The Trade-Off between Efficiency and Fiscal Equity in a Federation with Provincial Resource Revenues

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Abstract

We develop a model of a fiscal equalization system, financed by distortionary federal income taxes, with vertical tax externalities between the federal and provincial governments, endogenous provincial fiscal policies, imperfect labour mobility between provinces, and provision of quasi private goods by provinces for an economy where the marginal products of labour are independent of the provincial populations. In the context of this model, we show that an increase in resource rents received in one province can be a Pareto improvement because the resource rich province responds with a tax cut, which generates a vertical fiscal externality that allows the federal government to cut its income tax rate. However, the fiscally induced migration in response to the provincial tax cut creates an aggregate welfare loss relative to a situation where resource rents are equally shared between provinces. Numerical simulations of the model show that a Representative Tax System (RTS) formula for fiscal equalization transfer, which is financed by federal taxes, can result in a welfare loss in the recipient provinces as well as in the resource rich province. The model is also used to illustrate the efficiency-fiscal equity trade-offs from an RTS equalization formula.

Key Words: fiscal equalization, intergovernmental transfers, fiscally induced migration, fiscal externalities

JEL Classification: H77, H71, H72

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1. Introduction

Equalization transfers have been a key component of Canadian federal-provincial fiscal relations since 1957. Their importance was recognized in Section 36(2) of the *Constitution Act, 1982* as a commitment by the federal and provincial governments "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."

While the Canadian equalization system predates it, the seminal paper by Boadway and Flatters (1982) provides an efficiency rationale for equalization transfers in a federation when a household's decision where to live and work is influenced by the tax rates and public service levels offered in different provinces. (See Boadway (2005) and Boadway and Tremblay (2012) for reviews and extensions of the Boadway and Flatters model.) Labour is assumed to be perfectly mobile between provinces and will be allocated up to the point where the after-tax wage rates and the benefit from provincially provided public services are equalized across provinces. The equilibrium allocation of labour across provinces can be inefficient because individual workers do not take into account the fiscal externalities they impose, or provide, to existing residents when they move from one province to another. These fiscal externalities arise because, if the provinces provide pure public goods, the migrant does not add to the cost of providing the public good in that province, but helps to finance it through the provincial taxes that he pays. The other source of fiscal externality arises from provincial variations in the net fiscal benefits that workers can derive in different provinces because of differences in the source-based tax revenues—economic rents from provincial ownership or taxes on natural resources and source-based taxes on capital—and differences in average incomes that give rise to differences in personal income tax bases.[1] A key assumption in the Boadway and Flatters model is that production exhibits a diminishing marginal product of labour due to a fixed input, such as land or mineral resources, in each province. To the extent that labour is attracted to regions that provide

[1] Albouy (2012) argues that differences in residence based taxes should not be a source of transfers if workers are perfectly mobile across provinces.

these net fiscal benefits, the marginal product of labour will not be equalized across provinces, a condition that is required for an efficient allocation of labour across provinces. Boadway and Flatters also stress that an equalization grant system promotes horizontal equity in the provision of provincial public services at comparable levels of provincial taxes.

Although the Boadway and Flatters framework has been extremely useful in identifying potential sources of efficiency gains from equalization grants, it has a number of short-comings when it comes to analyzing the actual equalization system that has been adopted in Canada. Six limitations of the Boadway and Flatters model are listed below. First, equalization transfers are financed by the federal government by means of distortionary taxes on country-wide tax bases and not through lump-sum transfers from one province to another. Second, both levels of government levy distortionary taxes on the same tax bases, leading to potentially significant vertical tax externalities. Third, the equalization formula may influence the fiscal decisions of recipient provinces. Fourth, while labour is "reasonably mobile" in Canada, it is far from perfectly mobile because migrants lose access to their social networks in the provinces where they were are born and raised, and they incur transportation and other re-location costs when they move to another province.[2] To the extent that these mobility costs inhibit migration in response to differences in net fiscal benefits, the misallocation of labour caused by differentials in taxes and public service levels are reduced. Fifth, as Boadway and Tremblay (2012, p.1072) note, provincial governments' provide mainly "quasi-private goods" such as education, health care, and welfare and social services which limits the public good externalities created by population mobility. Finally, the Boadway and Flatters model assumes that the entire provincial economy is subject to diminishing returns to labour, but this is a highly questionable assumption because the resource sectors in resource-rich provinces directly employ only a small fraction of the labour force and the rest of the economy could be characterized by constant returns to scale in production.

In this paper, we use the framework developed in Boadway and Tremblay (2010) to model of an equalization system which has the following features—federal financing of equalization transfers with distortionary taxes on national tax bases, vertical tax externalities between the federal and provincial governments because they levy taxes on the same base,

[2] See Day and Winer (2012) and Amirault et al. (2013).

endogenous fiscal policies of the provinces that are influenced by the mobility of the population and the equalization transfer formula, imperfect labour mobility between provinces because of mobility costs, provision of quasi private goods by provinces, and marginal products of labour that are independent of the provincial populations because provinces are small open economies with constant returns to scale in the non-resource sector. It is hoped that this model captures features of the Canadian fiscal system that are relevant for evaluating policies with regard to the equalization system.

In particular, we use the model to illustrate the potential trade-off between efficiency and fiscal equity when the resource revenue inclusion rate in the equalization formula changes. The inclusion rate for natural resource revenues is one of the most important and controversial aspects of the equalization system. The average provincial per capita fiscal capacity from resource revenue in 2011-12 was $695, which was only a quarter of the personal income tax and consumption fiscal capacity measures. However, resource revenues are concentrated in three provinces—Newfoundland and Labrador, Saskatchewan and Alberta—and this implies that a substantial proportion of the equalization entitlements can be driven by the resource revenues. For example, using the 2011-12 figures for fiscal capacity, total equalization entitlements would have been $24.2 billion with a 100 per cent inclusion rate, $17.8 billion with a 50 per cent rate, $14.5 billion with a 25 per cent rate and $12.8 billion if resource revenues were excluded from the calculations altogether. In other words, a 50 per cent inclusion rate reduces total equalization entitlements by about 25 per cent compared to entitlements with a 100 per cent inclusion rate.

The problem created by the mismatch between the main sources of federal tax revenues and the equalization entitlements created by provincial resource revenues was first pointed out by Tom Courchene during the first oil price boom in the 1970s. Since that time, it has played an important role in shaping the program, including the adoption of the five 'representative' province standard in 1982 and the ceiling on total equalization entitlements in 2009. Recent commentaries on the reform of the equalization system also recognize the problems created by the mismatch:

> As currently designed, equalization cannot undo imbalances between have and have-not provinces. It is becoming increasingly difficult for the federal government to finance full equalization commitments with only limited access to the main source of imbalances. Boadway, Coulombe, and Tremblay (2013)

> A key reason why energy royalties pose such a challenge for the equalization program is that the federal government cannot constitutionally access provincial energy royalties/rents. Hence, any equalization payments driven by these energy royalties/rents must come out of the federal government's consolidated revenue fund which, in turn, means that the provinces' shares of this funding are not far off their population shares. Courchene (2013)

> Reform options must acknowledge that the federal government collects almost no resource royalties and that the funds available to the federal government for redistribution come disproportionately from the Ontario corporate, personal, and consumption tax bases. Mendelsohn (2013)

While federal financing of equalization entitlements has been an important consideration in the design of the equalization system, we have lacked an analytical framework for evaluating the alternative policy parameters for the equalization program. The goal of this paper is to develop a model that captures the key features of the Canadian equalization system and to use it to illustrate the welfare effects of varying the resource revenue inclusion rate. In Section 2, we adapt the Boadway and Tremblay (2010) model for a federation with imperfectly mobile workers in which resource revenues accrue to the provincial governments. The model predicts that a province receiving resource rents will adopt a fiscal policy that mainly creates a tax advantage for that province and that an increase in resource rents received by one province benefits the residents of other provinces through a vertical tax externality. In Section 3, we provide an intuitive description of the effects that resource revenues in one province have on the allocation of the population in the federation and on the welfare of individuals in both provinces. We show fiscally induced migration results in an efficiency loss per dollar of resource revenue that is approximately equal to the provincial marginal cost of public funds multiplied by one half the fraction of the population that has moved to take advantage of the differential in after-tax incomes and public services. In Sections 4 and 5 we use numerical simulations to illustrate the properties of the model and the potential efficiency-fiscal equity trade-off that occurs with federal financing of equalization transfers out of general tax revenues. We use a social welfare function that includes both efficiency and fiscal equity components, and we show that relatively small changes in the weight that is placed on fiscal equity relative to efficiency can make a big difference in the evaluation of an equalization program. The final section summarizes our conclusions.

2. The Model

Boadway and Tremblay (2010) developed a model of a federation with imperfectly mobile labour where the federal and provincial governments levy distortionary income taxes to finance their expenditures. The current model departs from the Boadway and Tremblay (hereafter BT) model in two important ways. First, it is assumed that the provincial governments provide private goods, not pure public goods.[3] Second, it is assumed that one of the provincial governments receives economic rent whereas in the BT model economic rents are received directly by workers in one of the provinces. As in the BT model, a key assumption of the model is that the marginal product of labour in each province is independent of its population. In this way, the model departs from the conventional assumption of most fiscal federalism models which assume that the production technology exhibits decreasing returns to labour because of a fixed factor such as land or resources. As noted above, the assumption of diminishing returns for an entire regional economy exaggerates the importance of fixed inputs that give rise to economic rents because, to take a Canadian example, the resource sectors are highly capital intensive and directly employ only a small fraction of the labour force in the resource-rich regions. It can be shown that if provinces are small open economies in which the non-resource sector exhibits constant returns to scale, then the marginal product of labour will be constant and determined by productivity in the non-resource sector. This provides the rationale for treating the per capita income in a province as independent of the size of the labour force in the model below.

The federation consists of two provinces, i = 1, 2, with the total population of the federation normalized to unity. Households are identical except for an "attachment to home" parameter, a, as in Mansoorian and Myers (1993), which is uniformly distributed over the interval [0, 1]. We focus on a symmetric model in which the two provinces would be of equal size in the absence of economic rents. A household with attachment parameter a derives utility of $1 - a$ from residence in province 1 and a from residence in province 2.

[3] As Boadway and Tremblay (2012, p.1072) note "While state governments do provide state public goods, by far their most important programs in most federations consist of quasi-private goods, social insurance and targeted transfers, including education, care for the elderly and children, health care, welfare and social services, and sometimes unemployment insurance."

2.1 Household Decisions

As in the BT model, the well-being of a household in the two provinces is given by the following quasi-linear utility functions:

$$U_1(a) = c_1 - h(y_1) + b(g_1) + B(G) + 1 - a \quad (1)$$

$$U_2(a) = c_2 - h(y_2) + b(g_2) + B(G) + a \quad (2)$$

where c_i is the consumption of private goods, y_i is the income earned, and g_i is the publicly-provided private good by the provincial government in province i. G is a public good provided by the federal government, which is the same in both provinces, and $h(y_i)$ is the effort expended to earn income y_i. It is assumed that:

$$h'(y_i) > 0,\ h''(y_i) > 0,\ b'(g_i) > 0,\ b''(g_i) < 0,\ B'(g_i) > 0,\ B''(g_i) < 0.$$

Private consumption is equal to $c_i = (1 - t_i - T)y_i$ where t_i is the income tax rate imposed by province i and T is federal income tax rate.

Households make two decisions—where to live and work and how much to earn. Given the decision to live and work in province i, y_i will satisfy the following condition, $h'(y_i) = 1 - t_i - T$, such that $dy_i/dt_i = dy_i/dT = -1/h'' < 0$. This implies that there is a negative vertical tax externality when either province or the federal government raises its tax rate. Let $V(t_i + T, g_i, G) = V_i$ denote the utility that a household can derive from the fiscal regime in province i. By Roy's theorem, $\partial V_i/\partial t_i = \partial V_i/T = -y_i$.

A household's location decision involves comparing $U_1(a)$ and $U_2(a)$ and the household will live and work in the province where its utility is highest, given t_i, T, g_i and G. There is a critical household with attachment-to-home parameter $\tilde{a}$ that is indifferent between living and working in the two provinces where $\tilde{a}$ satisfies the following condition:

$$V_1 + 1 - \tilde{a} = V_2 + \tilde{a} \quad (3)$$

Note that $\tilde{a}$ is the population of province 1, with $\tilde{a} = (1/2)(V_1 - V_2 + 1)$ and $\partial\tilde{a}/\partial V_1 = 1/2 = -\partial\tilde{a}/\partial V_2$.

2.2 Fiscal Decisions by Province 1

In the absence of federal transfers to the provinces, the budget constraint for province 1 is $t_1 y_1 = g_1$. The province's budget constraint is independent of its population, $\tilde{a}$, because g_1 is a publicly-provided private good and the total expenditure by the province varies with the population of the province, as does its total tax revenues. We assume that the province adopts the fiscal regime which maximizes the total utility of all its residents. For province 1, the total utility of its residents is $W_1 = \tilde{a}V(t_1 + T, g_1, G) + \tilde{a}(1 - \tilde{a}/2)$, where the first term is the fiscal component of W_1 and the second term in the attachment-to-province 1 component of total utility. The province choses t_1 and g_1 to maximize W_1, taking the tax rates and public services of the other provincial government and the federal government as given. However, the provincial government recognizes that its choice of t_1 and g_1 will affect its population and therefore we add the equilibrium migration condition in (3) as a constraint and $\tilde{a}$ as an artificial control variable to the province's maximization problem. The Lagrangian for province 1 is:

$$\Gamma_1 = \tilde{a}V(t_1 + T, g_i, G) + \tilde{a}(1 - \tilde{a}/2) + \lambda_1[t_1 y_1 - g_1] + \mu_1[V(t_1 + T, g_1, G) - V(t_2 + T, g_2, G) + 1 - 2\tilde{a}] \tag{4}$$

The first order conditions are:

$$t_1 y_1 - g_1 = 0 \tag{5}$$

$$V(t_1 + T, g_1, G) - V(t_2 + T, g_2, G) = 2\tilde{a} - 1 \tag{6}$$

$$V(t_1 + T, g_1, G) + 1 - \tilde{a} = 2\mu_1 \tag{7}$$

$$\lambda_1 = \left(\frac{\tilde{a} + \mu_1}{\tilde{a}}\right)\frac{\partial V_1}{\partial g_1} \tag{8}$$

$$\lambda_1 = \left(\frac{\tilde{a} + \mu_1}{\tilde{a}}\right)\frac{1}{1 + t_1 \nu_1} \tag{9}$$

where $\nu_1 = (1/y_1)(dy_1/dt_1) < 0$ is the semi-elasticity of y_1 with respect to t_1. (The semi-elasticity will be a function of $t_1 + T$, but the functional relation is suppressed to minimize notation.) It is assumed that the province is on the upward sloping section of its Laffer curve and therefore $0 < 1 + t_1 \nu_1 < 1$. The province's marginal cost of public funds, which will be defined as

$MCF_1 = (1 + t_1 \nu_1)^{-1}$, will be greater than one because an increase in the provincial tax rate reduces the incentive to earn income.

To provide insights into the optimal fiscal regime for province 1, we need to interpret the Lagrange multipliers, μ_1 and λ_1. Equation (7) can be written as:

$$\mu_1 = \left(\frac{\partial \tilde{a}}{\partial V_1} \right) [V(t_1 + T, g_1, G) + 1 - \tilde{a}] > 0 \qquad (10)$$

The term in square brackets is the utility of the "marginal" resident in province 1 and therefore μ_1 can be interpreted as the gain in total utility from the additional residents that are attracted to the province when the fiscal component of total utility increases. To interpret λ_1, note that $\partial W_1 / \partial V_1 = \tilde{a} + \mu_1$, i.e. the increase in total well-being from an increase in the fiscal component of a household's utility is proportional to the population in province 1 and to the gain from attracting additional residents to the province. Therefore the factor λ_1 in (8) can be interpreted as $\lambda_1 = \left(\frac{1}{\tilde{a}} \frac{\partial W_1}{\partial V_1} \right) \frac{\partial V_1}{\partial g_1}$ or the rate of increase in average utility in province from an increase in g_1.

With the optimal provision of g_1, the province equates the marginal benefit from an additional unit of g_1 with the marginal cost of financing it through a tax rate increase which is given by (9). Since both the marginal cost of public funds and the marginal benefit of public services are valued at $((\tilde{a} + \mu_1)/\tilde{a})$, the province's tax rate, t_1, and provision of g_1 are determined by the budget constraint in (5) and the condition $\partial V_1 / \partial g_1 = MCF_1$. Note that the optimal values for g_1 and t_1 are independent of the province's population, $\tilde{a}$. This implies that changes in province 2's tax rate and public expenditures that may result in changes in the population of province 1 will not affect the optimal values t_1 and g_1. This implies that the well-being of a resident of province 1 is not directly affected by, for example, an increase in the resource rents received by province 2.

2.3 Fiscal Decisions by Province 2

The budget constraint for province 2 is $t_2 y_2 + \Pi/(1 - \tilde{a}) = g_2$ where Π is total amount of resource rent that accrues to the provincial government. We do not model the source of the

resource rent, but assume that all of the rent accrues to province 2 and none is captured by the federal government. Note that province 2's budget constraint is affected by its population because a larger population reduces the per capita resource rent in the province. The province chooses t_2 and g_2 to maximize $W_2 = (1-\tilde{a})V(t_2 + T, g_2, G) + (1/2)(1-\tilde{a}^2)$ given its budget constraint and the equilibrium migration condition.

The Lagrangian for province 2's maximization problem is:

$$\Gamma_2 = (1-\tilde{a})V(t_2 + T, g_2, G) + \frac{1}{2}(1-\tilde{a}^2)$$

$$+ \lambda_2[(1-\tilde{a})t_2 y_2 + \Pi - (1-\tilde{a})g_2] + \mu_2[V(t_1 + T, g_1, G) - V(t_2 + T, g_2, G) + 1 - 2\tilde{a}] \quad (11)$$

The first order conditions are:

$$t_2 y_2 + \frac{\Pi}{1-\tilde{a}} - g_2 = 0 \quad (12)$$

$$V(t_1 + T, g_1, G) + 1 - \tilde{a} = V(t_2 + T, g_2, G) + \tilde{a} \quad (13)$$

$$V(t_2 + T, g_2, G) + \tilde{a} + \lambda_2[t_2 y_2 - g_2] = -2\mu_2 \quad (14)$$

$$\lambda_2 = \left(\frac{1-\tilde{a}-\mu_2}{1-\tilde{a}}\right)\frac{\partial V_2}{\partial g_2} \quad (15)$$

$$\lambda_2 = \left(\frac{1-\tilde{a}-\mu_2}{1-\tilde{a}}\right)\frac{1}{1+t_2\nu_2} \quad (16)$$

where ν_2 is the semi-elasticity of y_2 with respect to t_2.

Building on the interpretation of the Lagrange multipliers in the previous section, from (14) μ_2 can be written as:

$$\mu_2 = -\left(\frac{\partial(1-\tilde{a})}{\partial V_2}\right)\left[(V(t_2 + T, g_2, G) + \tilde{a}) - \left(\frac{1}{1-\tilde{a}}\frac{\partial W_2}{\partial V_2}\right)\frac{\Pi}{(1-\tilde{a})}\right] < 0 \quad (17)$$

In the analogous way, μ_2 can be interpreted as the (negative of the) gain in total utility in the province 2 from the additional residents that are attracted to the province, where the first term in square brackets is the utility of the "marginal" resident in province 2 and the second term

represents the decline in the per capita resource rents, valued at the average utility in province 2 from an increase in fiscal utility, from adding an additional population in province 2. Therefore the presence of resource rents reduces the total gain from attracting additional residents to the province.

While province 2's fiscal policy also satisfies the condition $\partial V_2/\partial g_2 = MCF_2 = (1 + t_2 \nu_2)^{-1}$ the province's response to an increase in resource revenue is biased toward lower taxes because higher values for g_2 increase migration to the province which erodes the per capita resource rent and necessitates higher tax rates which reduce the incentive to generate income in the province. By contrast, using resource rent to lower the tax rate, while it also induces migration from province 1, boosts income generation for the existing population as well as the migrants. In the numerical simulations in Section 4, we show that the model exhibits this feature—a resource-rich province will mainly use its resource rents to create a tax advantage, rather than a spending advantage, over the other province. This response is consistent with Raveh (2013, p.1338) who found that resource abundant US states "present a more competitive business environment, in terms of taxation, investment in infrastructure, and public good provision." It is also consistent with the fiscal policy of the government of Alberta which has been to emphasize the "Alberta Advantage" of low corporate and personal income tax rates and no provincial sales tax.

3. Evaluating the Impact of an Increase in Provincial Resource Revenues

Figure 1 provides an intuitive description of the effect of resource revenues in province 2 on the allocation of the population between the two provinces and the impact on the welfare of individuals in both provinces. Initially, there are no resource revenues and the population is equally divided between the two regions, $\tilde{a}_0 = 0.5$. All the individuals with *a* values less than $\tilde{a}_0$ live in province 1 and those with *a* values greater than $\tilde{a}_0$ live in province 2. Now suppose the province 2 receives resource revenues of Π and the government of province 2 responds by reducing its income tax rate, $dt_2 < 0$. The gain to individuals who reside in province 2 from the tax rate reduction is $-y_2 dt_2$. This shifts the utility curve $U_2(a)$ up by $-y_2 dt_2$. As a result of the tax rate reduction, incomes in province 2 increase, which increases the federal government's tax base. It is assumed that the federal government holds its total expenditure constant and cuts the

federal tax rate. The gain from the federal tax rate cut is $-y_i\, dT$ and both $U_1(a)$ and $U_2(a)$ shift up by this amount. As a result of these tax rate changes, some individuals with relatively low attachment to province 1 move to province 2, and the population of province 1 declines to $\tilde{a}$ in the new equilibrium.

We can examine the effect of the increase in resource rents on three groups of individuals. The individuals who were resident in province 2 at the time of the resource rent receive a total gain equal to the area abcd. Those who move to province 2 receive a total gain equal to the area abfe, and those who remain in province 1 in the new equilibrium gain hefg. Thus the resource rent that is received by province 1 generates a Pareto improvement. The residents of province 1 benefit indirectly from the resource rent in province 2 through a reduction in the federal income tax rate that is caused by the positive tax externality created by the tax cut in province 2.

For a small increase in resource revenues, we can derive expressions for the gain received by each group. For the initial residents of province 2, the provincial tax rate cut is equal to:

$$y_2 dt_2 + t_2 \frac{dy_2}{dt_2} dt_2 + \frac{d\Pi}{1-\tilde{a}} + \frac{\Pi_0}{1-\tilde{a}} d\tilde{a} = 0 \tag{18}$$

If we start from a symmetric equilibrium, $\Pi_0 = 0$, the gain from the tax rate cut in province 2 is:

$$-y_2 dt_2 = MCF_2 \frac{d\Pi}{1-\tilde{a}} \tag{19}$$

The reduction in the federal tax rate is equal to:

$$\left[\tilde{a} y_1 + (1-\tilde{a}) y_2\right] dT + T\left[y_1 d\tilde{a} - y_2 d\tilde{a} + \tilde{a}\, dy_1 + (1-\tilde{a}) dy_2\right] = 0 \tag{20}$$

Starting from the symmetric equilibrium where $y_1 = y_2$, the gain from the reduction in the federal tax rate is:

$$-y_i dT = -T(1-\tilde{a}) \frac{dy_2}{dt_2} dt_2 = -T \nu_2 MCF_2 d\Pi \tag{21}$$

Therefore to total gain from the increase in resource rent is:

$$Gain = \left[-T\nu_2 + \left[\frac{1 - \widetilde{a}_0}{1 - \widetilde{a}} \right] + \frac{1}{2} \left[\frac{\widetilde{a}_0 - \widetilde{a}}{1 - \widetilde{a}} \right] \right] MCF_2 \, d\Pi \tag{22}$$

where the first term is the gain to residents of both provinces as a result of the vertical fiscal externality caused by province 2's tax cut, the second term is the total gain by the initial residents of province 2 from the province 2's tax cut and the third term is the gain to those who move to province 2 as a result of the its tax rate reduction. Combining the last two terms, the gain can be expressed as:

$$Gain = \left[-T\nu_2 + \frac{\left[1 - \frac{\widetilde{a} + \widetilde{a}_0}{2} \right]}{1 - \widetilde{a}} \right] MCF_2 \, d\Pi \tag{23}$$

The first term is positive since $\nu_2 < 0$. The second term in square brackets is positive but less than one. The total gain is proportional to the initial MCF_2 and the increase in resource revenues.

If the resource revenues had been shared equally through a lump-sum transfer from province 2 to province 1, there would by no change in the provinces' populations and the total gain from the resource revenues would be:

$$Gain^* = \left[-T\nu_2 + 1 \right] MCF_2 \, d\Pi \tag{24}$$

In other words, total gain would be higher if resources revenues could be costlessly shared between the two provinces. When all of the resource rent accrues to province 2, some individuals are induced to move to province 2, and they give up some of the benefits that they received from living in province 1 in order to take advantage of the provincial tax rate reduction by moving to province 2. The welfare loss from this fiscally induced migration is:

$$Loss = \left[1 - \frac{\left[1 - \frac{\widetilde{a} + \widetilde{a}_0}{2} \right]}{1 - \widetilde{a}} \right] MCF_2 \, dR = \frac{1}{2} \left[\frac{\widetilde{a}_0 - \widetilde{a}}{1 - \widetilde{a}} \right] MCF_2 \, d\Pi \tag{25}$$

Thus the loss per dollar of resource revenue is approximately equal to the marginal cost of public funds multiplied by one half the fraction of the population of province 2 that was induced to

move. In other words, the loss from the unequal distribution of resource rents is proportional to the amount of fiscally induced migration.

4. Numerical Simulation of the Basic Model

The model contains relatively complex interactions between the two provinces which make it difficult to derive an analytical solution. However, we can compute the solution to the model based on equations (5) to (9) and (12) to (16) to illustrate the three main features of the model— that the province receiving the resource rent will adopt a fiscal policy that creates mainly a tax advantage for that province, that an increase in resource rents received by province 2 also benefits the residents of province 1 because a vertical tax externality allows the federal government to cut its income tax rate while holding its expenditures constant, and that the fiscally induced migration to province 2 represents an aggregate welfare loss relative to a situation where resource rents are shared equally between the two provinces.

Table 1 shows some simulations of the model which illustrate the above points. Column (1), labelled "No Resource Rents", shows a symmetric equilibrium with the federal government imposing a tax rate of T = 0.231 and a balanced budget expenditure with G = 0.20.[4] Both provinces provide the same level of the public service, $g_i = 0.136$, at the same tax rate, $t_i = 0.157$. The ratio of total provincial and federal spending to total income is 0.388. The utility level of a representative household (not including attachment to location) is the same in both provinces and given by $V_i = 0.947$. The marginal cost of public funds is 1.084. Aggregate welfare, as measured by a utilitarian social welfare function, $\Psi = W_1 + W_2$, is 1.78203.

In Column (2), province 2 receives resource rents equal to $\Pi = 0.015$, or approximately 22 percent of its per capita spending in Column (1). These computations indicate that province 2 will adopt a tax advantage strategy by cutting its tax rate by three percentage points, but only marginally increasing its expenditure on public services. As a result of the tax cut, the per capita income in province 2 increases by 2.2 percent to 0.886. The higher incomes in province 2 allow the federal government to cut its tax rate from 0.231 to 0.228, while holding its provision of its

[4] To operationalize the model, $b(g_i)=b(g_i)^{\beta}$ and $B(G)=b(G)^{\beta}$ where $b = 0.80$ and $\beta = 0.5$ and $h(y_i) = \eta(y_i)^{\theta}$ where $\eta = 0.25$ and $\theta = 3.5$. Copies of the Mathcad file used to compute the results are available upon request.

public good constant. The lower provincial tax rate and higher incomes in province 2 induce migration from province 1 to province 2 of approximately 1.6 percent of the population. The government of province 1 imposes virtually the same tax rate and provides virtually the same level of public services as in Column (1), but per capita incomes in province 1 increase because of the reduction in the federal tax rate. Consequently a representative household in province 1 is better off than in the initial equilibrium as shown by the increase in V_1, but there is fiscal inequity because a representative household in province 2 is better off than a representative household in province 1.

Column (3) shows that if the resource rents are costlessly shared between the two provinces a symmetric equilibrium is restored because there is no fiscally induced migration. Residents of province 1 are better off as a result of lower provincial and federal tax rates and higher provincial public services, while the residents of province 2 are worse off, mainly because of a higher provincial tax rate. However, aggregate welfare, as measured by a utilitarian social welfare function Ψ, increase because fiscal induced migration is eliminated when resource rents are shared between the two provinces.

5. Simulating the Impact of a Federally Financed Equalization Transfer

While the equal sharing of resource revenues through lump-sum transfers might promote overall economic efficiency, in the Canadian context it is unrealistic because of provincial ownership and control of natural resources. One consequence is that the Canadian equalization system is based on a Representative Tax System (RTS) and is funded by the federal government out of its general revenues. In the context of our model, this means that the provincial government that receives resource rents does not contribute to the equalization transfer and is not "equalized down" to the fiscal capacity of the other province. Below we examine the performance of an equalization transfer system with "Canadian Characteristics" under a variety of scenarios concerning the resource revenue inclusion rate in the equalization formula

With the RTS equalization system, the government of province 1 receives a per capita transfer, S, equal to:

$$S = \tau_s\left(y_s - y_1\right) + \gamma \cdot (\Pi - 0) \tag{26}$$

where $\tau_s = \dfrac{\tilde{a}\, y_1 t_1 + (1-\tilde{a})\, y_2 t_2}{y_s}$ is the standard tax rate, $y_s = \tilde{a} y_1 + (1-\tilde{a}) y_2$ is the standard tax base, and γ is the inclusion rate for resource revenues for equalization purposes. The budget constraint of province 1 is now $t_1 y_1 + S = g_1$ and the federal government's budget constraint is $T(\tilde{a} y_1 + (1-\tilde{a}) y_2) = \tilde{a}\, S + G$. Province 1 takes τ_s, y_s, and γ as given. However, in the computations that are shown in Table 1, τ_s and y_s are endogenous and reflect the fiscal decisions of the two provinces. The only other major change in the first order conditions for province 1's maximization problem is that the marginal cost of public funds becomes:

$$MCF_1 = \frac{1}{1 + (t_1 - \tau_s)\nu_1} \tag{27}$$

because the province is now compensated for reductions in income caused by a tax rate increase. See Smart (1998) on the effect of the equalization system on a recipient government's marginal cost of public funds.

Column (4) in Table 1 shows the equilibrium when resource revenues are excluded from the RTS equalization system, $\gamma = 0$. First note that, compared to column (2) when there is no equalization transfer, the representative individual in province 2 is worse off, as measured by the decline in V_2, because of the 0.003 point increase in the federal tax rate, T, that is required to finance the equalization payment to province 1, as well as the 0.001 point increase in t_2, while g_2 and G remain constant. Perhaps more surprisingly, V_1 also declines relative to Column (2), in spite of a transfer that represents 15.6 percent of province 1's expenditures, in part because of the increase the federal income tax rate, but also because the 0.023 point increase in provincial income tax rates, t_2, more than offsets the increase in g_2. Provincial spending increases because MCF_1 declines, in spite of the increase in t_1, because of the downward bias in the province's marginal cost of public funds caused by the RTS formula.[5] Obviously, this case is based on particular parameter values for a highly simplified model, but the declines in V_1, V_2, and the utilitarian social welfare function, Ψ, illustrate the potential welfare loss that could arise with an RTS equalization system that is financed by a general federal tax rate increase.

[5] See Ferede (forthcoming) for an econometric study which indicates that the equalization formula induces higher personal and corporate income tax rates in the recipient provinces in Canada.

But this raises the question of what criterion should used to evaluate the equalization program. The Canadian constitution explicitly values fiscal equity—an entitlement to "reasonably comparable levels of public services at reasonably comparable levels of taxation". As such, it seems appropriate to evaluate the equalization program using a social welfare function that incorporates both efficiency and fiscal equity objectives. We have assumed that the efficiency objective can be captured by the sum of the utilities of the members of the society, Ψ. There are various ways in which the fiscal equity objective in the Canadian constituent might be operationalized. We have chosen the following approach using a modified version of the concept of the net fiscal benefits that households derive from their provincial governments. In particular, we defined fiscal inequity for a household in province 1 as the difference between its net fiscal benefit from provincial spending and taxes and the net fiscal benefit for a household in province 2:

$$FI_1 = (g_1 - t_1 \cdot y_1) - (g_2 - t_2 \cdot y_2) \tag{28}$$

FI_1 is negative if the per capita federal transfer to province 1 is less than the per capita resource revenues received by province 2. We define the total harm caused by fiscal inequality as $\Phi = \tilde{a} FI_1$ .We posit that the social welfare function is a weight sum of the efficiency and fiscal equity objectives:

$$SWF(\Omega) = \Omega \cdot \Phi + (1 - \Omega) \cdot \Psi \tag{29}$$

where $0 \le \Omega \le 1$ is the weight that is placed on the fiscal equity objective in the social welfare function.

The last four row in Table 1 show the Ψ and Φ components of the SWF and the value of the SWF for $\Omega = 0.50$ and 0.75. In Column (4), with $\Omega = 0.5$, the SWF would decline with the with the introduction of a federally financed RTS equalization system, while with $\Omega = 0.75$, the SWF would increase because of the greater weight that is place on the reduction in fiscal inequality. Columns (5) and (6) show that V_1 is increasing in the resource revenue inclusion rate and while V_2 is decreasing and the utilitarian measure of social welfare is lower than in Column (2). However, with equal weights attached to the utilitarian and fiscal inequality components, the SWF would be higher than in Column (2) with either a 50 percent or 100 percent inclusion rate for resource revenues.

Obviously the model and the parameter values represent a specific case and these results would not hold in general. However, they illustrate the possibility of a trade-off between efficiency and fiscal equity when a federally financed fiscal equalization program is introduced or made more generous and that social welfare may decrease if the weight given to fiscal equity is relatively low. It also illustrates how relatively small differences in the weight that is placed on fiscal equity relative to efficiency can make a big difference in an individual's attitude towards equalization in general and how redistributive the system should be.

6. Conclusion.

The goal of this paper has been to develop a model that captures the key features of the Canadian fiscal system that are relevant for evaluating the fiscal equalization system. We use the framework developed in Boadway and Tremblay (2010) to model of an equalization system which has the following features—federal financing of equalization transfers with distortionary taxes on national tax bases, vertical tax externalities between the federal and provincial governments because they levy taxes on the same base, endogenous fiscal policies of the provinces that are influenced by the mobility of the population and the equalization transfer formula, imperfect labour mobility between provinces because of mobility costs, provision of quasi private goods by provinces, and marginal products of labour that are independent of the provincial populations because provinces are small open economies with constant returns to scale in the non-resource sector. The model predicts that a province receiving resource rents will adopt a fiscal policy that mainly creates a tax advantage for that province and that an increase in resource rents received by one province benefits the residents of other provinces through a vertical tax externality. We show fiscally induced migration results in an efficiency loss per dollar of resource revenue that is approximately equal to the provincial marginal cost of public funds multiplied by one half the fraction of the population that was moves to take advantage of the induced to move. Numerical simulations of the model demonstrate the potential efficiency-fiscal equity trade-off that occurs with federal financing of equalization transfers out of general tax revenues.

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Table 1
Simulations of the Effect of an RTS Equalization System

	No Resource Rents	Resource Rents Accrue to Province 2, No Fiscal Transfers	Equal Sharing of Resource Rents	RTS Equalization Formula, Financed by a Federal Income Tax		
	(1)	(2)	(3)	(4)	(5)	(6)
				Resource Revenue Inclusion Rate, γ		
				0.00	**0.50**	**1.00**
a	0.500	0.484	0.500	0.485	0.488	0.492
y_1	0.867	0.868	0.877	0.854	0.856	0.858
t_1	0.157	0.157	0.141	0.180	0.172	0.164
g_1	0.136	0.136	0.139	0.156	0.156	0.157
S/g_1	0.000	0.000	0.000	0.015	0.060	0.105
V_1	1.032	1.035	1.051	1.032	1.036	1.040
MCF_1	1.084	1.083	1.074	1.014	1.012	1.009
y_2	0.867	0.886	0.877	0.884	0.881	0.879
t_2	0.157	0.126	0.141	0.127	0.127	0.127
g_2	0.136	0.141	0.139	0.141	0.141	0.141
V_2	1.032	1.067	1.051	1.063	1.060	1.056
MCF_2	1.084	1.065	1.074	1.066	1.066	1.066
T	0.231	0.228	0.228	0.231	0.235	0.240
Ψ	1.78203	1.80087	1.80126	1.79807	1.79817	1.79822
Φ	0.00000	-0.01407	0.00000	-0.01297	-0.00972	-0.00640
SWF(0.50)	0.89102	0.89340	0.90063	0.89255	0.89423	0.89591
SWF(0.75)	0.44551	0.43966	0.45032	0.43979	0.44226	0.44475

Figure 1
The Effect of an Increase in Resource Revenue in Province 2