than a dollar is hard to justify, as the receiving area would then have a higher per capita post-transfer income.

3.2. Realized income adjusted for local costs

This second criterion treats households as equal if their realized incomes adjusted for local costs, p^j, are equal. When labor markets are in equilibrium, low real incomes in an area signal either low earnings potential or high quality of life (or public productivity). When markets are in disequilibrium, low real incomes may signal an oversupply of labor, unrelieved by emigration because of moving costs or other frictions. In this case, real-income differences may not be compensated by local benefits. It may then be equitable to provide transfers to areas with low real incomes, since lower consumption levels reflect lower welfare levels.

This criterion is most appropriate when real income differences originate from unequal earnings potential. It is less appropriate within metropolitan areas, where differences in local costs, such as rents, stem mainly from differences in amenities or job accessibility (see Albouy and Lue, 2011). If an area is inexpensive because it is unsafe or far from employment centers, these lower costs do not result in higher welfare. In a unified labor market, realized nominal income is a more appropriate criterion. Transfers made to residents in areas with low realized income, real or nominal, may improve the welfare of residents in the short-run, but distort long-run incentives for labor to move to where it is in greatest demand. Grants of this kind may perpetuate the welfare differences they seek to eliminate.

3.3. categorical Equity

While it is inefficient to direct funds to areas where public services are costlier, such a practice may help secure greater equity in important categories of consumption, known as "categorical equity" (Tobin, 1970). This assumes that local governments will indeed spend marginal funds on these more important services. Furthermore, it suggests that public categories of consumption, e.g., for schools and sewers, are more basic than private ones, e.g., for food, clothing, and shelter. Categorical equity may be an important criterion, although it deserves careful scrutiny in both theory and application.

4. Estimating the net fiscal benefits of residence across provinces

As seen in Section 2.2, differences in NFBs distort migration decisions. In practice, the components of NFB differences are hard to measure, especially at the household level. Nevertheless, at the aggregate level, we would expect efficient and equitable transfers to obey Eq. (8). Efficient transfers will balance terms on the right of this equation: the first and second terms discouraging residency; the third, reflecting positive externalities, and the fourth, reflecting equity goals. For the application below, I put the first two terms on the left:

$$\underbrace{\bar{F}^j-\tau_w^F\left(\bar{w}^j-\bar{w}^{j,F}\right)+\frac{\tau_L^j r^j L^j+\tau_K^j i^j K^j}{N^j}}_{\widehat{NFB}^j}=(1-\alpha)\frac{p_G^j G^j}{N^j}+\frac{1}{N^j}\sum_e N_e^j F_e. \quad (9)$$

The three terms on the left reflect incentives to locate in province j and are relatively easy to measure: together I term them the *measurable* NFB of province j, or $\widehat{NFB}^j$.

I apply this model to Canada using 2001 data on individuals from the Census and on provinces from CANSIM. In this section, I explain how these data may be used to estimate the three components of $\widehat{NFB}^j$, reported in Table 1. For the application, I normalize each component of Eq. (9) to have a population average of zero. In the next section, I examine where these estimates are related to more speculative measures of public-good externalities and fiscal need, reported in Table 2, to evaluate the efficiency and equity of federal fiscal equalization.[16] Fiscal equalization policy that improves efficiency should make $\widehat{NFB}^j$ equal across provinces if $\alpha=1$, or positively related to local government expenditures if $\alpha<1$. Fiscal equalization policy that improves equity should make $\widehat{NFB}^j$ positively related with at least one of the criteria discussed in Section 3. A policy that does both should be related to a combination of the two.

Although incomplete, the theoretical model seems realistic enough to shed light on whether an existing federal grant system is efficient and equitable, provided the main assumptions hold. In particular, differences in NFB must be sufficiently stable for the static framework, giving households a long window over which they may be mobile. These assumptions should apply to Canada, where interprovincial mobility is quite high (e.g. Bernard et al., 2008), and measurable NFBs show considerable persistence over time, as seen in Fig. 3 below.

4.1. Equalization and other federal grants

Federal grant differences across provinces stem mostly from explicit fiscal equalization payments, which are unconditional block grants. These payments are calculated from a Representative Tax System model that treats source and residence bases similarly, roughly according to the formula

$$EP^j=\max\left\{0,\sum_k\bar{\tau}_k\left(\bar{B}_k-B_k^j\right)\right\} \quad (10)$$

where k indicates a tax base, B_k^j is the quantity of the tax base in province j, $\bar{B}_k$ is the population-weighted average of the tax base, and $\bar{\tau}_k$ is a federally chosen representative tax rate. The sum $\sum_k\bar{\tau}_k B_k^j$ measures the fiscal capacity of province j, while $\sum_k\bar{\tau}_k\bar{B}_k$ is the national standard to which it is compared. The asymmetry of the formula benefits provinces with fiscal capacities below average, but does not penalize those with capacities above average. Equalization payments from this system in 2001 amounted to C$14.2 B (billion), or 1.4% of GDP. Other grant differences arise through small (and since disappeared) asymmetries in the Canadian Health and Social Transfer, a system of block grants worth C$34.9 B, and other federal grants, worth C $3.5 B. As shown in Appendix Table 1, grant differences outside equalization are fairly small.[17]

[16] This model can also be applied in other countries. In the United States, Alaska may offer the highest measurable NFB across states. In the year 2000, Alaska received federal grants of $3619 per capita, or $2582 above average, while its federal-tax burden was only $259 above average. To this should be added source-based revenues: per-capita revenues from oil and gas were $7670, of which $1964 was paid directly to residents through the Alaska Permanent Fund. While I do not have data on source-based revenues in the rest of the United States, they are certainly much smaller per capita. Alaska has no state sales or personal income tax, and yet had combined state and local expenditures of $13,762 per capita, relative to a national average of $6208. Per-capita personal income in Alaska was $30,558 compared to $30,399 nationally.

[17] According to the Canadian Constitution, "Parliament and the government of Canada are committed to the principle of making equalization payments to ensure that provincial governments have sufficient revenues to provide reasonably comparable levels of public services at reasonably comparable levels of taxation." (Subsection 36(2) of the Constitution Act, 1982) Because of its asymmetry, the formula in Eq. (10) does not guarantee this Constitutional goal, which differs significantly from the goal of economic efficiency.

Table 1
Measurable net fiscal benefits of residing in Canadian provinces, relative to the national average: 2001.

Province	Code	Population	Measurable net fiscal benefit			
			Federal grant differential (1)	Federal tax deficit due to wage level (2)	Source-based revenue differential (3)	Measurable net fiscal benefit = (1) + (2) + (3) (4)
Newfoundland	NL	522,033	2117	548	−494	2171
PEI	PEI	136,663	1856	739	−643	1952
Nova Scotia	NS	932,454	1161	622	−542	1241
New Brunswick	NB	749,801	1436	649	−71	2014
Quebec	QC	7,396,331	32	169	−396	−195
Ontario	ON	11,896,663	−417	−244	−422	−1083
Manitoba	MB	1,151,439	1119	415	214	1748
Saskatchewan	SK	1,000,221	570	515	716	1801
Alberta	AB	3,058,017	−343	45	2081	1783
British Columbia	BC	4,076,264	−294	−216	339	−171
Territories	Terr	99,134	15,561	−536	1157	16,182

Measured in 2001 Canadian dollars. Population from CANSIM Table 54-0001. Total federal transfers from CANSIM 384-0011. Federal tax differential based on a marginal tax rate of 24.1% and log wage differences from Table 2 using an earnings base of $16,721. Source-based revenues are the sum of corporate income taxes, mining and logging taxes, natural resources taxes and licenses, and investment income from CANSIM 385-0002. Federal transfer and source-based revenue differentials averaged over 1998 to 2003. See text for further detail.

Table 2
The relationship between federal grants and measurable net fiscal benefits with efficiency and equity criteria: 2001.

Province	Nominal wage level (location effect) (1)	Predicted earnings human cap and minority (2)	Predicted earnings minority only (3)	Realized income adj for costs-of living (4)	Population growth 1991 to 2001 (5)	Population density (per sq. km) (6)	Prov. and local public expenditures (7)
Panel A: measures							
Newfoundland	−2278	125	602	1240	−10.6	1.29	652
PEI	−3070	384	653	−665	4.7	24.15	−272
Nova Scotia	−2584	498	535	−65	1.8	16.87	−1108
New Brunswick	−2693	368	704	144	0.4	10.28	−1119
Quebec	−705	254	417	700	4.4	4.80	748
Ontario	1009	−145	−303	−123	13.1	11.05	−395
Manitoba	−1718	−129	70	−2	3.6	1.78	221
Saskatchewan	−2136	62	317	−148	−0.5	1.54	293
Alberta	−180	14	70	174	16.5	4.62	−53
BC	905	−223	−366	−1241	18.8	4.31	171
Territories	2230	−640	−319	3672	9.9	0.03	−3517
Panel B: regression on federal grants							
Coefficient	−0.43	1.58	1.12	0.29	−70.1	−24.14	0.08
Std. Error	(0.06)	(0.65)	(0.40)	(0.16)	(20.0)	(49.21)	(0.34)
Adjusted R^2	0.77	0.24	0.43	−0.02	0.59	−0.09	−0.12
Panel C: regression on measurable net fiscal benefits							
Coefficient	−0.73	2.25	1.83	0.31	−63.7	−133.34	0.27
Std. Error	(0.15)	(1.62)	(0.98)	(0.32)	(53.4)	(90.77)	(0.73)
Adjusted R^2	0.55	0.07	0.26	−0.09	0.03	0.13	−0.11

Measured in 2001 Canadian dollars. Predicted income based off of predicted wages using an income base of $21,766. Local and provincial expenditures are based on provincial and local government expenditures in CANSIM 385-0002 and 385-0003 averaging from 1999 to 2003. Robust standard errors are in parentheses. Regressions using 10 provinces, excluding territories, are weighted by population. See text for further detail.

Column 1 of Table 1 reports the per-capita distribution of federal grants across areas, averaging over 1999 to 2003 to smooth out any temporary variations. Together, residents of Ontario, Alberta, and British Columbia receive C$379 less than average; Manitoba and Saskatchewan, C$864 more than average; the Atlantic provinces, C$1503 more; and the Territories, C$15,563 more. Quebec, sometimes depicted as equalization's greatest beneficiary, receives just C$32 more than average.

4.2. Local wage levels and federal-tax burdens

To calculate differences in federal-tax burdens across provinces, I first estimate wage levels across provinces, controlling for labor-force characteristics. These wage-levels are supposed to give the causal effect of location on wages, which determine federal-tax burdens. For this exercise, I take full-time workers, ages 25 to 55, from the 2001 Census, based on a 2.7 percent public-use sample of Canadians. I estimate wage differences with the regression equation

$$w_e^{ij} = X_e\beta + \mu^j + \varepsilon_e^{ij}, \tag{11}$$

where w_e^{ij} is the logarithm of wages of individual i in province j, X_e is a vector of characteristics for type e, and μ^j are provincial indicators. The characteristics divide into three categories: (i) standard human-capital, i.e., education (including field of study) and experience; (ii) minority characteristics, related to immigration, language, and ethnicity; and (iii) industry and occupation. Appendix B catalogs these variables in detail, which I fully interact with gender. Identification using least-squares regression requires that the idiosyncratic error term, ε^{ij}, obeys $E(\varepsilon^{ij}|X_e,\mu^j) = 0$.[18]

Average wages in a province, $\bar{w}^j$, decompose into the sum $\bar{w}^j = \mu^j + \bar{X}^j\beta$, where μ^j is the provincial wage level, and $\bar{X}^j\beta$ is the wage predicted by worker composition, where $\bar{X}^j = \left(1/N^j\right)\sum_e N_e^j X_e$. I normalize these components to have a national average of zero. Fig. 1a graphs the estimated composition effects $\bar{X}^j\hat{\beta}$ against the

[18] The regression equation implies that compensating wage differentials across provinces are multiplicatively uniform across types, eliminating comparative advantage. Thus, two individuals who have the same predicted wage in one province have the same predicted wage in another. This appears to be fairly accurate: I have estimated β coefficients separately in different provinces and found them to be very similar.

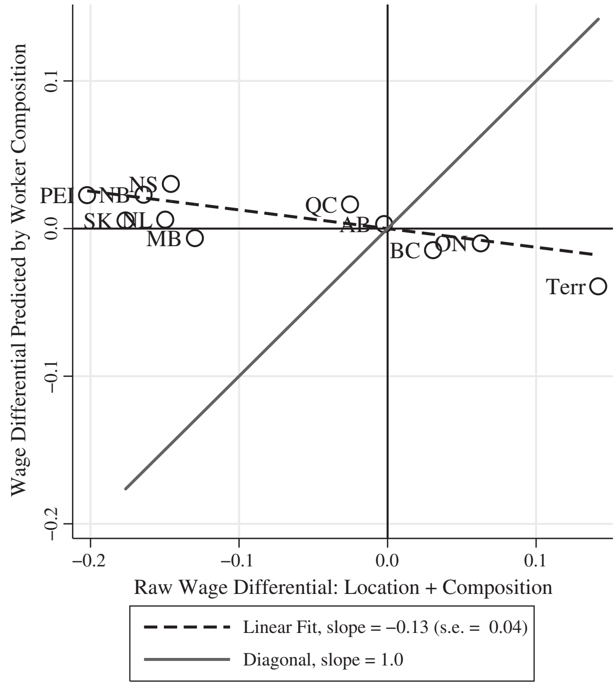

Fig. 1. Wages levels across provinces.

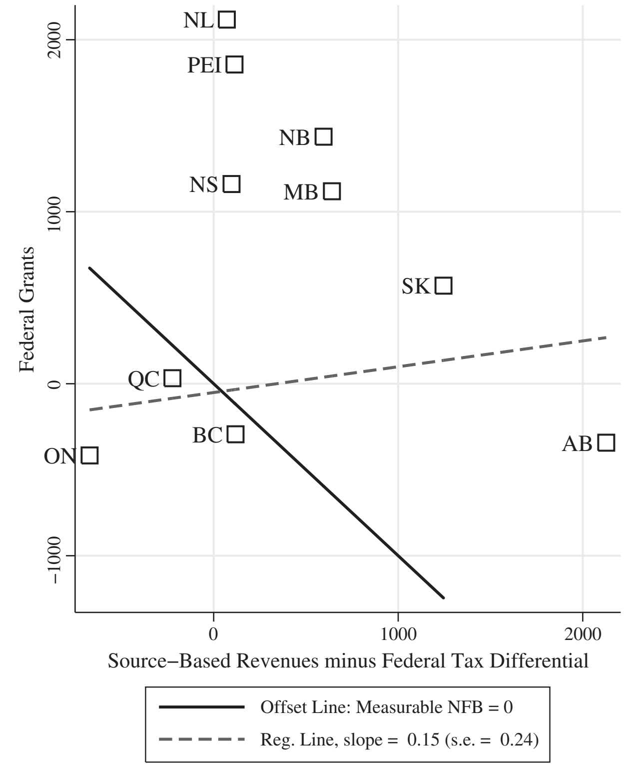

Fig. 2. Per-capita federal grants relative to federal taxes and source-based revenues.

estimated raw-wage differences, $\hat{w}^j$. The distance between the markers and the diagonal line measures the estimated local-wage levels, $\hat{\mu}^j$. Columns 1 and 2 of Table 2 report these components in dollar terms; column 3 reports predicted wages due only to minority characteristics. I report detailed decompositions in Table A2.[19]

The local-wage level estimates, $\hat{\mu}^j$, are large and precise. Ontario and British Columbia offer a 6% premium over the average, while Alberta and Quebec offer wages just below. The remaining six provinces have considerably lower wage levels. In comparison, the composition effects, $\bar{X}^j\hat{\beta}$, are small: workers sort little across provinces according to their average observable skill levels. Workers in Ontario and British Columbia are better educated, but are also more likely to be lower-paid immigrants and minorities. The opposite is true of those in the Atlantic and Prairie provinces. Interestingly, the coefficient from a regression of composition on raw-wage differences in Fig. 1 is -0.13 (s.e. $= 0.04$). Thus, workers in higher-paying provinces have lower-paying characteristics, which is interesting since $\bar{X}^j\hat{\beta}$ measures average earnings potential.[20]

I estimate federal-tax differentials from local wage levels using an effective marginal federal-tax rate of 24.1%. This rate accounts for federal income taxes and the General Sales Tax.[21] In column 2 of Table 1, I report the estimated federal-tax savings, or "deficit", of moving into a province using this calculation. As with wage levels, tax burdens are lowest in the Atlantic and Prairie provinces and high in Ontario and British Columbia.

4.3. Source-based tax revenues

Some judgment is needed to determine what provincial tax revenues are truly source-based. The main criterion is that these revenues may not provide significant benefits to the factors on which they are levied. Instead, source-based revenues benefit local residents, who may not pay them. In the available sources from CANSIM, I use four categories of revenues that appear to be largely source-based. First are provincial corporate income taxes, worth C$14.3 B in 2001, which I take as taxes on capital. Second and third are "mining and logging taxes" and "natural resource taxes and licenses," worth C$1.1 B together, which are from land-based natural resources. Most tax revenues from natural resources, mainly from royalties, fall under CANSIM's vaguely-named category of "investment income," worth C $28.0 B. On average, source-based revenues comprise about 20% of provincial revenues, albeit 37% of Alberta's.[22]

Differentials averaged over 1999 to 2003 are reported in column 3 of Table 1, with all of the sub-components listed in Table A3, together with other provincial revenues. Per capita, Alberta offers the most in source-based revenues: C$2081 more than the national average. Saskatchewan, British Columbia and Manitoba are also above average; the other provinces are below.

4.4. The distribution of net fiscal benefits

Column 4 of Table 1 adds up the measurable NFB for residing in different provinces. These are seen in Fig. 2, which plots federal grant levels

[19] These estimates exclude wage differences due to industry and occupation under the assumption that they capture compensating differentials. Results including industry and occupation do not differ much from the results reported here, and are available from the author.

[20] Identification of μ^j requires that workers do not sort across provinces according to unobserved characteristics that affect wages. To test this possibility, I compare the location effects for workers currently in their province of birth – 69% of the sample – against location effects for the entire sample. The estimated location effects are virtually identical, suggesting that sorting across provinces does not severely bias the estimates.

[21] Direct taxes are measured in CANSIM matrix 354-0006, excluding the General Sales Tax. These data imply larger estimates of federal tax differences across provinces that are strongly correlated with more conservative estimates used here. Modeling progressive changes in federal tax rates would also increase the differentials, but by only a small amount. Using larger tax differentials would only reinforce the conclusions made in this paper.

[22] The distinction between source-based and destination-based taxes is imperfect in the data. For instance, consumption taxes, which I exclude, are source-based when they are paid by visitors from outside the province. The majority of consumption taxes are paid for by residents; arguably, revenues paid by non-residents may pay for services, such as infrastructure, that they use.

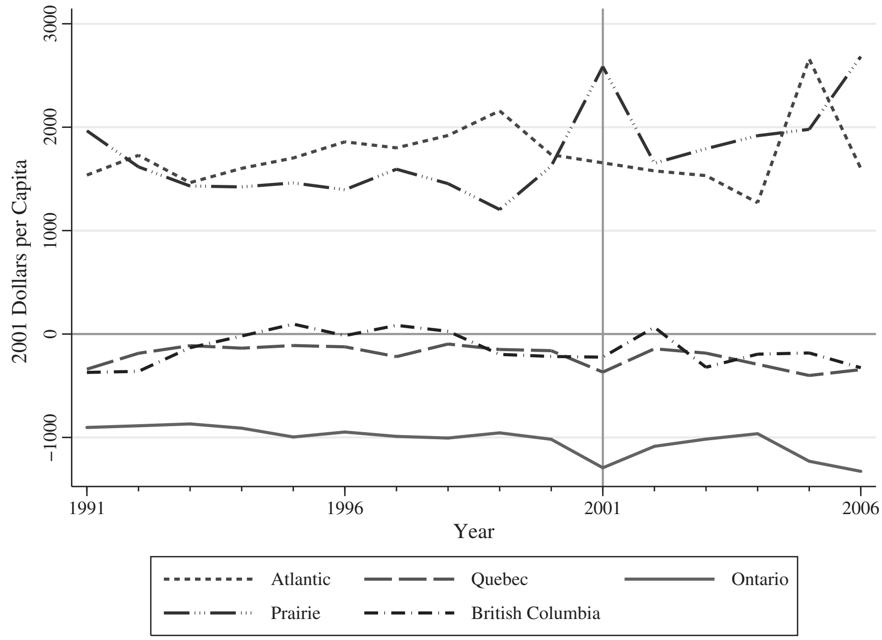

Fig. 3. Net fiscal benefits over time. Atlantic provinces include Newfoundland, PEI, Nova Scotia, and New Brunswick. Prairie Provinces include Manitoba, Saskatchewan, and Alberta.

against source-based revenues added to federal-tax deficits. A province's NFB is equal to the distance between its marker and the solid downward-sloping line that delineates the grants necessary to make measurable NFB zero. Here, we see the provinces cluster into three groups. Ontario has the lowest NFB, at C$1089 per capita below average. Next are British Columbia and Quebec, with benefits C$186 below average. In the remaining provinces, the NFB are quite positive, averaging C$1765. Furthermore, we see that equalization policy does not offset the fiscal benefits from source-based revenues and federal-tax deficits. The positive slope of the regression line suggests that the policy slightly exacerbates them. Finally, in Fig. 3, we see that differences in measurable NFB across the provinces are fairly stable around the time period considered here. According to figures in Courchene and Beavis (1973), these differences have persisted since the 1960s.

5. Are differences in measurable net fiscal benefits justified?

Differences in federal grants or NFBs may be justified if they help reduce regional inequities or correct for externalities. In Canada, these inequities or externalities need to be large to justify the measured differences. Regression results in panels B and C, column 1, of Table 2, imply that a worker who moves to raise her wage level by one dollar expects to see a 42-cent drop in federal grants, and an overall 72-cent drop in NFB, so that her net income rises by only 28 cents. Thus, the current system seriously dulls the incentive to move to where labor productivity is high.

5.1. Equity

The first equity criterion requires that grants or NFBs be directed toward areas with low average earnings potential. These averages, already discussed in Section 4.2, are reported in columns 2 and 3 of Table 2.[23] Using these measures requires that the empirical model (11) is correctly specified and identified: it does appear fairly accurate. Regression results in panels B and C indicate that provinces with higher potential earnings receive more in grants and measurable NFB, contrary to what seems equitable. The positive relationship in column 3 implies that benefits are directed toward provinces with more English-speaking native whites, away from lower-earning immigrants and minorities.[24]

The second equity criterion requires that grants or NFB be directed toward areas with low realized real incomes. Income must be deflated by a local cost-of-living index, which I compute from local housing-cost differences – following Albouy et al. (in press) – seen in column 2 of Table 3. Local costs are high in British Columbia and Ontario, and low in the Atlantic and Prairie provinces. Column 4 reports the resulting real-income differences, which according to panels B and C, are positively related to grants and NFB, again contrary to what seems equitable.

The first equity criterion seems better than the second when labor markets are in equilibrium. In a typical disequilibrium setting, real income levels should be positively related with population growth rates, as high real wages attract workers. Instead, the opposite is true: the correlation between growth rates and real-wage levels is −0.81 reinforcing concerns raised in Shaw (1986). Migration to Ontario and British Columbia is strong in spite of their low real wages, possibly because of their amenities. Yet, as seen in column 5, a 1-percent increase in the growth rate is associated with a C$70 decrease in federal grants. Thus, it appears that equalization policy does not satisfy either equity criterion and is slowing down the equilibration of regional labor markets, encouraging households to live where both productivity and quality of life are low.

As for categorical equity, costs are not an explicit factor in Canada's equalization formula. Empirically, it appears that public-service costs are lower in fiscally advantaged provinces. As seen in Fig. 4, wage levels in education, health, and public administration – mainly public services – are similar to wage levels in other sectors. Following the results in column 1, fiscal benefits are directed toward areas where public labor costs are lower. Costs may also increase in the area of land that needs to be serviced, say for roads. Provinces with a low population density may be at a fiscal disadvantage as

[23] Sample selection problems are avoided by including the predicted earnings of non-workers.

[24] One caveat to this observation is that transfers are directed disproportionately to provinces with more aboriginals, but this is a small portion of the population of any province. Manitoba has the highest portion of 13%.

Table 3
Relative price, wage, quality-of-life differences across provinces and the effects of net fiscal benefits on prices, wages, and employment: 2001.

Benefit rank	Province	Wage-level (location effect) (1)	Hous. cost (2)	Inferred land rent (3)	Net fiscal benefit (4)	Quality of life (5)	Predicted long-run effects of net fiscal benefits			
							Wage (6)	Hous. cost (7)	Land rent (8)	Employment (9)
1	Newfoundland	−0.15	−0.68	−2.39	0.10	−0.22	−0.03	0.24	1.01	0.33
2	New Brunswick	−0.18	−0.41	−1.29	0.09	−0.11	−0.03	0.22	0.93	0.30
3	PEI	−0.21	−0.41	−1.13	0.09	−0.08	−0.03	0.21	0.91	0.29
4	Saskatchewan	−0.15	−0.63	−2.06	0.08	−0.19	−0.03	0.19	0.84	0.27
5	Alberta	−0.01	−0.22	−0.72	0.08	−0.14	−0.03	0.19	0.81	0.26
6	Manitoba	−0.11	−0.52	−1.66	0.08	−0.17	−0.03	0.19	0.80	0.26
7	Nova Scotia	−0.17	−0.16	−0.39	0.06	0.01	−0.02	0.14	0.58	0.19
8	BC	0.05	0.36	1.30	−0.01	0.09	0.00	−0.02	−0.09	−0.03
9	Quebec	−0.03	−0.23	−0.80	−0.01	−0.05	0.00	−0.03	−0.11	−0.04
10	Ontario	0.06	0.07	0.15	−0.05	0.03	0.02	−0.11	−0.47	−0.15

All quantities expressed in logarithmic terms except for net-fiscal-benefit and quality-of-life, each measured as a fraction of average income. Housing-cost and gross real income measures explained in the Appendices. Quality of life is equal to 0.33 times housing cost minus 0.70 times wages minus net fiscal benefits. Wage, housing-cost, land-rent, and employment effects based on model in Albouy (2009a, 2009b) using Canadian parameters in Albouy et al. (2012) and using an elasticity of employment with respect to transfers of 3.23 based on Wilson (2003).

they have fewer people to pay for their land. As seen in column 6, this explanation does not appear to apply as fiscal benefits favor provinces with higher density, particularly in the Atlantic.

5.2. Externalities

The only externality modeled arises from local public-good externalities, represented by $(1-\alpha)p_G^jG^j/N^j$. In a first-best world, where G^j is provided efficiently, estimating this externality requires knowing total local public expenditures and the congestion parameter, α, which is likely small. Combined provincial and sub-provincial public expenditures per capita are reported in column 7 of Table 2. Here we see that expenditures are particularly high in Quebec, and generally high in the Western provinces. Expenditure levels do exhibit a slightly positive, but insignificant, relationship with transfers and measurable NFBs. This evidence turns negative if expenditures are adjusted to account for how they may be increased by NFB differences.[25] Overall, the evidence that equalization corrects for public-good externalities is weak.[26]

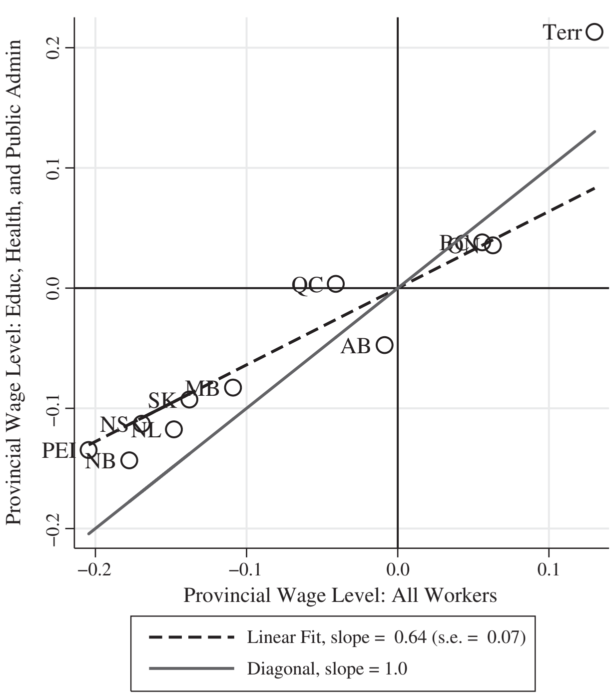

Fig. 4. Local wage levels for public service workers.

6. Simulated effects of inefficient equalization policy

As seen above, differences in measurable NFB across provinces are persistent and do not appear to improve equity or correct for externalities. It seems appropriate to treat a province's advantage in NFB as a locational subsidy, raising the demand to live in that province. Consequently, fiscally advantaged provinces are overpopulated relative to efficient levels, have inflated land and housing costs, and possibly depressed wage levels.

[25] These effects may be particularly important if there are “flypaper effects” (Hines and Thaler, 1995). In a previous version, I correct for endogenous spending effects by subtracting from local expenditures its measurable NFB times a coefficient of 0.36, the share of income spent on local and provincial public services. The relationship is significantly negative, suggesting that benefits are directed toward areas with smaller public-good externalities.

[26] Other reasons, yet to be considered, may justify current equalization policy. In a dynamic setting, federal transfers may stabilize local revenue differences over time: provinces may mutually insure each other through economic swings, reducing inefficiencies due to volatile consumption and mobility. Boadway and Hayahsi (2004) find that variations in transfer payments over time appear to have the opposite effect, making provincial revenues less stable over time. The framework above also ignores externalities from urban agglomeration and congestion. Incorporating them would require quantifying their relative magnitudes across provinces, which is difficult with our current knowledge. Qualitatively, some would argue that Canada's larger cities – Toronto, Montreal, and Vancouver – are inefficiently overcrowded, and hence it is efficient for their provinces to pay others to stay away. This view conflicts partly with the fact that nominal wages in these cities are high, while real wages are low, implying that these cities have high levels of productivity and quality-of-life — see Albouy et al. (in press). Albouy and Seegert (2010) argue that residents of the best cities may wish to pay others to live in less desirable areas, but that such a policy may be inefficient federally. Moreover, the provinces contain many inhabitable areas outside of metropolitan centers. Another justification is that equalization policy promotes residence in remote areas, which yields direct public benefits. Yet, the market is likely to provide most of the necessary incentives to procure such benefits, such as for resource extraction. Among benefits that may have national externalities, e.g., through defense, transportation, or preservation, most would be best procured through direct federal purchases: e.g., opening military bases, building roads, or hiring rangers. Giving a broad subsidy to live in a remote region is a very blunt policy instrument. Furthermore, there may be national benefits from not occupying remote areas, such as in helping preserve wilderness areas. Whatever the case, equalization policy, outside of the Territories, does not promote residence in provinces with fewer residents per square kilometer. Equalization could also promote federal unity. Provinces that benefit from unity may pay those who benefit less, and raise aggregate welfare through greater economies of scale (Alesina and Spolaore, 1997). This is a debatable point, especially since the least-attached province, Quebec, gains little from equalization. Ultimately, it is difficult to provide a strong compelling economic justification to merit such large NFB differences across provinces.

Table 4
Estimated price, employment, and welfare effects of net fiscal benefits, or its components, across provinces, 2001.

	Total net fiscal benefit (1)	Source-based taxes only (2)	Fed taxes and source-based taxes (3)
Average percent effects (mean absolute values)			
Net fiscal benefit differential: E|NFB/m|	0.042	0.027	0.030
Wage effect: E|dw|	0.013	0.009	0.010
Home-good price effect: E|dp|	0.097	0.063	0.069
Land rent effect: E|dr|	0.418	0.270	0.295
Employment effect: E|dN|	0.135	0.087	0.095
Deadweight loss from locational inefficiency			
As a percent of income, E(DWL/Nm)	0.413%	0.212%	0.257%
Total DWL (billions per year, 2001$)	4.3	2.2	2.7
Per capita (per year, 2001$)	144.4	74.0	89.7

Territories excluded. Net fiscal benefit differential measured as a fraction of average income. Other price changes in terms of log changes. Price effects based on calibrated model similar to Albouy (2009a, 2009b). Employment elasticity with respect to net fiscal benefit based on Wilson (2003). See text for formulas and other details.

Through comparative statistics, the theoretical model can predict the effects of NFB differences on prices and quantities relative to a long-run equilibrium where such differences are zero. As migration happens slowly, these effects may take decades. But, as equalization has been persistent for several decades, it is reasonable to think that current prices and quantities already reflect these effects. I simulate the effects here assuming $\alpha = 1$ and that households can be aggregated into a single type. This allows me to apply the methods in Albouy (2009a), where higher taxes are a disamenity to households; symmetrically, I treat measurable NFB as a positive amenity.

As derived in Appendix A.6, the percent effects of fiscal distortions on land rents, wage levels, and housing costs, relative to their efficient levels, are approximated by:

$$\frac{dr^j}{r^j} = \frac{1}{s_R}\frac{dNFB^j}{\bar{m}} \tag{12a}$$

$$\frac{dw^j}{w^j} = -\frac{1}{s_w}\frac{\lambda_L}{\lambda_N}\frac{dNFB^j}{\bar{m}} \tag{12b}$$

$$\frac{dp_Y^j}{p_Y^j} = \frac{1}{s_y}\frac{\lambda_N - \lambda_L}{\lambda_N}\frac{dNFB^j}{\bar{m}} \tag{12c}$$

s_R and s_w are the average shares of income received from land and labor, s_y is the share of expenditures on housing, λ_N and λ_L are the shares of labor and urban land used to produce tradable private goods, and $dNFB^j/\bar{m}$ is the differential net benefit in province j, divided by average income. These parameters are calibrated using the values $s_R = 0.10$, $s_w = 0.70$, $s_y = 0.33$, $\lambda_L = 0.17$, and $\lambda_N = 0.70$, following Albouy et al. (in press).

Long-run employment effects are simulated with a reduced-form elasticity, ε, which gives the percent increase in local employment that arises from a permanent increase in NFB equal to 1% of average income, so that by definition

$$\frac{dN^j}{N^j} = \varepsilon\frac{dNFB^j}{\bar{m}}.$$

Estimates of this elasticity based on Canadian data are controversial, although Wilson (2003) gives the most plausible number by extending the short-run estimates of Watson (1986) and Winer and Gauthier (1983) to a long-run encompassing 50 years. His estimates imply an average elasticity of $\varepsilon = 3.23$.[27] These population shifts create locational inefficiencies, with costs as a fraction of income given by the dead-weight-loss formula:

$$DWL = \varepsilon \cdot \text{var}\left(\frac{dNFB^j}{m}\right).$$

In the spirit of Harberger (1964), this formula captures not only the costs of distortions in the labor market but also distortions in other factor markets, such as mobile capital.

Columns 1 through 5 of Table 3 report equilibrium wage, housing-cost, land-rent, quality-of-life, and net-fiscal benefit differences across provinces, ranked from most to least advantaged. Columns 6 through 9 report the predicted effects on prices and population. Taken together, the Atlantic and Prairie provinces have populations of 30%, and housing-costs of 21%, beyond their efficient levels, while their wage levels are slightly depressed. The effects for Quebec and British Columbia are small, meaning the results would not change considerably if Quebec residents are less mobile. Ontario is the most adversely impacted, with housing-cost and employment levels 10 and 14% below their efficient levels. In sum, the results imply that Canada's less amenable and less productive provinces contain over 2 million people who would rather move if they were not paid to stay where they are.

The employment and deadweight loss predictions are robust to many assumptions of the model, since they are simulated from a reduced-form parameter, which may include many un-modeled effects. The wage effects are sensitive to the assumption that NFB accrue to households; if they improve the productivity of firms, the effects on wages would be positive, although the effects on prices and rents would be similar.[28] The mobility of households and capital imply that local land owners bear the final incidence of NFB differences, raising the relative value of land in advantaged provinces. If households are imperfectly mobile, the model predicts weaker effects on prices and wages; households bear some of the incidence, as real wages do not completely adjust to offset the NFB.

The average effects of NFB on prices, wages, and employment, and the total deadweight loss across the economy are reported in column 1 of Table 4. The deadweight loss of the locational inefficiencies created by NFB differences is 0.41% of income per year, or roughly C $4.3 billion in 2001 dollars. Since equalization policy exacerbates differences in NFB, columns 2 and 3 present counterfactual estimates of the efficiency costs without them. They imply that if the only distortion came from source-based revenues and federal taxes the deadweight loss would be 0.23% of income. Therefore, equalization policy

[27] This is obtained by regressing proportional population flows between provinces, "*deltm*", on changes in net fiscal benefits between provinces, "*delt77*", normalized as a fraction of income. The estimate of 3.23 using provinces is almost half the size of $\varepsilon = 6$ that Bartik (1991) finds using metropolitan areas. As mobility responses across provinces should be smaller than across metropolitan areas, these differences seem plausible and consistent. Of course, symmetric treatment of federal transfers and taxes may not be fully warranted.

[28] If there are agglomeration effects from higher populations, the effects of NFB on wages may be positive, while the effects on rents and housing will be larger.

increases inefficiency costs by 0.18% of income, or C$1.9 billion per year, more than 13% of the value of equalization grants.

7. Conclusion and application to other countries

If the analysis here is at all accurate, it deserves considerable thought by economists and policy-makers interested in place-based policies in Canada and elsewhere. The theoretical analysis adds to the literature by establishing that inter-regional transfers that maximize the efficiency of long-run household location choices will (i) focus on source, rather than residence-based capacities; (ii) ignore local cost differences; (iii) separate income differences due to the location of labor from those due to its composition; and (iv) recognize that regions with higher federal-tax burdens are less attractive unless they receive higher federal transfers. The analysis also suggests two extensions of Buchanan's equity criterion: rather than defining equals according to nominal income, they may be defined according to real income or potential income.

According to the criteria used here, equalization policy in Canada appears to be inefficient and somewhat inequitable. Fiscal benefits are tilted toward less productive and less amenable provinces and seem to disadvantage minority households. Equalization policy would be more efficient if it redistributed source-based revenues more intensely and refunded interregional federal-tax disparities. Such reform would likely meet considerable political opposition: Evans (2005) finds that per-capita representation in the House of Commons is 50% higher for provinces that benefit from equalization relative to provinces that do not. While it may be that Canadians wish to pay households to live in certain provinces for reasons not considered here, it could be that equalization policy has more of a political basis than an economic one.

The lessons learned have applications for other countries as well. For example, equalization systems in Australia, Scandinavia, and Japan all lower federal payments to areas with greater residence-based tax capacities. Unlike the Canadian system, their systems also distribute more to areas deemed to have higher public-service costs, such as rural areas where the costs of providing infrastructure are higher per capita, which could make them more inefficient. However, in Australia, a major factor in determining “costs” are the number of Aboriginals: if properly targeted, these types of categorical transfers are compatible with efficiency goals.

Some lessons may also be applied to the United States. Most states have school finance equalization programs based on nominal property values (see Hoxby, 2001), although these often apply across areas with shared labor markets, making the framework here less applicable. Nevertheless, in California, Downes (1992) finds that in school finance equalization eliminated the relationship between school funding and incomes, including those tied to local wage levels. This makes it harder for schools in high-wage areas to hire qualified teachers. At the federal level, Title I education grants are allocated according to nominal poverty thresholds, ignoring the role of local wage levels. Nominal incomes are also used to determine federal matching rates for large programs such as Medicaid: in 2010, Mississippi and West Virginia received nearly 3-to-1 matching, while Colorado and Virginia received only 1-to-1 matching.[29] Since each system has its idiosyncrasies, separate analyses are required to evaluate the efficiency and equity of federal transfers systems in other countries, but the framework provided here may serve as a helpful starting point to further study.

[29] This matching rate for Medicaid is determined by the Federal Medical Assistance Percentage which sets the state share at 0.45× (State per capita income/U.S. per capita income)^2, bounded below by 0.5 and above by 0.83.

Appendix A. Theoretical Derivations

Appendix A.1. Set-up

The total population is distributed across the regions according to the constraint $\sum_j \mathbf{N}^j = \mathbf{N}^{TOT}$, where, $\mathbf{N}^{TOT} = (N_1^{TOT}, \ldots, N_E^{TOT})$. Assume that capital is fixed in the economy at the level K^{TOT}. Consumption bundles within each region are described by the vectors $\mathbf{x}^j = (x_1^j, \ldots, x_E^j)$, and $\mathbf{y}^j = (y_1^j, \ldots, y_E^j)$. We use F_X to denote the production function for tradable goods, the quantities K_X^j, L_X^j and $\mathbf{N}_X^j = (N_{1X}^j, \ldots N_{EX})$ to denote the capital, land, and labor used to produce the traded good, and X^j the amount of the traded good produced in region j. Notation for the non-traded good and government-provided good is similar, leading to the following 3 production constraints for each region j

$$F_X\left(K_X^j, L_X^j, \mathbf{N}_X^j; A_X^j\right) \geq X^j$$
$$F_Y\left(K_Y^j, L_Y^j, \mathbf{N}_Y^j; A_Y^j\right) \geq Y^j$$
$$F_G\left(K_G^j, L_G^j, \mathbf{N}_G^j; A_G^j\right) \geq G^j.$$

In addition, there are $J(2+E)$ local resource constraints:

$$K^j \geq K_X^j + K_Y^j + K_G^j$$
$$L^j \geq L_X^j + L_Y^j + L_G^j$$
$$\mathbf{N}^j \geq \mathbf{N}_X^j + \mathbf{N}_Y^j + \mathbf{N}_G^j$$

although federally, capital and land are mobile, so that local resources are simply limited by the $1+E$ aggregate constraints

$$K^{TOT} \geq \sum_j K^j$$
$$\mathbf{N}^{TOT} = \sum_j \mathbf{N}^j.$$

In addition, we may write a plethora of non-negativity constraints, the most interesting ones being

$$K^j \geq 0, \quad \mathbf{N}^j \geq 0$$

for each j. Finally there are two consumption constraints, a global one for the tradable goods, and J local ones for non-tradable goods:

$$\sum_j X^j \geq \sum_j \left(\mathbf{N}^j \cdot \mathbf{x}^j + x^F\right)$$
$$Y^j \geq \mathbf{N}^j \cdot \mathbf{y}^j + y^{jF}$$

where x_F and y^{jF} are goods appropriated by the federal government to produce G^F, a process which does not require modeling.

Appendix A.2. The planner's problem

Pareto efficient allocations are solved for using a planner's problem under the constraint of perfect mobility. The perfect mobility case corresponds best with the market economy over the very long run, and avoids problems of redistribution within types across different regions. With multiple types, we maximize the utility of one type in a single region, chosen arbitrarily, and guarantee that all others of that type in other regions get the same utility, so that there are no moves. Furthermore, we assign each other type an arbitrary level of utility regardless of where they live, combining the conditions for mobility and efficiency.

This planner then chooses $\left\{\mathbf{N}^j, \mathbf{x}^j, \mathbf{y}^j, G^j, K_X^j, K_Y^j, K_G^j, L_X^j, L_Y^j, L_G^j, \mathbf{N}_X^j, \mathbf{N}_Y^j, \mathbf{N}_G^j\right\}_{j=1}^J$ to solve the program

$$\max U_1\left(x_1^1, y_1^1, \frac{G^1}{(N^1)^\alpha}; Q^1\right)$$

subject to the constraints

$$U_1\left(x_1^j, y_1^j, \frac{G^j}{(N^j)^\alpha}; Q^j\right) \geq U_1\left(x_1^1, y_1^1, \frac{G^1}{(N^1)^\alpha}; Q^1\right)$$

for all j and that

$$U_e\left(x_e^j, y_e^j, \frac{G^j}{(N^j)^\alpha}; Q^j\right) \geq \bar{U}_e$$

for all j and each e.

Combining as many constraints as possible, and leaving out the non-negativity constraints, produces a combined Lagrangian

$$\begin{aligned}\mathcal{L}() = & \sum_j \sum_e \eta_e^j U_e\left(x_e^j, y_e^j, \frac{G^j}{(N^j)^\alpha}; Q^j\right) \\ & + \pi_X\left[\sum_j F_X\left(K_X^j, L_X^j, \mathbf{N}_X^j; A_X^j\right) - \sum_j \mathbf{N}^j \cdot \mathbf{x}^j - x^F\right] \\ & + \sum_j \pi_Y^j\left[F_Y\left(K_Y^j, L_Y^j, \mathbf{N}_Y^j; A_Y^j\right) - \mathbf{N}^j \cdot \mathbf{y}^j - y^{jF}\right] \\ & + \sum_j \pi_G^j\left[F_G\left(K_G^j, L_G^j, \mathbf{N}_G^j; A_G^j\right) - G^j\right] + \sum_j \pi_K^j\left(K^j - K_X^j - K_Y^j - K_G^j\right) \\ & + \kappa\left(K^{TOT} - \sum_j K^j\right) + \sum_j \pi_L^j\left(L^j - L_X^j - L_Y^j - L_G^j\right) \\ & + \sum_j \pi_N^j \cdot \left(\mathbf{N}^j - \mathbf{N}_X^j - \mathbf{N}_Y^j - \mathbf{N}_G^j\right) + \nu \cdot \left(\mathbf{N}^{TOT} - \sum_j \mathbf{N}^j\right)\end{aligned}$$

where the multipliers follow an obvious notation, with $\pi_N^j = (\pi_{N1}^j, .., \pi_{NE}^j)$, and $\nu = (\nu_1^j, \ldots, \nu_E^j)$.[30]

The necessary conditions for a solution are characterized by a large number of first-order Karuch–Kuhn–Tucker conditions, not all of which can be explored here. For each of the goods

$$\begin{aligned}\frac{\partial \mathcal{L}}{\partial x_e^j} &= \eta_e^j \frac{\partial U^j}{\partial x} - \pi_X N_e^j \leq 0 \\ \frac{\partial \mathcal{L}}{\partial y_e^j} &= \eta_e^j \frac{\partial U^j}{\partial y} - \pi_Y^j N_e^j \leq 0 \\ \frac{\partial \mathcal{L}}{\partial G^j} &= \sum_e \eta_e^j \frac{\partial U^j}{\partial g}\left(N^j\right)^{-\alpha} - \pi_G^j \leq 0\end{aligned}$$

which hold with equality when the related quantities are positive. For the allocation of factors within regions, the conditions have the form

$$\begin{aligned}&\frac{\partial \mathcal{L}}{\partial N_{Xe}^j} = \pi_X \frac{\partial F_X^j}{\partial N_{Xe}} - \pi_{Ne}^j \leq 0, \quad \frac{\partial \mathcal{L}}{\partial N_{Ye}^j} = \pi_{Ye}^j \frac{\partial F_Y^j}{\partial N_{Ye}} - \pi_{Ne}^j \leq 0 \\ &\frac{\partial \mathcal{L}}{\partial K_Y^j} = \pi_X \frac{\partial F_X^j}{\partial K_X} - \pi_K^j \leq 0, \quad \frac{\partial \mathcal{L}}{\partial L_Y^j} = \pi_Y^j \frac{\partial F_Y^j}{\partial L_Y} - \pi_L^j \leq 0.\end{aligned}$$

Assuming all goods are produced within regions, we get the classical tangency result for private goods and a generalized Samuelson rule for local-government goods:

$$\begin{aligned}&\frac{N_e^j}{\eta_e^j}\pi_X = \frac{\partial U_e^j}{\partial x}, \frac{N_e^j}{\eta_e^j}\pi_Y^j = \frac{\partial U_e^j}{\partial y} \Rightarrow \frac{\pi_Y^j}{\pi_X} = MRS_{YX}^j = \frac{\partial U_e/\partial y^j}{\partial U_e/\partial x^j} = \frac{\partial F_X^j/\partial N_{Xe}}{\partial F_Y^j/\partial N_{Ye}} = MRT_{YX}^j \\ &\frac{\pi_G^j}{\pi_X} = \frac{1}{(N^j)^\alpha}\sum_e N_e^j \frac{\partial U^j/\partial g}{\partial U^j/\partial x} \Rightarrow \frac{\pi_G^j}{\pi_X} = \left(N^j\right)^{1-\alpha}\overline{MRS}_{gx}^j = MRT_{GX}^j.\end{aligned}$$

The equations imply that within each region, standard allocative, production, and match efficiency conditions should hold.

[30] The first term of the Lagrangian comes from defining $\eta_1^1 = 1 - \sum_{j>1}\eta_1^j$.and simplifying $U_1\left(x_1^1, y_1^1, \frac{G^1}{(N^1)^\alpha}; Q^1\right) + \sum_{j>1}\eta_1^j\left[U_1\left(x_1^j, y_1^j, \frac{G^j}{(N^j)^\alpha}; Q^j\right) - U_1\left(x_1^1, y_1^1, \frac{G^1}{(N^1)^\alpha}; Q^1\right)\right] + \sum_j \sum_{e>1}\eta_e^j U_e\left(x_e^j, y_e^j, \frac{G^j}{(N^j)^\alpha}; Q^j\right)$.

The most interesting conditions relate to the mobile production factors, particularly labor:

$$\begin{aligned}\frac{\partial \mathcal{L}}{\partial K^j} &= \pi_K^j - \kappa \leq 0 \\ \frac{\partial \mathcal{L}}{\partial N_e^j} &= -\alpha \sum_e \eta_e^j \frac{\partial U^j}{\partial g}\frac{G^j}{(N^j)^{\alpha+1}} - \pi_X x_e^j - \pi_Y^j y_e^j + \pi_{Ne}^j - \nu_e \leq 0.\end{aligned}$$

With sufficient Inada conditions applied to the utility function, all regions produce both home and government goods, with labor in each sector. Some regions may not produce tradable goods (e.g. resort regions), but this is ignored for now since it adds little to the analysis. Positive agglomeration spillovers may be contained in π_{Ne}^j as there is no assumption of constant returns to scale.

Using the within-region factor equations, the condition for capital reduces to

$$\frac{\partial F_X^j}{\partial K_X} = \frac{\partial F_X^{j'}}{\partial K_X}$$

in any two regions j and j' with capital. Substituting in $\partial\mathcal{L}/\partial G^j = 0$, which assumes that $G^j > 0$ and is set efficiently, the equation for labor, assuming $N_e^j > 0$ becomes

$$\pi_{Ne}^j - \pi_X x_e^j - \pi_Y^j y_e^j - \alpha\pi_G^j \frac{G^j}{N^j} = \nu_e.$$

Dividing by π_X and substituting in production conditions, this expression becomes

$$\frac{\partial F_X^j}{\partial N_{Xe}} - x_e^j - MRT_{YX}^j y_e^j - \alpha MRT_{GX}^j \frac{G^j}{N^j} = \frac{\nu_e}{\pi_X}$$

seen in Eq. (5) above. Since the right-hand side does not depend on j the left-hand side must be equal across all regions with $N_e^j > 0$. The first term accounts for the marginal productivity of labor. The next two terms give the resource cost of private consumption (perfectly congestible) that goes to residents of each region. In regions with greater quality of life or uncongested local-government goods, these terms will be smaller, since less consumption is required to compensate residents of type e for living in region j. The term starting with α gives the degree of congestion of the public caused by the new inhabitant, which reflects their resource-cost in terms of the government good: if $\alpha = 0$ this term vanishes.

Appendix A.3. Market equilibrium and efficient fiscal grants

In the market environment, factors are perfectly mobile across sectors within region, and labor and capital are perfectly mobile across regions. All input and goods markets are perfectly competitive, and the government is efficient and pays factors for their marginal product. Take x to be the numeraire good, with a price $p_X = 1$, and let p_Y^j be the market price of home goods. The budget constraint of a worker of type e in region j is given by

$$x_e^j + p_Y^j y_e^j + T_e^j = w_e^j + R_e^j + I_e^j + F_e^j$$

where T_e^j is the amount of local taxes paid by resident e in region j. w_e^j are local wages, R_e^j are incomes from land, I_e^j are incomes from capital, and F_e^j are net fiscal transfers, which can include federal income taxes. All income sources are super-scripted to indicate their possible dependence on location.

With perfectly competitive markets we have that

$$\frac{\partial F_X^j}{\partial N_{Xe}} = p_Y^j \frac{\partial F_Y^j}{\partial N_{Ye}} = w_e^j.$$

This can be related to the conditions in the planner's problem through $MRT^j_{yx} = p^j_Y$ and defining $p^j_G \equiv MRT^j_{Gx}$. Putting these into the population condition implies

$$w^j_e - x^j_e - p^j_Y y^j_e - \alpha p^j_G \frac{G^j}{N^j} = \frac{\nu_e}{\pi_X}.$$

Substituting in the budget constraint

$$T^j_e - F^j_e = \alpha p^j_G \frac{G^j}{N^j} + R^j_e + I^j_e + \frac{\nu_e}{\pi_X}.$$

This condition says that local tax levels, net of fiscal transfers, i.e. total payments to both levels of government, should equilibrate congestion of government-good consumption, and any place-based income differentials from land and capital incomes. The constant term implies that this can differ across types but not across regions.

Appendix A.4. The Boadway–Flatters (1982a) model

In this article there is no private home-good sector, and no differences in Q^j, A^j_X, or A^j_Y across locations, only L^j. G^j is produced out of X^j, which can be simulated here by assuming that $p^j_G = 1$. Production exhibits constant returns to scale in all factors, implying falling returns to scale in N and K.

Case 1. Lump-sum taxes and local rent sharing.

In this first case, labor is homogenous and there is no capital. Local government goods are paid with a local uniform head tax, and residents inherit land in the location that they move to, sharing it equally with all other residents (although they don't live on it).

$$T^j = G^j / N^j$$
$$R^j = r^j L^j / N^j$$

where $r^j = \partial F^j_X / \partial L_X = (X^j - N^j_X \partial F^j_X / \partial N_X)/L^j$, by Euler's Theorem. Substituting in and rearranging

$$F^j - F^{j'} = (1-\alpha)\left(\frac{G^j}{N^j} - \frac{G^{j'}}{N^{j'}}\right) - \left(R^j - R^{j'}\right)$$

for any two regions j and j'. Federal transfers should subsidize federal externalities, which increase with the level of per-capita government-good provision, and completely tax away differences in locally appropriated land rents.

Case 2. Source-based and residence-based taxes.

Labor is still homogenous, but capital is reintroduced, and property is owned uniformly regardless of location. Source-based taxes on capital and land are given by τ^j_K, τ^j_L, and a residence-based tax on labor is τ^j_N. In addition, there is a property-tax rate, τ^j_P on income from land and capital.

$$I^j = \frac{1}{N^{TOT}} \sum_j \left(1 - \tau^j_K\right) i K^j = \frac{1}{N^{TOT}} i \left(K^{TOT} - \sum \tau^j_K K^j\right)$$
$$R^j = \frac{1}{N^{TOT}} \sum_j \left(1 - \tau^j_L\right) r^j L^j$$
$$T^j = \tau^j_N w^j + \tau^j_P \left(I^j + R^j\right)$$
$$G^j = \tau^j_K i K^j + \tau^j_L r^j L^j + \tau^j_N w^j N^j + \tau^j_P \left(I^j + R^j\right) N^j$$

where $r^j = \partial F^j_X / \partial L_X = (X^j - K^j_X \partial F^j_X / \partial K_X - N^j_X \partial F^j_X / \partial N_X)/L^j$, by Euler's Theorem. Because these taxes are uniform within regions, they do not distort production efficiency within regions. However, they do distort the allocation of mobile resources across regions. If $\tau^j_K \neq \tau^{j'}_K$ then the allocation of capital will be distorted as

$$i = \frac{\partial F^j_X}{\partial K_X}\left(1 - \tau^j_K\right) = \frac{\partial F^{j'}_X}{\partial K_X}\left(1 - \tau^{j'}_K\right).$$

The allocation of labor will be distorted unless federal transfers are set so that

$$F^j - F^{j'} = \left(T^j - T^{j'}\right) - \alpha\left(\frac{G^j}{N^j} - \frac{G^{j'}}{N^{j'}}\right) = (1-\alpha)\left(\frac{G^j}{N^j} - \frac{G^{j'}}{N^{j'}}\right) + \left[T^j - \frac{G^j}{N^j} - \left(T^{j'} - \frac{G^{j'}}{N^{j'}}\right)\right].$$

Substituting in for T^j and G^j inside the square brackets:

$$F^j - F^{j'} = (1-\alpha)\left[\frac{G^j}{N^j} - \frac{G^{j'}}{N^{j'}}\right] - \left[\frac{\tau^j_K i K^j + \tau^j_L r^j L^j}{N^j} - \frac{\tau^{j'}_K i K^{j'} + \tau^{j'}_L r^{j'} L^{j'}}{N^{j'}}\right]$$

which is the result that fiscal externalities should be subsidized, and that all source-based revenues should be redistributed.

Case 3. Worker heterogeneity.

In this case the location condition for workers becomes

$$F^j_e - F^{j'}_e = \left[T^j_e - \frac{G^j}{N^j} - \left(T^{j'}_e - \frac{G^{j'}}{N^{j'}}\right)\right] + (1-\alpha)\left(\frac{G^j}{N^j} - \frac{G^{j'}}{N^{j'}}\right)$$

or just

$$F^j_e = \left(T^j_e - \frac{G^j}{N^j}\right) + (1-\alpha)\left(\frac{G^j}{N^j}\right) + F_e$$

where F_e satisfies the overall federal budget constraint.

With worker heterogeneity, residence-based taxes and total revenues are given by the following formulas

$$T^j_e = \tau^j_N w^j_e + \tau^j_P \left(I^j_e + R^j_e\right)$$
$$G^j = \tau^j_K i K^j + \tau^j_L r^j L^j + \sum_e \left(\tau^j_N w^j_e N^j_e + \tau^j_P \left(I^j + R^j\right) N^j_e\right)$$
$$= \tau^j_K i K^j + \tau^j_L r^j L^j + \tau^j_N \bar{w}^j N^j + \tau^j_P \left(\bar{I}^j + \bar{R}^j\right) N^j$$

where $\bar{w}^j = \left(1/N^j\right) \sum_e N^j_e w^j_e$. Substituting in we get

$$F^j_e = F_e + (1-\alpha)\frac{G^j}{N^j} - \left\{\frac{\tau^j_K i K^j + \tau^j_L r^j L^j}{N^j} + \tau^j_N\left(\bar{w}^j - w^j_e\right) + \tau^j_P\left[\left(\bar{I}^j + \bar{R}^j\right) - \left(I^j_e + R^j_e\right)\right]\right\}.$$

The addition here is that residents whose tax payments are below the local average should be given less federal money; residents with above-average tax payments should receive a subsidy.

This implies that the average level of transfers that should be given to region j is given by

$$\bar{F}^j = \frac{1}{N^j} \sum_j N^j_e F^j_e = \frac{1}{N^j} \sum_j N^j_e F_e + (1-\alpha)\frac{G^j}{N^j} - \left\{\frac{\tau^j_K i K^j + \tau^j_L r^j L^j}{N^j}\right\}.$$

The terms related to income from labor and property add up to zero when averaged. The grants have to be targeted directly at the right population or they do not have the corrective effect: effectively taxes on those types who are locating for fiscal reasons are exactly canceled out by subsidies on those with above average incomes. The federal government can give differential grants according to the composition of types across locations, but this is for redistributional purposes, not for efficiency.

Appendix A.5. The final model

The case in the main text is a fairly straightforward expansion of the last model, using the assumption that income from capital and land are location independent. p_G^j is assumed to equal MRT_{Gx}^j instead of one. The attribute differences, Q^j, A_X^j, A_Y^j, A_G^j, affect the quantities and prices in the model, but do not change the fundamental nature of the conditions. In addition, we can redefine federal grant differences $\tilde{F}_e^j - \tilde{F}_e = \left(F_e^j + \tau_w^F w_e^j\right) - \left(F_e + \tau_w^F \bar{w}_e\right)$ to add back in differential federal-tax payments, so that they then become pure federal transfers, with federal taxes accounted for separately, and use the previously derived formulas.

Appendix A.6. Equilibrium conditions and foundations of the simulated effects

The expenditure function for a household, $e(p^j, Q^j, w, g^j, T^j.u)$ measures the cost of consumption needed to attain utility u, and is increasing in p^j, and decreasing in w^j, Q^j, T^j, and g^j.[31] Since households are fully mobile, all cities must have the same utility, $\bar{u}$. This means that firms in cities with higher prices or lower quality of life, compensate their workers with a greater after-tax income:

$$e(p^j, \bar{u}; Q^j) = m^j + NFB^j.$$

The unit cost of producing a tradable good is $c_X\left(r^j, w^j, \bar{\imath}; A_X^j\right) = c_X\left(r^j, w^j, \bar{\imath}\right)/A_X^j$ where $c(r,w,i) \equiv c(r,w,i;1)$.[32] A symmetric definition holds for the unit cost of a home good, c_Y. As markets are competitive, firms make zero profits in equilibrium. Therefore, for given output prices, more productive cities must pay higher rents and wages to achieve zero profits. In equilibrium, the following zero-profit conditions hold in all producing cities

$$c_X\left(r^j, w^j, \bar{\imath}\right)/A_X^j = 1 \tag{A.1}$$

$$c_Y\left(r^j, w^j, \bar{\imath}\right)/A_Y^j = p^j. \tag{A.2}$$

Applying the envelope theorem and Shepard's Lemma, the differentials for these conditions are:

$$y \cdot dp^j - \cdot dw^j = dNFB^j$$
$$l_X \cdot dr^j + n_X \cdot dw^j = 0$$
$$l_Y \cdot dr^j + l_Y \cdot dw^j = dp^j$$

where $l_X = L_X/X$, $l_Y = L_Y/Y$, etc. This is taken to be an approximation around the national average. Solving further yields the solution

$$dw^j = -\frac{\lambda_L}{\lambda_N} dNFB^j, \tag{A.3a}$$

$$l \cdot dr^j = dNFB^j, \tag{A.3b}$$

$$y \cdot dp^j = \frac{\lambda_N - \lambda_L}{\lambda_N} dNFB^j. \tag{A.3c}$$

These lead directly to the solutions in Section 6.

Appendix B. Data and estimation

I use Canadian Census data from the 2001 Public Use Microdata Files to calculate wage and housing-cost differentials. The wage differentials are calculated for workers ages 25 to 55, who report working at least 30 h a week, 26 weeks a year. The CMA (Census Metropolitan Area) assigned to a worker is determined by their place of residence, with non-CMA residents pooled by province into a single fictional CMA. The wage differential of a CMA is found by regressing log hourly wages on individual covariates and indicators for a worker's CMA, using the coefficients on these CMA indicators. Province-level wage levels are calculated by averaging CMA-wage effects, weighted by population. Just using province indicators would produce fairly similar results, but would control less for rural–urban disparities.

The covariates are split into three main categories, as mentioned in the text, which can be further sub-categorized.

- i.a 9 indicators of educational attainment, and three variables indicating highest grade, years of university, and years of other schooling;
- i.b a quartic in potential experience, and potential experience interacted with years of education;
- i.c 12 indicators for major field of study;
- ii.a 13 indicators of industry (1980 definition);
- ii.b 25 indicators of occupation (2001 SOC);
- iii.a 4 indicators of marital status (married, divorced, widowed, separated);
- iii.b 5 indicators of minority status (Black, Chinese, South Asian, Aboriginal and other);
- iii.c indicators of immigrant status, time since immigration, and citizenship status;
- iii.d indicators of mother tongue (English, French, or other) and indicators for bilingualism interacted with mother tongue, and for other mother tongue interacted with speaking only French and only English;

All covariates are interacted with gender.

Appendix C. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.jpubeco.2012.05.015.

[31] Formally, $e(p^j, u; Q^j) \equiv min_{x,y}\{x + p^j y : U(x, y; Q^j) \geq u\}$. The use of a single index Q^j assumes that amenities are weakly separable from consumption.

[32] $c_X\left(r^j, w^j, \bar{\imath}; A_X^j\right) \equiv min_{L,N,K}\left\{r^j L + w^j N + \bar{\imath} K : A_X^j F(L,N,K) = 1\right\}$.

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