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Fiscal Federalism

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A POLITICAL ECONOMY MODEL OF THE VERTICAL FISCAL GAP AND VERTICAL FISCAL IMBALANCES IN A FEDERATION

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ABSTRACT: We develop a political economy model of intergovernmental transfers. Vertical fiscal balance occurs in a federation when the ratio of the marginal benefit of the public services provided by the federal and provincial governments is equal to their relative marginal costs of production. With majority voting in national elections, the residents of a "pivotal province" will determine the level of transfers such that the residents of that province achieve a vertical fiscal balance in spending by the two levels of government. We test the predictions of the model using Canadian time series data and cross-section data for nine federations.

JEL Codes: H71, H73, H77

Keywords: Fiscal federalism, vertical fiscal imbalance, fiscal gap

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1 Introduction

In most federations, central governments transfer funds to regional and local governments. The difference between sub-national governments' spending and their own tax revenues is known as the vertical fiscal gap. The term vertical fiscal imbalance has had more ambiguous definitions. In some studies, such as OECD (2007), vertical fiscal imbalance is synonymous with a vertical fiscal gap while in others, such as Breton (1996), it is define it as a mismatch between a government's spending responsibilities and its access to tax revenues.[1] In Australia and Canada, there have been major political clashes between politicians representing the two levels of government over whether a vertical fiscal imbalance exists or not, whether further tax powers should be ceded to subnational governments, and whether transfers subnational governments should be increased. These debates have been made more contentious because of the lack of a meaningful definition of "vertical fiscal balance" or any agreement on what constitutes an "optimal vertical fiscal gap".

In this paper, we adopt the a definition of "fiscal balance" in a federation that is based on the efficiency of resource allocation between the central and subnational governments. In particular we will define a vertical fiscal balance as occuring in a federation when the ratio of the marginal benefit of the public services provided by the subnational governments and by the central government is equal to their relative marginal cost of production. Defined in this way, a vertical fiscal balance implies that the residents of a subnational government are indifferent between having one more dollar spent public services provided by the central government and one less dollar spent on public services provided by subnational governments or vice versa. When voters detemine the size of intergovernmental grants through elected representatives in a federal legislature, equalizing the ratio of the marginal benefits from spending on central and subnational public services requires that the tax prices of public services are equalized between the two orders of government. In most federations, the sub-national governments' tax bases are narrower, or more tax sensitive, than the tax bases the central government and as a consequence, they often have a high marginal cost of public funds (MCFs). Lump-sum transfers from the central govenment are therefore required to

[1] See Sharma (2012) for an extensive review of the literature on the vertical fiscal gap and vertical fiscal imbalance concepts.

equalize or at least reduce the differential in the MCFs of the two levels of government. The "optimal" vertical fiscal gap will be the level of transfers that eliminates the vertical fiscal imbalance between the two levels of government.

Our approach to the analysis of fiscal imbalances and the optimal vertical fiscal gaps is most closely related to the papers of Boadway and Tremblay(2006, 2010). However, unlike their models, we have adopted a framework in which there are no vertical or horizontal fiscal externalities between and across governments. Therefore, in our model, the motivation for providing intergovernmental grants is to address vertical fiscal imbalances in the federation. Another important difference is that we adopt a political economy approach to try to explain how majority voting can give rise to a system of transfers. Thus the focus of our model is more predictive and less normative than the Boadway and Tremblay contributions.[2]

In Section 2 we outline the basic structure of the model. We adopt the simplifying assumption that the federal transfer is restricted to an equal per capita grant to all provinces. While this assumption is clearly very restrictive and does not accurately reflect the system of grants in most federations, it helps to clarify the structure of the model and the key forces that drive the main results. In Section 3, we relax the assumption of equal per capita grants by assuming that the federation uses a fiscal equalization formula to make transfers to subnational governments with below average fiscal capacities as well as equal per capita transfers. In these broad features, the model has similarities with the Canadian intergovernmental grant system which combines fiscal equalization grants with other lump-sum grants. In Section 4, we extend the model to the case where the choice of the equalization formula is determined by voting in the federal legislature and we derive predictions concerning the characteristics of that formula. In Section 5, we provide some preliminary tests of the predictions of the model based on time series data from Canada and cross-section data from nine federations. We find that a key prediction of the political economiy model–that transfers should be negatively related to the average income in a "pivotal province"–are rejected for the Canadian time series data, but the key predict is consistent with the allocation of intergovernmental grants within the federations in the cross-section data. Furthermore, we find

[2]For other political economy models on the level and pattern of intergovernmental transfers, see Pereira (1996), Dixit and Londregan (1998), Crémer and Palfrey (2000), Snoddon and Wen (2003), and Volden (2007).

that there are substantial differences in the allocation of intergovernmental grants in presidential and parliamentary systems of government. The final section of the paper contains some concluding remarks.

2 A Model of Vertical Fiscal Imbalances with Equal Per Capita Grants

We begin by considering a simple model of a federation with two levels of government. At the federal level, elections are based on a nation-wide vote. The federal legislature is unicameral and based on representation by population. There are n subnational governments, which we will call provincial governments, and the election of a unicameral provincial legislature is based on majority voting within each province. In the provincial elections, voters take the federal expenditure on the federal public good, the federal tax rate, and transfers to their province as given.

The utility function of individual h in province i is:

$$U_{hi} = \phi \ln G + \rho \ln g_i + \beta \ln X_{hi} + b \ln Z_{hi} \tag{1}$$

where $0 < \phi, 0 < \rho, 0 < \beta < 1, 0 < b < 1$, and $b + \beta = 1$. G is the expenditure on the public good or service provided by the federal government. It is uniform across the country. The per capita expenditure on the public service provided by province i is g_i. X_{hi} and Z_{hi} are the private goods consumed by individual h in province i. The producer prices of all four goods are equal constant and equal to one. The federal government finances its expenditures by imposing a nation-wide per unit tax of t_f on X, and therefore the consumer price of X is $1 + t_f$ in all provinces. Similarly, province i imposes a per unit tax of t_i on the consumption of Z, and its consumer price in province i is $1 + t_i$. Individual h has a fixed income Y_h, and his demand functions for the two private goods are:

$$X_{hi} = \beta \frac{Y_h}{1 + t_f} \tag{2}$$

$$Z_{hi} = b\frac{Y_h}{1+t_i} \tag{3}$$

It is assumed that all individuals in all provinces have the same preferences for provincial and federal public services and for the private goods. Individuals' incomes vary within each province and between provinces. The average income in province i is Y_{ai}. Let s_i be the population of province i with the national population normalized to equal one. The population shares of the provinces are fixed, i.e. there is no inter-provincial migration due to differences in fiscal variables. The national average income is $Y_{ave} = \sum s_i Y_{ai}$.

There are no vertical or horizontal fiscal externalities in this model. The federal government's tax base, X, is not affected by t_i or g_i and the provincial tax base Z_i is not affected by t_f or G. Similarly, there are no spillovers of benefits across provincial boundaries from the provision of the provincial public service and province i's tax base is not affected by the tax rates imposed in other provinces.

For future reference, we will define *vertical fiscal balance* in the provision of public services as occurring when the marginal rate of substitution between federal and provincial public services equals their marginal rate of transformation. With the utility function in (1), vertical fiscal balance implies that $g_i/G = \rho/\phi$. If $g_i/G < \rho/\phi$, there is a vertical fiscal imbalance in the sense that the residents of province i would be better off with a small increase in spending on the provincial public service and a corresponding reduction in spending on the federal public service. In this case, the residents of province i will perceive a federal imbalance in spending Conversely, if $g_i/G > \rho/\phi$, the residents of province i would be better off with a small increase in spending on the federal public service and a corresponding reduction in spending on the provincial public service. We will refer to this case as a provincial imbalance in spending.

In order to illustrate the properties of the model, we begin by assuming that the federal government provides an equal per capita transfer to all provincial governments. Our objective is to illustrate how the level of this transfer, T, would be determined along with the other federal and provincial fiscal variables, G, t_f, g_i, and t_i. Since voters in the provincial elections are assumed to take the T, G, and t_f as given when they make their voting decisions, we analyze the provincial fiscal decisions first. Then we turn to the determination of

the federal fiscal variables.

2.1 Provincial Fiscal Decisions

Each provincial government finances its expenditures from its tax on Z and its transfer from the federal government. Province i's budget constraint, expressed in per capita terms, is:

$$g_i = \frac{t_i}{1+t_i} bY_{ai} + T \tag{4}$$

where T is the per capita federal lump-sum grant which is the same for all provinces. In most of our discussion, it will be assumed that transfers flow from the federal government to the provinces, i.e. $T \geq 0$. However, we also consider the possibility, later in this section, that transfers could flow from the provinces to the central government.

In making his decision about the preferred level of provincial services and the provincial tax rate that is needed to finance it, each individual takes the federal transfer, federal public services, and the federal tax rate as given. The optimal g_i and t_i for individual h in province i are can be found by substituting g_i from equation (4) and Z_{hi} from (3) into (1) and maximizing the resulting utility function with respect to t_i.

$$g_i = \frac{\rho}{\rho + b} \left(bY_{ai} + T \right) \tag{5}$$

$$t_i = \frac{\rho Y_{ai} - T}{bY_{ai} + T} \tag{6}$$

Note that the provincial fiscal variables that are preferred by individual h do not depend on his own income, but are determined by the average income in his province. This implies that all individuals in the province desire the same fiscal package, given by (5) and (6). This unanimity concerning the desired provincial fiscal variables arises because of the assumption that all individuals have the Cobb-Douglas utility function (1). The intuition underlying this result is explained below.

The marginal benefit that an individual derives from the provincial public service is:

$$MB_{hg_i} = \frac{1}{\lambda_h}\frac{\partial U}{\partial g_i} = \frac{\rho Y_h}{g_i} \tag{7}$$

where $\lambda_h = Y_h^{-1}$ is the individual's marginal utility of income. The individual's tax price for the provincial service, P_{hi}, is the cost to the individual of an additional dollar spent on the provincial public service and is equal to:

$$P_{hi} = -\frac{1}{\lambda_h}\frac{\dfrac{\partial U_h}{\partial t_i}}{\dfrac{\partial R_i}{\partial t_i}} \tag{8}$$

where $R_i = t_i Z_{ai} = \left(\frac{t_i}{1+t_i}\right) bY_{ai}$ is the province's per capita tax revenue and Z_{ai} is the average consumption of the commodity taxed by the province. From Roy's theorem, $\dfrac{\partial U_h}{\partial t_i} = -\lambda_h Z_{hi}$, the above equation can also be expressed as:

$$P_{hi} = \frac{Z_{hi}}{Z_{ai} + t_i \frac{\partial Z_{ai}}{\partial t_i}} = \left(\frac{Z_{hi}}{Z_{ai}}\right)\left[\frac{1}{1 + t_i \frac{\partial \ln Z_{ai}}{\partial t_i}}\right] \tag{9}$$

The expression in square brackets can be interpreted as the marginal cost of public funds for the provincial government, MCF_i, and therefore:

$$P_{hi} = \left(\frac{Y_{hi}}{Y_{ai}}\right) MCF_i \tag{10}$$

Note that given the demand function for Z_{ai}, $MCF_i = (1 + t_i) = (1 - \tau_i)^{-1}$ where $\tau_i = (t_i/(1 + t_i))$ is the equivalent ad valorem tax rate. This implies that the province's MCF_i is increasing in its tax rate. It also implies that if the provincial governments have a "narrower" tax base because b is lower, or a smaller tax base because Y_{ai} is lower, a province will need to impose a higher tax rate to collect a given amount of revenue, and it will have a higher MCF_i. For future reference, the federal government's marginal cost of public funds is $MCF_f = 1 + t_f = (1 - \tau_f)^{-1}$ where $\tau_f = (t_f/(1 + t_f))$ is the equivalent federal ad valorem tax rate.

The tax price of provincial public services is the product of two factors—a *redistributive factor* (Y_{hi}/Y_{ai}) and a *tax distortion factor*, the MCF_i. The redistributive factor arises because, in the absence of tax distortions, the increase in per capita revenues from a tax rate increase is proportional to the average income in the province while the increase in an individual's tax burden is in proportion to his income. The redistributive effect can make the effective tax price of a dollar of provincial spending less than a dollar for an individual whose income is less than the average income. The tax distortion effect implies that the tax price for public services can exceed a dollar because the tax base shrinks when the tax rate is increased.

At the individual's preferred level of service, MB_{hg_i} equals his P_{hi}. Note from (7) and (10), both the marginal benefit and the tax price increase in proportion to the individual's income and therefore all individuals in a given province will agree on the optimal level of provincial public service. This situation is illustrated in Figure 1 where $Y_{2i} > Y_{1i}$ and $P_{2i} > P_{1i}$, but both individuals prefer g_i^o because MB_{2g_i} exceeds MB_{1g_i} by exactly the amount necessary to compensate for the higher tax price faced by individual 2. While unanimity with respect to the desired provincial fiscal policy is clearly unrealistic, this implication of the Cobb-Douglas utility function greatly simplifies our analysis of voting in multi-level elections and allows us to focus on inter-provincial differences in the desired fiscal policies of the federal and provincial governments.

Note that this model exhibits the "flypaper effect", i.e. the increase in provincial government spending from an increase in the federal transfer is larger than an equivalent increase in its average per capita income since:

$$\frac{dg_i}{dT} = \frac{\rho}{\rho + b} > \frac{dg_i}{dY_{ai}} = \frac{\rho b}{\rho + b} \tag{11}$$

The flypaper effect will be greater when the provincial governments' tax base is narrower, i.e. b is lower, and its MCF_i is larger.[3] Furthermore, note that the increase in spending on the provincial public service is less than the the increase in transfers. Therefore an increase in the federal transfer will lead to a reduction in the provincial tax rate and an increase in

[3]See Hamilton (1986), Becker and Mulligan (2003), Volden (2007) and Dahlby (2011) on the flypaper effect arising from subnational governments' use of distortionary taxation to finance their expenditures.

consumption of the commodity taxed by the provincial governments.

2.2 Federal Fiscal Decisions

We will now consider the fiscal decisions made at the federal level based on a national election to a unicameral legislature. The federal government's per capita budget constraint is:

$$G + T = \frac{t_f}{1 + t_f} \beta Y_{ave} \equiv R_f \tag{12}$$

where Y_{ave} is the national average income. It is assumed that voting on the federal government's fiscal variables occurs in two stages.[4] First, there is a vote on the size of the federal government's budget, R_f, or equivalently a vote on the federal tax rate. In the second stage, there is vote on the allocation of the budget between G and T. Since the decision in the first stage of voting will depend on the outcomes of the voting in the second stage, we begin by analyzing the second stage voting in which the size of the federal budget, R_f, is fixed.

2.2.1 Second Stage Voting: The Allocation of the Federal Budget Between G and T

Given the fiscal decisions that will be made at the provincial level based on the federal transfer, the utility function of individual h in province i can now be written as:

$$U_{hi} = \phi \ln G + \rho \ln \left(\frac{\rho}{\rho + b} \left(bY_{ai} + T \right) \right) + \beta \ln X_{hi} + b \ln \left[\left(\frac{Y_{hi}}{Y_{ai}} \right) \left(\frac{b}{\rho + b} \right) \left(bY_{ai} + T \right) \right] \tag{13}$$

where (5) has been used to substitute to g_i and (6) has been substituted for t_i in the demand function for Z_{hi}. Maximizing (13) with respect to G and T, subject to the constraint that $R_f = G + T$, yields the following expressions for the optimal G and T for an individual with income Y_h residing in province i:

$$G = \frac{\phi}{\phi + \rho + b} \left(R_f + bY_{ai} \right) \tag{14}$$

[4] See Casamatta et al. (2000) and Cremer et al. (2007) for public choice models of social security systems where voting on the parameters of the systems occurs in two stages.

$$T = \frac{(\rho + b)\, R_f - \phi b Y_{ai}}{\phi + \rho + b} \tag{15}$$

Again, the optimal G and T for an individual residing in province i do not depend on his income, but instead they depend on the average income in the province. Consequently, all individuals in province i would favour the same allocation of the federal budget between G and T. If the optimal T in (15) is substituted in (5), then the ratio g_i/G based on (14) is ρ/ϕ. In other words, for the residents of each province, the optimal allocation of the federal budget between G and T would allow them to achieve a vertical fiscal balance in the provision of provincial and federal services.

Which fiscal package will be successful in voting in the federal legislature? First, note that all of the representatives in the federal legislature from province i prefer the level of federal services and the transfer to the provinces given by (14) and (15) and that the preferred G is increasing in the province's average income and the preferred T is decreasing in the province's average income. Suppose the provinces can be ordered according to their average income such that $Y_{a1} \leq Y_{a2} \leq ... \leq Y_{an}$. We will define the *pivotal province* as province p such that less than 50 percent of the population live in provinces with average incomes less than Y_{ap} and less than 50 percent of the population live in provinces with average incomes greater than Y_{ap}. More formally, the pivotal province p is defined by the conditions:

$$\sum_{i=1}^{p-1} s_i < 0.5 \;\; and \;\; \sum_{i=p+1}^{n} s_i < 0.5 \tag{16}$$

With majority voting in the federal legislature, the dominant fiscal package will be the one preferred by the representatives from the pivotal province. An alternative fiscal package that contained a higher level of G and a lower T than the one preferred by the pivotal province would be defeated by a majority of representatives from the provinces 1 to p. Any alternative fiscal package that contained a lower level of G and a higher T than the one preferred by province p would be defeated by a majority of representatives from provinces p to n. Consequently, in our model the allocation of the federal budget will be based on (14) and (15) with $Y_{ai} = Y_{ap}$.

This implies that there will be a vertical fiscal balance for the residents of the pivotal

province, i.e. $g_p/G = \rho/\phi$. However, the residents of the other provinces will perceive a vertical fiscal imbalance, since G is the same in all provinces while g_i varies from province to province. Since g_i increases with Y_{ai}, the model predicts that the residents of provinces with average incomes below Y_{ap} will complain that there is too little provincial spending on public services, compared to federal spending, whereas the residents of provinces with average incomes greater than Y_{ap} would prefer an expansion of federal services at the expense to provincial services. More formally, it can be shown that:

$$\frac{g_i}{G} = \frac{\rho}{\phi}\left[\frac{(\rho+b)\,R_f + b\,(\rho+b)\,Y_{ai} + \phi b\,(Y_{ai} - Y_{ap})}{(\rho+b)\,R_f + b\,(\rho+b)\,Y_{ap}}\right] \qquad \frac{g_i}{G} \gtrless \frac{\rho}{\phi} \quad as \quad Y_{ai} \gtrless Y_{ap} \tag{17}$$

An index of the vertical fiscal imbalance in province i is derived below.

2.2.2 First Stage Voting: The Size of the Federal Budget R_f

The optimal R_f, from the perspective of individual h in province i is determined by the following first-order condition:

$$\frac{dU_{hi}}{dR_f} = \frac{\phi}{G}\frac{dG}{dR_f} + \frac{\rho}{g_i}\frac{dg_i}{dR_f} + \frac{\beta}{X_{hi}}\frac{dX_{hi}}{dR_f} + \frac{b}{Z_{hi}}\frac{dZ_{hi}}{dR_f} = 0 \tag{18}$$

where:

$$\begin{aligned} &\frac{dG}{dR_f} = \frac{\phi}{\phi+\rho+b}, \quad and \quad \frac{dg_i}{dR_f} = \frac{\rho}{\phi+\rho+b}, \\ &\frac{dX_{hi}}{dR_f} = -\frac{Y_{hi}}{Y_{ave}}, \quad and \quad \frac{dZ_{hi}}{dR_f} = \frac{b}{\phi+\rho+b}\frac{Y_{hi}}{Y_{ai}} \end{aligned} \tag{19}$$

As indicated above, an increase in the federal budget increases spending on the provincial public service, g_i, as well as the federal public service, G, because a one dollar increase in the federal budget increases the per capita transfer to the provinces by $(\rho+b)/(\phi+\rho+b)$ dollars. A larger federal budget implies a higher federal tax rate, which reduces consumption of the private good, X, but increases consumption of the private good, Z, because the increase in transfers to the provinces results in a reduction in the provincial tax rate, t_i, as indicated in (6).

Substituting the derivatives in (19) into (18), the condition for the optimal R_f for an individual with income Y_h residing in province i can be written in the following intuitive form:

$$P_{hf} = \left(\frac{\phi}{\phi+\rho+b}\right) MB_{hG} + \left(\frac{\rho}{\phi+\rho+b}\right) MB_{hg_i} + \left(\frac{b}{\phi+\rho+b}\right) P_{hi} \tag{20}$$

where $P_{hf} = (Y_h/Y_{ave})MCF_f$ is the individual's tax price for an additional dollar of spending by the federal government. For individual h, the optimal federal budget balances the tax price he has to pay for an additional dollar of spending by the federal government with his marginal benefit from additional dollar spent federal government on federal public services and transfers to the provinces, which is given by the terms on the right-hand side of (20). The additional benefit from federal spending is made up of the marginal benefit from the federal public service, MB_{hG}, the marginal benefit from additional provincial services, MB_{hg_i}, and the marginal benefit from consumption of the good taxed by the provincial government, Z_{hi}, where this is measured by the individal's tax price for provincial services, P_{hi}. The factors in brackets indicate how an additional dollar spent by the federal government is allocated between spending on the federal public service and transfers which result in more provincial public services and provincial tax cuts.

For purposes of analysis, it will be more convenient to write the optimality condition in (20)as the following:

$$\frac{\rho^2}{g_i} + \frac{\phi^2}{G} = \frac{\beta\left(\phi+\rho+b\right)}{X_{hi}} \frac{Y_{hi}}{Y_{ave}} - \frac{b^2}{Z_{hi}} \frac{Y_{hi}}{Y_{ai}} \tag{21}$$

Note that the left-hand side of (21) does not depend on Y_{hi} because from (5) g_i is independent of Y_{hi}, and from (14) G is independent of Y_{hi}. Since the left-hand side of (21) is independent of Y_{hi}, the right-hand side will also be independent of Y_{hi}. Therefore the optimal R_f for an individual in province i depends on the average income in the province, and we will evaluate the right-hand side of (21) at the $Y_{hi} = Y_{ai}$. In the Appendix, we show that $dR_f/dY_{ai} < 0$. Since the desired federal budget declines as the province's average income increases, by the same argument that was employed in the previous section, a majority of the representatives in the federal legislature will support the R_f that is preferred by the residents of the pivotal province.

As noted above, the residents of the pivotal province are able to achieve a vertical fiscal

balance in expenditures on the federal and provincial public services. Therefore, with the equilibrium R_f the residents of pivotal province equalize the tax price of federal spending with the tax price of provincial spending. This result is fairly intuitive. The residents of the pivotal province effectively control the federal tax rate as well as their province's tax rate, and it is not in their interest to buy federal public services at a lower or higher tax price than the tax price they pay for provincial public services. It is in their interest to equate the tax prices that they pay for public services from the two levels of government through their choice of R_f and T.

Given that the equality of the tax prices of federal and provincial public services in the pivotal province, the size of the federal budget is will be:

$$R_f = \frac{\beta\left(\phi + \rho + b\right) Y_{ave} - b\beta Y_{ap}}{\phi + \rho + b + \beta} \tag{22}$$

which implies that federal tax revenue as a proportional of average national income level, R_f/Y_{ave}, will be decreasing in the ratio of the average income in the pivotal province to average national income, Y_{ap}/Y_{ave}.

The equilibrium transfer to the provinces is equal to:

$$T = \frac{\beta(\rho + b)Y_{ave} - b(\phi + \beta)Y_{ap}}{\phi + \rho + b + \beta} \tag{23}$$

The transfer will increase with average national income and decrease with the average income of the pivotal province, and it will be positive if and only if:

$$\frac{(1 + \rho/b)}{(1 + \phi/\beta)} > \frac{Y_{ap}}{Y_{ave}} \tag{24}$$

In other words, transfers will flow in the "normal" direction, i.e. from the federal government to the provinces, if individuals place a relatively high value on the provincial public service compared to the size of the provincial tax base, and a relatively low value of federal public services compared to the size of the federal tax base, and the average income in the pivotal province is low compared to the average national income. Note that transfers to the provinces can occur even if the pivotal province's average income exceeds the national average if $\rho/b >$

ϕ/β. In other words, it is possible for an above averge income province to desire a positive level of transfers from the federal government, even though an additional dollar of federal transfers "costs" its average taxpayer more than a dollar, if the value that its residents place on provincial public services, relative to the size of the provincial tax base, exceeds the ratio of the value of federal public services to the size of the federal tax base.

The equilibrium expenditures on the federal and provincial public services will be equal to:

$$G = \frac{\phi(\beta Y_{ave} + bY_{ap})}{\phi + \rho + b + \beta} \tag{25}$$

$$g_i = \frac{\rho b}{\rho + b} Y_{ai} + \frac{\rho\beta}{\phi + \rho + b + \beta} Y_{ave} - \frac{\rho b(\phi + \beta)}{(\rho + b)(\phi + \rho + b + \beta)} Y_{ap} \tag{26}$$

where:

$$g_p = \frac{\rho(\beta Y_{ave} + bY_{ap})}{\phi + \rho + b + \beta} \tag{27}$$

Again, note that $g_p/G = \rho/\phi$ and the residents of the pivotal province will achieve a fiscal balance in expenditures on provincial and federal services.

We will measure the size of the vertical fiscal gap as the proportion of provincial spending that is financed by the transfer from the federal government:

$$VFG = \frac{T}{\sum_{i=1}^{n} s_i g_i} = \frac{\rho + b}{\rho} \frac{\beta(\rho + b)Y_{ave} - b(\phi + \beta)Y_{ap}}{[b(\phi + \rho + \beta + b) + \beta(\rho + b)]\, Y_{ave} - b(\phi + \beta)Y_{ap}} \tag{28}$$

This expression is quite complex, but it can be shown that the VFG is decreasing the ratio Y_{ap}/Y_{ave}. Note also that if $b = 0$, then $VFG = 1$. In other words, if the provinces do not have access to a tax base, the federal government finances all provincial spending. Thus we expect the VFG to be higher in federations where the provinces have narrower or more restrictive tax bases. The formula for the VFG is greatly simplified when $Y_{ap} = Y_{ave}$, in which case (28) becomes:

$$VFG = \frac{\beta}{b + \beta} - \left(\frac{\phi}{\rho}\right) \frac{b}{b + \beta} \tag{29}$$

In other words, when the average income of the pivotal province is equal to the national average income and the residents of the pivotal province do not have a redistributive motive for receiving a transfer from the federal government, the vertical fiscal gap will be equal to

the federal government's share of the tax base minus the province's share of the tax base weighted by the relative valuation of federal and provincial public services.

The model also allows us the define a measure of vertical fiscal imbalance for the residents of province i as:

$$VFI_i \equiv \frac{g_i/G}{\rho/\phi} = \frac{bY_{ai} + \beta Y_{ave} + \dfrac{b(\phi+\beta)}{\rho+b}(Y_{ai} - Y_{ap})}{\beta Y_{ave} + bY_{ap}} \tag{30}$$

where $VFI_i \lesseqgtr 1$ as $Y_{ai} \lesseqgtr Y_{ap}$. The residents of provinces with average incomes below Y_{ap} will desire more provincial services relative to federal services and argue that the federal government should provide higher transfers to the provinces. Conversely, the residents of provinces with average incomes in excess Y_{ap} would prefer a reduction in federal transfers and a corresponding increase in spending on the federal public service. One implication of this model is that vertical fiscal imbalances are an inevitable feature of a federation if there are differences in the fiscal capacities of the provinces, which in this model is reflected in differences in average incomes across provinces.

2.2.3 Comparative Static Results

Let y_p equal Y_{ap}/Y_{ave}. The following predictions can be derived from the model outline above:

$$\frac{d(G/Y_{ave})}{dy_p} > 0 \tag{31}$$

i.e. the ratio of spending on federal public services to the national average income should be increasing in the ratio of the pivotal province's income to the national average income.

$$\frac{d(T/G)}{dy_p} < 0 \tag{32}$$

i.e. the ratio of federal transfers to spending on federal public services should be decreasing in the ratio of the pivotal province's income to the national average income.

$$\frac{d(T/Y_{ave})}{dy_p} < 0 \tag{33}$$

i.e. ratio of federal transfers to national average income should be decreasing in the ratio of the pivotal province's income to the national average income.

$$\frac{d(g_{ave}/Y_{ave})}{dy_p} < 0 \tag{34}$$

i.e. the ratio of spending on provincial public services to the national average income should be decreasing in the ratio of the pivotal province's income to the national average income.

$$\frac{d(T/g_{ave})}{dy_p} = \frac{dVFG}{dy_p} < 0 \tag{35}$$

i.e. the vertical fiscal gap should be decreasing in the ratio of the pivotal province's income to the national average income.

3 Transfers Under a Representative Tax System Form of Fiscal Equalization

A major limitation of the preceding model is the assumption that every province receives the same per capita lump-sum grant from the federal government. Most, but not all, federations have a system of fiscal equalization grants which increases the fiscal resources of provinces with low "fiscal capacity". By their nature, these transfers vary across the provinces. Examples of countries with these types of transfers are Australia, Canada, and Germany. Since fiscal equalization is an important component of the intergovernmental transfer systems of these and other countries, we investigate the implications of a fiscal equalization system for fiscal imbalances in the context of the political economy model outlined in the previous section.

In this section, we consider the pattern of transfers that would arise under the Representative Tax System (RTS) approach to fiscal equalization because it is often viewed as the "Gold Standard" for fiscal equalization systems. Under the RTS, a province with a below average fiscal capacity receives a per capita grant such that if it imposes the average tax rate on its tax base it will have the same per capita revenues as a province with the average per capita tax base that imposes the average tax rate. We will consider the "net equalization" version of an RTS system. Provinces with above average fiscal capacity contribute to the pool of revenue that is used to finance the transfers to the provinces with low fiscal capacity. The federal government does not contribute to the financing of the grants. In the RTS equalization framework, the fiscal capacity of a province is meaured by its per capita tax base and the transfer recieved by province i (or the contribution by province i) is equal to:

$$T_i = t_{ave} \left[Z_{ave} - Z_{ai} \right] \tag{36}$$

where t_{ave} is the national average tax rate, Z_{ave} is the national average per capita tax base for the pronvinces, and Z_{ai} is the average per capita tax base in province i. A province is either a net contributor or a net recipient of the transfers as its per capita base is greater than or less than the national average. Since $t_{ave} = R_{ave}/Z_{ave}$ where R_{ave} is the average per capita own-source tax revenues of the provinces, the equalization tranfer for province i can also be written as:

$$T_i = R_{ave} \left[1 - \frac{Z_{ai}}{Z_{ave}} \right] \tag{37}$$

The quantum of equalization varies with the total revenues of all of the provinces and their relative disparities. This transfer system allows recipient provinces to increase spending on local public services and to reduce their tax rates, while provinces with above average per capita tax bases will have to raise their tax rates or cut their expenditures to finance their contributions to the transfers to the other provinces. We will assume that voters treat the RTS transfers as lump-sum grants. This is not an innocuous assumption because Smart (1998) and others have shown that this type of equalization system creates an incentive for provinces to increase tax rates because a province's transfer will increase (or its contribution

will decline) when a higher tax rate erodes its tax bases through tax avoidance and evasion.[5] Based on equations (3) and (6), the components of the RTS equalization formula are:

$$R_{ave} = \frac{\rho b}{\rho + b} Y_{ave} \tag{38}$$

$$Z_{ai} = \frac{b^2 Y_{ai} + b T_i}{\rho + b} \tag{39}$$

$$Z_{ave} = \frac{b^2 Y_{ave}}{\rho + b} \tag{40}$$

since the average per capita transfer is zero. Substituting the above into the RTS, a province's transfer will be equal to:

$$T_i = \frac{\rho b}{b + 2\rho} \left(Y_{ave} - Y_{ai} \right) \tag{41}$$

Note that the marginal transfer rate, $\theta = \rho b/(b + 2\rho)$, is a constant and less than one. The RTS transfer only fills part of the gap between a province's average income and the national average income. The marginal transfer rate is increasing in b, the relative size of the provinces' tax base and with ρ, the strength of preference for the provincial public service.

Substituting T_i into (5), where it is understood that this is a province-specific grant, the level of the provincial public good provided by province i is:

$$g_i = \frac{\rho b}{2\rho + b} \left(\frac{\rho}{\rho + b} Y_{ave} + Y_{ai} \right) \tag{42}$$

Thus the level of the public service in a province depends on both the national average income and the province's average income. Public service levels are higher in provinces with higher average incomes, but the range of provision of provincial service shrinks, with a higher level of service provided in the below average income provinces and a reduction the provision of provincial public services in the above average income provinces, compared to the no transfer case.

[5] The model becomes analytically intractable when this type of fiscal behaviour is incorporated in the model. In the future we may try to simulate the system of grants that would emerge with this type of response.

With the RTS system, federal taxes are only used to finance federal public services, and the level of federal services will satisfy the following condition:

$$G = \frac{\phi\beta}{\phi + \beta} Y_{ave} \tag{43}$$

Combining (42) and (43), we obtain the following expression for the relative provision of provincial and federal services:

$$\frac{g_i}{G} = \frac{\rho}{\phi}\left[\frac{\rho b\left(\phi + \beta\right)}{\beta\left(b + 2\rho\right)\left(\rho + b\right)} + \frac{b\left(\phi + \beta\right)}{\beta\left(b + 2\rho\right)}\frac{Y_{ai}}{Y_{ave}}\right] \tag{44}$$

There will be a fiscal imbalance in province i, with provincial (federal) imbalance in spending if the expression in square brackets is greater than (less than) one or:

$$\frac{g_i}{G} \gtreqless \frac{\rho}{\phi} \;\; as \;\; \frac{Y_{ai}}{Y_a} \gtreqless \frac{\left(1 - b\right)\left(b + 2\rho\right)}{b\left(1 + \phi - b\right)} - \frac{\rho}{\rho + b} \tag{45}$$

where we make use of the restriction that $\beta = 1 - b$. Thus the conditions under which the residents of a province might perceive an inadequate provision of provincial services under an RTS grant system is quite complex. One relatively simple case occurs when $\rho = \phi$ and $b = \beta = 0.5$. In this case, $g_i/G \gtreqless \rho/\phi$ as $Y_{ai} \gtreqless Y_{ave}$. That is, the residents of provinces with below average incomes will perceive a federal imbalance in spending while the residents in provinces with above average incomes will perceive a provincial imbalance in spending. Note also that when the provinces have a very narrow tax base and b is very small, even the residents of very high income provinces will perceive a federal imbalance in spending because their province's tax rate will be relatively high in order to finance the transfers to the recipient provinces. Similarly, if ρ becomes very large relative to ϕ, residents of high income provinces will perceive a federal imbalance in spending. Thus an RTS fiscal equalization system will not eliminate vertical fiscal imbalances in a federation, and it entirely possible that the residents of all provinces will perceive a federal imbalance in spending.

Given that an RTS fiscal equalization grants could lead to a wide-spread perception of federal fiscal imbalance, the majority of voters may desire per capita transfers from the federal government. In this section, we extend the model by combining voting on an equal

per capita transfer with the existence of an RTS fiscal equalization system. Here we will assume that the RTS transfers are mandated by the constitution and therefore the federal legislature only determines an equal per capita transfer that is financed out of federal tax revenues. (In the next section, we consider a model where the federal legislature determines the equalization formula.) Consequently the per capita transfer received by province i will be equal to:

$$T_i = \theta \left(Y_{ave} - Y_{ai} \right) + T \tag{46}$$

where θ is the marginal transfer rate under the RTS transfer system and T is the equal per capita. The determination of the key fiscal variables is determined in the same manner as in Section 2 and therefore we simply note that at the provincial level we will have:

$$t_i = \frac{\left(\rho + \theta \right) Y_{ai} - \theta Y_{ave} - T}{\left(b - \theta \right) Y_{ai} + \theta Y_{ave} + T} \tag{47}$$

$$g_i = \frac{\rho \left(T + \theta Y_{ave} + \left(b - \theta \right) Y_{ai} \right)}{\rho + b} \tag{48}$$

At the federal level, the choice of G and T, given total federal revenues, R_f, will be determined by the pivotal province and will be equal to:

$$G = \frac{\phi}{\phi + \rho + b} \left[R_f + \theta Y_{ave} + \left(b - \theta \right) Y_{ap} \right] \tag{49}$$

$$T = \frac{1}{\phi + \rho + b} \left[\left(\rho + b \right) R_f - \phi \theta Y_{ave} - \phi \left(b - \theta \right) Y_{ap} \right] \tag{50}$$

The voters of the pivotal province will determine R_f based on equation (18) to equalize the tax price of federal services and the tax price of provincial services, such that:

$$R_f = \frac{\beta}{\phi + \rho + \beta + b} \left[\left(\phi + \rho + b - \theta \right) Y_{ave} - \left(b - \theta \right) Y_{ap} \right] \tag{51}$$

With this level federal transfers and services, the residents of the pivotal province will achieve a fiscal balance with $g_p / G = \rho / \phi$. As before, provinces with an average income below that of the pivotal province will perceive a federal fiscal imbalance and those provinces with average incomes above the pivotal province will perceive a provincial fiscal imbalance.

Substituting (51) into (50), the total per capita transfer to province i is:

$$T_i = \frac{(\beta+\theta)(\rho+b)Y_{ave} - (\beta+\phi)(b-\theta)Y_{ap}}{\phi+\rho+\beta+b} - \theta Y_{ai} \tag{52}$$

The total per capita transfer received by province i will be increasing in the national average income, decreasing with the average income of the pivotal province, and decreasing with the average income of province i. With this combination of per capita and RTS equalization grants, even province n with the highest average income can a net recipient of a grant if:

$$\frac{Y_{an}}{Y_{ave}} < \frac{(\beta+\theta)(\rho+b)}{\theta} - \frac{(\beta+\phi)(b-\theta)}{\theta}\frac{Y_{ap}}{Y_{ave}} \tag{53}$$

If this condition holds, the fiscal equalization grant is effectively financed by the federal government even though provincial governments with above average incomes nominally finance the equalization transfer. For example, if $Y_{ap} = Y_{ave}$, $b = 0.4$, $\beta = 0.6$, $\rho = 0.6$, $\phi = 0.4$, and $\theta = 0.15$, the highest income province will be a net transfer recipient if $Y_{an}/Y_{ave} < 3.33$. Since regional disparities are rarely this large, the model suggests that we could observe federally-financed transfer systems that have the characteristics of a net equalization RTS combined with an equal per capita grant.

Finally, in the Section 5.2 we test the predictions of the model using data on the relative transfer received by province i, T_i/T. It can be shown that the relative transfer received by province i is:

$$\frac{T_i}{T} = \frac{\theta(\phi+\rho+\beta+b)\left(\frac{Y_{ai}}{Y_{ave}}\right) + (\phi+\beta)(b-\theta)\left(\frac{Y_{ap}}{Y_{ave}}\right) - (\rho+b)(\beta+\theta)}{\theta(\phi+\beta) - \beta(\rho+b) + (b-\theta)(\phi+\beta)\left(\frac{Y_{ap}}{Y_{ave}}\right)} \tag{54}$$

From the above equation, we can derive the prediction that a province i's relative transfer will decrease as its relative income increases and increase (decrease) as the pivotal province's relative income increases if province i's average income is below (above) the national average

income. The is:

$$\frac{d\left(\frac{T_i}{T}\right)}{d\left(\frac{Y_{ai}}{Y_{ave}}\right)} < 0 \tag{55}$$

$$\frac{d\left(\frac{T_i}{T}\right)}{d\left(\frac{Y_{ap}}{Y_{ave}}\right)} = a\left(1 - \frac{Y_{ai}}{Y_{ave}}\right) \tag{56}$$

where a is a positive coefficient. Therefore in the regression model in Section 5.2, we include the effect of the two relative income variables on T_i/T as $a\left(1 - \frac{Y_{ai}}{Y_{ave}}\right)\left(\frac{Y_{ap}}{Y_{ave}}\right)$.

4 A Political Economy Model of Fiscal Equalization

In the preceding section, the RTS equalization system was exogenous to the model. In this section, we consider the determination of the fiscal equalization formula by a federal government. As in the previous models, we assume that voters at the provincial level take the federal tax rate and the per capita transfer to their province, T_i, as given when they vote to determine g_i and t_i. As before, equations (5) and (6) indicate the provision of the provincial public good and the provincial tax rate.

Individuals in each province will have a preferred fiscal equalization formula. To put some structure on these choices, we assume that the equalization formula has to have the following general form:

$$T_i = \tau_s \left[Y_s - Y_{ai}\right] \; and \; T_i = 0 \; for \; Y_{ai} \geq Y_s \tag{57}$$

That is, province i's per capita transfer will be determined by the deviation of its average per capita income from a standard income level, Y_s, and a parameter, τ_s, which will determine the quantum of the grant. We assume that choices are restricted to a "gross equalization" formula such as the one that has been used in Canada for 50 years. The equalization grants are financed out of the federal government's general revenues, and the provinces with average incomes above the standard do not fund the transfers.

As before, the residents of each province will be unanimous in their preferred values for τ_s and Y_s. Consider the residents of province i with average income Y_{ai}. The equalization standard that will maximize their per capita grant is $Y_s = Y_{ai+1}$ because they will not have to share the transfer with any of the higher income provinces. Only provinces with incomes from Y_{a1} to Y_{ai} will receive grants. The average per capita grant with this standard will be:

$$T = \sum_{j=1}^{i} s_j T_j = \tau_s \sum_{j=1}^{i} s_j \left[Y_{ai+1} - Y_{aj} \right] = \tau_s w_i \left[Y_{ai+1} - \hat{Y}_{ai} \right] \tag{58}$$

where $w_i = \sum_{j=1}^{i} s_j$ is the population of the recipient provinces and $\hat{Y}_{ai}$ is the average income in the recipient provinces. Consequently, the per capita transfer that province i will receive, for a given T, is:

$$T_i = \frac{1}{w_i} \frac{(Y_{ai+1} - Y_i)}{\left(Y_{ai} - \hat{Y}_{ai} \right)} T = \theta_i^* T \tag{59}$$

This is the equalization grant formula that would be preferred by province i, given that the formula has to satisfy the general restriction in (54). Note also that it will be assumed that $\theta_i^* > 1$. There is an average income level $Y_{ac} = h_c \hat{Y}_{ac} + (1 - h_c) Y_{ac+1}$ where $\theta_c^* = 1$. Provinces with average income above Y_{ac} will prefer an equal per capita grant.

While each province has a preferred equalization formula of this form, the formula that is preferred by the pivotal province will garner a majority of votes in the federal legislature in any competition against an alternative equalization formula. Therefore the equalization formula that is adopted by the federal government will have the form $T_i = \theta_i T$ where:

$$\theta_i = \frac{1}{w_p} \frac{(Y_{ap+1} - Y_{ai})}{\left(Y_{ap+1} - \hat{Y}_{ap} \right)} \tag{60}$$

With this parameter in equalization formula, the provinces with a lower income will receive a higher transfer relative to the average per capita transfer and that province with income in excess of the pivotal province will not receive equalization grants.

Next we consider voting in the federal legislature to determine T and G for a given size of the federal budget, R_f. Again, maximizing the utility function in (13) subject to the

constraint $R_f = G + T$, yields the preferred values for G and T for each province given R_f. Again the levels of these fiscal variables that will receive majority support in the federal legislature are those that are desired by the pivotal province and they will be equal to:

$$G = \frac{\phi}{\phi + \rho + b}\left(R_f + \frac{b}{\theta_p} Y_{ap}\right) \tag{61}$$

$$T = \frac{1}{\phi + \rho + b}\left((\rho + b)\, R_f - \phi \frac{b}{\theta_p} Y_{ap}\right) \tag{62}$$

The determination of the size of the federal budget satisfies the condition in (18) but now in (19) we have $dg_i/dR_f = (\theta_i \rho)/(\phi + \rho + b)$. As a result, the first order condition for the optimal R_f from the perspective of the residents of province i will satisfy this modified version of (21):

$$\frac{\theta_i \rho^2}{g_i} + \frac{\phi^2}{G} = \frac{\beta\,(\phi + \rho + b)}{X_{hi}} \frac{Y_{hi}}{Y_{ave}} - \frac{b^2}{Z_{hi}} \frac{Y_{hi}}{Y_{ai}} \tag{63}$$

As before, all households in province i will agree on their preferred R_f, and it will be decreasing in the province's average income. The privotal province's preferred R_f will receive majority support in the legislature and it will be equal to:

$$R_f = \frac{\beta\,(\phi + \rho + b)\, Y_{ave} - b\beta\theta_p^{-1} Y_{ap}}{\phi + \rho + b + \beta} \tag{64}$$

Note that since $\theta_p > 1$, the federal revenue and therefore federal taxes will be higher under the equalization program than they would be if the federal transfer was restricted to an equal per capita transfer. The larger federal revenues and federal transfers occur because now the pivotal province will get more than equal per capita grant. The key fiscal variables will be:

$$T = \frac{\beta(\rho + b) Y_{ave} - b(\phi + \beta)\theta_p^{-1} Y_{ap}}{\phi + \rho + b + \beta} \tag{65}$$

$$g_p = \frac{\rho\,(bY_{ap} + \beta\theta_p Y_{ave})}{\phi + \rho + b + \beta} \tag{66}$$

$$G = \frac{\phi\,(bY_{ap} + \beta\theta_p Y_{ave})}{\theta_p(\phi + \rho + b + \beta)} \tag{67}$$

Dividing (63) by (64), we obtain:

$$\frac{g_p}{G} = \theta_p \frac{\rho}{\phi} \tag{68}$$

This indicates that with their preferred fiscal variables, the residents of the pivotal province will prefer to have a provincial fiscal imbalance. The pivotal province now gets more benefit from a dollar of federal revenue spent on transfers than it does on federal services. Consequently, the residents of the province prefer higher per capita transfers and lower per capita federal services compared to the situation described in Section 2 where transfers were restricted to be equal per capita. The provision of the provincial public good in province i where $i \leq p$ will be equal to the following:

$$g_i = \frac{\rho b}{\rho + b} Y_{ai} + \frac{\rho \beta \theta_i}{\phi + \rho + b + \beta} Y_{ave} - \left(\frac{\theta_i}{\theta_p}\right) \frac{\rho b(\phi + \beta)}{(\rho + b)(\phi + \rho + b + \beta)} Y_{ap} \tag{69}$$

Since g_i is increasing in Y_{ai}, but it is also affected by θ_i, it is not clear whether other recipient provinces will perceive a federal fiscal imbalance or not. Numerical simulation of the model may shed some light on this aspect of the model.

5 Testing the Predictions of the Model

The political economy model in this paper was developed to provide insights concerning perceptions of vertical fiscal imbalances in federations and to describe the determination of intergovernmental grants when there are significant differences in the MCFs between the provinces and the federal government. In this section, we preliminary tests of the predictions of the model based on time series data intergovernmental grants for Canada and cross-section data on intergovernmental grants for nine federations developed by Dragu and Rodden (2010).

5.1 Time Series Data for Canada

Without going into details, the Canadian federal-provincial transfer system combines a system of equalization grants, where the equalization standard has varied over time and

the equalization grants are financed out of federal revenues, with lump-sum grants to the provinces, now known as the Canada Health Transfer (CHT) and Canada Social Transfer (CST).[6] In the past the per capita transfers varied by province, but the CST has become an equal per capita grant and the CHT is set to become an equal per capita grant in 2014. Thus the grant system has elements of fiscal equalization and equal per capita lump-sum transfers that might be best captured by the model in Section 3.

Figure 2 shows that these cash transfers to the provinces as a percentage of GDP has declined from just over four percent of GDP in the mid 1980s to around 2.5 percent of GDP from the mid-1990s to 2003. Subsequently, they have increased and are currently just over three percent of GDP. The dramatic reduction in the federal transfers to the provinces that occurred in the mid-1990s was the result of federal government adopting a stringent fiscal restraint program to eliminate chronic federal budget deficits. As part of its fiscal restraint measures, the federal government reduced spending on its programs as well as the non-equalization transfers to the provinces. The provincial governments became very vocal in complaining about a federal fiscal imbalance during this period.

Given that an "exogenous" budgetary shock was the main determinant of the size of the fiscal gap in the 1994-2003 period, the explanatory power of the political economy model will be mainly tested by its ability to explain the trends in transfers pre-1994 and post-2003.

A key prediction of the models outlined in the previous sections was that the relative average income of the "pivotal province" should be a key determinant of the transfers. Therefore the first step in testing the model is to indentify the "pivotal province" and to calculate its average income relative to the national average. Although the model has been formulated in terms of an income measure that might interpreted as personal income, we have chosen to measure average income as GDP per capita because this is a better approximation to the provincial tax bases in Canada which include corporate income tax and royalty payments on natural resources which are owned by the provinces. Figure 3 indicates that the identity as well as the relative average income of the pivotal province in Canada has varied over time. Ontario was the pivotal province in the early 1980s, but when Ontario emerged from the recession, British Columbia (BC) became the pivotal province

[6] See Dahlby and Roberts (2010) for an overview of the system of intergovernmental grants in Canada.

and remained pivotal until 2000, when Saskatchewan (Sask) become pivotal. Then in 2004 Ontario once again became pivotal.

Of course it is not the identity of the pivotal province, but its relative average income that affects the magnitude of federal transfers to the provinces. Figure 3 shows that the relative average income of the pivotal province in Canada has varied over time, with an upward trend from the mid-1980s to the mid-1990s, followed by a downward trend to 2000, then a recovery to the national average, followed by a decline from the mid-2000s to the end 2009. While our measure of the relative average income of the pivotal province shows some interesting variations over time, the range is relatively modest, from a peak of 1.065 in 1993 to a low of 0.917 in 2001. In most years, the pivotal province's average income is close to the national average. Note also that the period of federal fiscal restraint coincided with the period when the relative income of the pivotal province was at its nadir and transfers according to the model should have been a relatively high during this period. Thus an exogenous event, federal fiscal restraint, may limit the explanatory power of the key variable in the model. As Figure 4 indicates, there may in fact be a positive correlation between federal transfers and the relative average income of the pivotal province.

Figure 5 shows the cross-sectional variation in federal transfers to individual provinces and their relative per capita GDPs. A strong negative relationship emerges in all four years that are shown in these figures with the notable exception of the observations for Alberta, which is the data point on the extreme right in each of the figures. In other words, Alberta has received more in transfers than would be warranted by its relative per capita GDP. This suggests that the federal transfers to Alberta (and to other provinces) have been motivated by more than concerns about correcting fiscal imbalances. For example, receipt of the CHT obliges provincial governments to abide by the principles of the Canada Health Act in organizing provincial heath care systems.

To perform a formal statistical test of the model, based on equation (52), we have regressed the ratio of each province's per capita transfer to the national average income against the province's relative average income, the relative average income of the pivotal province, a dummy variable, FR, for the period of federal fiscal restraint fom 1995 to 2003, and a dummy variable, AB, for Alberta. The data set consists of the 290 observation on the 10

provinces from 1981 to 2009. The regression equation is reported below:

$$\frac{T_i}{Y_{ave}} = \underset{(5.86)}{0.116} - \underset{(26.48)}{0.113}\frac{Y_{ai}}{Y_{ave}} + \underset{(1.73)}{0.0331}\frac{Y_{ap}}{Y_{ave}} - \underset{(3.82)}{0.00613}\,FR + \underset{(8.69)}{0.0268}\,AB \tag{70}$$

Adjusted $R^2 = 0.763$. The t statistics are reported in parentheses. As expected, a province's relative average income is a major determinant of its per capita transfers. The coefficient estimate indicates that when a province's per capita GDP increases by one dollar, holding the national average GDP constant, transfers by 11.3 cents. The regression results confirm that federal fiscal restaint lowered transfers. The coefficient on the dummy variable for Alberta is positive and statistically significant. The pivotal province's relative average income has a positive coefficient, contrary to the predictions of the model, but it is not statistically significant by a two tail test.

Further investigation of the statistical relationships is warranted, but our preliminary results based on the time series data for Canada do not support the key prediction of the model in Sections 2 and 3 that an increase in the relative income of the pivotal province should be associated with a reduction in federal transfers.

Furthermore, the predictions of the model from Section 4 concerning the form or pattern of fiscal equalization are not consistent with the Canadian experience. The model in Section 4 predicts that the pivotal province will always be a recipient of fiscal equalization grants. Indeed it is predicted to be the highest income recipient province. However, the pivotal province only received equalization grants in six of the 29 years in our data set. Thus the model in Section 4 does not predict the equalization standard used to determine equalization payments in Canada.

5.2 Cross-Section Data for Nine Federations: Preliminary Results

Rodden (2009) and Dragu and Rodden (2010) have shown that provinces that are over-representated in the federal legislatures tend to receive higher per capita grants than other provinces. Indeed in Argentina, Mexico, and the United States, provinces with higher per capita GDPs receive higher per capita grants than poorer provinces. Rodden attributes

this pattern of intergovernmental grants to the ability of legislators from over-representated provinces to form coalitions with other legislators to extract higher grants from the federal government. He notes that this tends to occur in presidential systems of government where party discipline is weak. In this section of the paper, we test whether the models developed in Sections 2 and 3 can explain the pattern of transfers in nine federations based on the cross-section data from the Dragu and Rodden (2010) study, with particular attention to the question of whether the model applies to presidential or parliamentary federations.

We begin by determining the pivotal province in each of the nine federations based on the provinces' shares of the representatives in the federal legislatures. As noted above, in many federations provinces, such as the United States, small states are over-representated because there is an upper house where representation is by province rather than by population. As well, in some federations, such as Argentina, small states are over-represented in the lower house. Thus to determine the pivotal province in each federation, we use data on the proportion of federal legislators that come from the province rather than its share of the population in each federation.

Table 1 shows the pivotal province in each of the nine federations, the pivotal province's relative income, the number of provinces in the federation, whether the federation has a presidential or a parliamentary system, and the time period covered by the data. In most of these federations the pivotal provinces' per capita incomes are close to the national averages. They are above the national average in Australia and Canada. Only in Switzerland is the average income of the pivotal province, Basel-Landschaft, substantially below the national average. The data set consists of observation on transfers to 209 provinces in the nine federations based on average values of the variables over the time periods noted in Table 1. Of the 209 observations, 51 are from federations with parliamentary systems of government and 158 are from federations with presidential systems.

Table 2 shows the regression results where the dependent variable, Transfers, is the ratio of the province's per capita transfer to the average per capita transfer for all provinces in the federation. In Model 1 we regress Transfers on Representation which is the ratio of the number of legislative seats per capita in a province to the average number of seats per province; Population Change which is the difference between the relative population

of a province in the first year for which there are observations on grants and the relative population of the province approximately 10 years after the first observation; Province Size which is the ratio of the area of the province to the average area of the provinces in the federation; Capital Province which is a dummy variable that takes a value of one if the federal capital is located in the province; and Relative Incomes which is defined as $(1 - Y_{ai}/Y_{ave})(Y_{ap}/Y_{ave})$. The predicted sign of the estimated coefficient for Relative Incomes is positive because an increase in province i's relative income should reduce its relative transfer to the extent that the federation adopts a system of equalization grants given by (46) and an increase in the relative income of the pivotal province will increase (reduce) the relative transfer of a province if it is below (above) the average national income. In Model 1, the estimated coefficients of the Representation variable and Capital Province are positive and statistically significant at the one percent level. The estimated coefficients of Population Change, Capital Province and Relative Incomes are positive but not statistically significant.

As previously noted, the allocation of transfers among provinces may be quite different under parliamentary and presidential systems of government because in a presidential system the representatives of the provinces may have more scope for forming coalitions with other provinces to capture more of the federal transfers. The model of the pattern of transfers that was developed in Sections 2 and 3 is more consistent with a parliamentary setting, where a particular political party can represent a set of regions with a common interest in setting the transfers to redistribute income in their favour. Based on this conjecture, we introduce a dummy variable, DP, which has a value of one if the country has a presidential system. We hypothesize that under a presidential system, the allocation of transfers is largely determined by the Representation variable, whereas under a parliamentary system, the Relative Incomes variable will determine the allocation of transfers. To capture the differential effects of Representation and Relative Incomes under parliamentary and presidential systems we multiply these variables by DP and add these two additional variables in Model 2. With this regression model, Representation is positive and highly significant although the Representation*DP is not statistically significant. However, the coefficient of Relative Incomes increases in magnitude and is statistically significant at the five percent

level and the Relative Incomes interacted with the DP is negative and statistically significant at the 10 percent level. These results indicate that the Relative Incomes variable seems to have the predicted effects on the relative transfers in parliamentary systems but little or no effect on the distribution of transfers in presidential systems. Model 3 shows a simplied version of Model 2 by dropping Province Size, Population Change, and Representation*DP from the regression equation. The coefficients of the remaining variables and their t statistics are little changed from the results obtained in Model 2.

6 Concluding Remarks

In this paper we have developed a political economy model that determines the size of the vertical fiscal gap and the vertical fiscal imbalances in the expenditures of the central government and subnational governments. We have assumed that the system of transfers reflects the interests of voters located in different subnational governments across the country. We eschew the assumption of identical regions because regional variations in key economic variables is one of the main reasons for federal forms of government exist. We have attempted to define the concept of fiscal balance, and its opposite, fiscal imbalance, in terms of the allocation of spending at the two levels of government, rather than in terms of the conventional definition of a difference between own source revenues and expenditures at the subnational level of government.

By making a strong assumption about the form of voters' utility functions, we are able to derive closed form expressions for the key fiscal variables in the model. The basic model predicts that the residents in each province will vote for a combination of federal public services and transfers to the provinces such that they can achieve a fiscal balance between spending at the federal level and at the provincial level. In general, this means that they would like to equalize the tax price of federal public services and provincial public services. Since the federal government is assumed to provide the same level of public service across the country, the residents of only one province can achieve a fiscal balance. A simple majority voting model in the federal legislature predicts that this fiscal balance will be achieved by the residents of the "pivotal province". The residents in provinces with lower average

incomes will perceive a federal imbalance, and they would like to see higher transfers to fund more provincial services and less spending on the federal public good. On the other hand, provinces with above average incomes will see a provincial imbalance in spending. The simple models outlined in Sections 2 and 3 indicate that a vertical fiscal imbalance cannot be resolved through major voting in legislatures, but at least the imbalace will "balanced". While the objective of the paper is provide insights into the potential for resolving fiscal imbalance by democratically elected governments, the model can also be used to predict the allocation of intergovernmental transfers in a federation. We have tested the key prediction of the model–that grants to reduce the vertical fiscal imbalance between the two levels of government will be inversely related to the relative average income of the pivotal province–using time series data for Canada and cross-section data from nine federations. The key prediction of the model is rejected with the time series data for Canada, but the main prediction is verified for the federations with parliamentary forms of government based on the cross-section data. The latter results then indicate that there are significant differences in the pattern of transfers to subnational governments under presidential and parliamentary systems. Further research may help to clarify and confirm the differences in the pattern of transfers to subnational governments with these two forms of government.

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7 Appendix

To determine how the desired federal budget varies with average province income, we can write the left-hand side of (21) as $\Lambda(R_f, Y_{ai})$ and the right-hand side as $\Pi(R_f, Y_{ai})$. Using this notation and taking the total differential, we can obtain the following comparative static result:

$$\frac{dR_f}{dY_{ai}} = \frac{\Pi_{Y_{ai}} - \Lambda_{Y_{ai}}}{\Lambda_{\tau_f} - \Pi_{\tau_f}} \tag{71}$$

It can be shown that:

$$\Pi_{Y_{ai}} = \frac{b^4}{Z_{ai}^2} \frac{1}{\phi + \rho + b} > 0 \tag{72}$$

$$\Lambda_{Y_{ai}} = -\left(\frac{b}{\phi + \rho + b}\right)\left(\frac{\rho^3}{g_i^2}\right) < 0 \tag{73}$$

$$\Lambda_{R_f} = -\left(\frac{1}{\phi + \rho + b}\right)\left(\frac{\rho^3}{g_i^2} + \frac{\phi^3}{G^2}\right) < 0 \tag{74}$$

$$\Pi_{R_f} = \frac{\beta\left(\phi + \rho + b\right)}{X_{ai}^2}\left(\frac{Y_{ai}}{Y_{ave}}\right)^2 + \frac{b^3}{Z_{ai}^2}\left(\frac{1}{\phi + \rho + b}\right) > 0 \tag{75}$$

and therefore:

$$\frac{dR_f}{dY_{ai}} < 0 \tag{76}$$

Figure 1
The Detemination of the Preferred Level of the Provincial Public Good

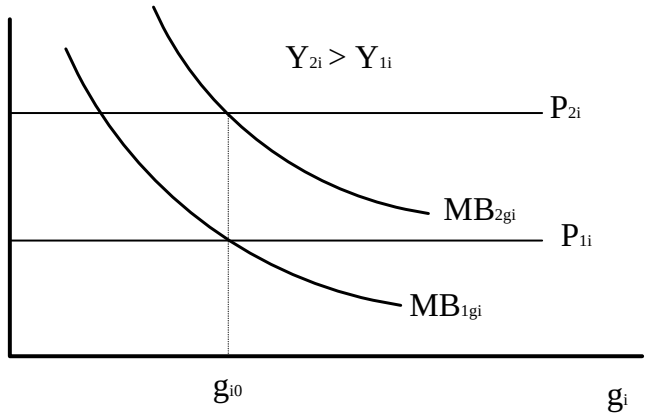

Figure 2
Cash Transfers to the Provinces as a Percentage of GDP

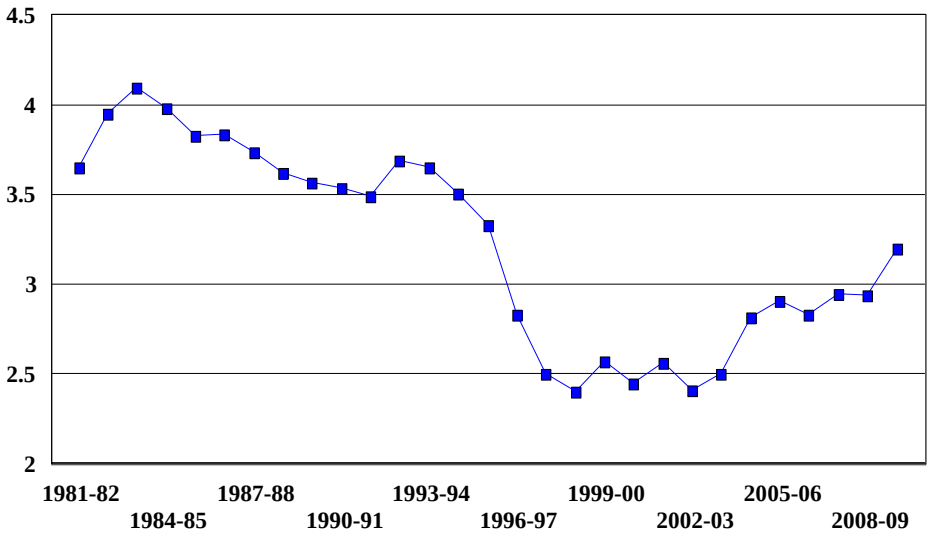

Figure 3
Relative Average Income in the Pivotal Province

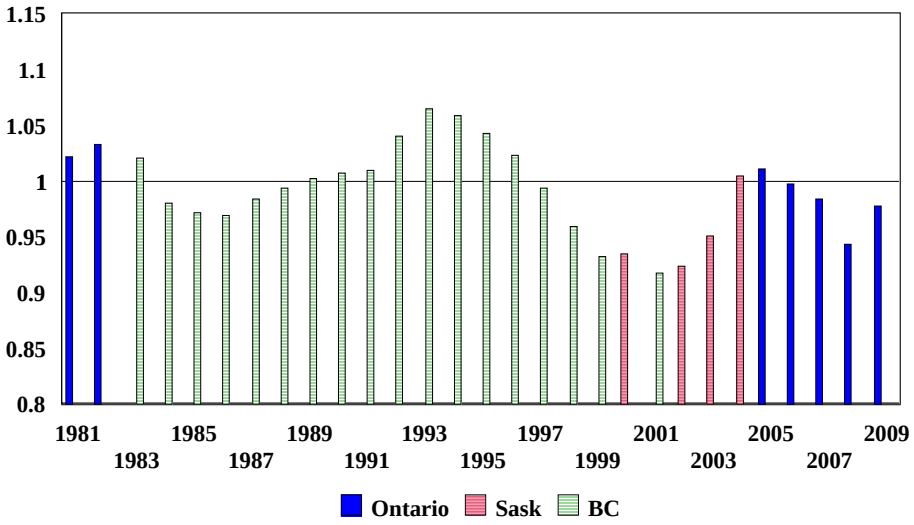

Figure 4
Transfer to GDP versus Relative Income of the Pivotal Province

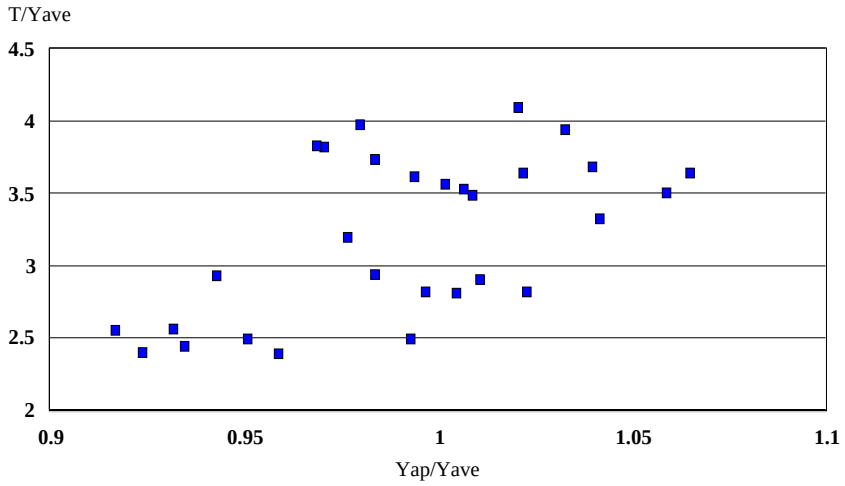

Figure 5
Ratio of Per Capita Transfers to National Average GDP Per Capita versus the Provinces' Relative Per Capita GDP

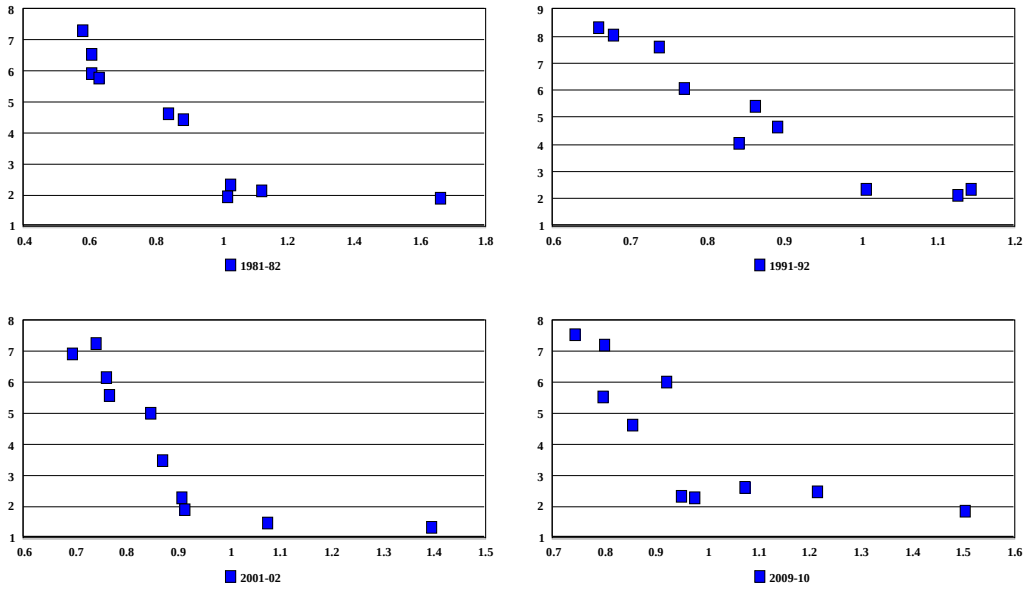

Table 1 Pivotal Provinces and Systems of Government for Nine Federations

Country	Pivotal Province	Relative Income of the Pivotal Province	Number of Provinces	System of Government	Time Period
Argentina	La Rioja	0.887	24	Presidential	1983-1996
Australia	Victoria	1.029	8	Parliamentary	1990-2001
Brazil	Mato Grosso	0.904	27	Presidential	1986-2000
Canada	British Columbia	1.199	10	Parliamentary	1968-1997
Germany	Berlin	0.959	16	Parliamentary	1995-2003
Mexico	Mexico	0.841	32	Presidential	1993-2006
Spain	Castile and León	0.953	17	Parliamentary	1984-2001
Switzerland	Basel-Landschaft	0.519	26	Presidential	1998-2007
United States	Ohio	0.965	50	Presidential	1977-1997

Table 2 Regression Results From Cross-Section Data

Variable	Model 1	Model 2	Model 3
constant	0.259 (2.46)	0.278 (2.48)	0.324 (3.99)
Representation	0.584 (20.27)	0.550 (5.40)	0.578 (20.29)
Representation*DP		0.0302 (0.75)	
Population Change	0.101 (0.56)	0.104 (0.59)	
Province Size	0.062 (1.01)	0.0515 (0.84)	
Capital Province	1.18 (3.67)	1.258 (3.87)	1.22 (3.80)
$(1 - Y_{ai}/Y_{ave})(Y_{ap}/Y_{ave})$	0.235 (1.60)	1.141 (2.07)	1.122 (2.07)
$(1 - Y_{ai}/Y_{ave})(Y_{ap}/Y_{ave})$*DP		-0.965 (1.70)	-0.974 (1.75)
Adj. R^2	0.6685	0.6700	0.6728

Note: The dependent variable is the province's relative per capita transfer from the central government. The number of observations is 209. Absolute values of t statistics are shown in parentheses.

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