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Abstract

We test the hypothesis that the flypaper effect can arise if the recipient government finances part of its expenditures with a distortionary tax. We present a simple theoretical framework that shows how a lump-sum transfer stimulates the marginal expenditures of a recipient government through an income effect and a price effect. We test the predictions of this model using data on Canadian provincial expenditures and federal transfers to the provinces over the period 1981 to 2008. Our econometric results indicate that a $0.10 increase in a provincial government's marginal cost of public funds increases the stimulative effect of lump-sum grants by $0.32.

JEL-Code: H720, H770.

Keywords: intergovernmental grants, marginal cost of public funds, flypaper effect.

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1. Introduction

Intergovernmental grants are an important feature of many federations around the world. There have been ongoing debates in academic and political circles on the merits and possible effects of federal grants on the behaviour of recipient governments. The literature on intergovernmental grants has been mainly concerned with the response of local government spending to changes in grants. Oates (1999) and Gamkhar and Shah (2007) provide detailed surveys of the literature. In the conventional model, lump-sum grants to a subnational government augment the resources of the recipient community without affecting the relative price of public goods provided by the subnational government.[1] Thus an increase in lump-sum grants should have the same effect on local government spending as an equivalent increase in private income. However, empirical studies overwhelmingly reject this hypothesis. (See Gamkhar and Shah (2007)). In fact, most studies show that nonmatching grants have a higher stimulative effect on subnational government spending than an equal change in private income. This nonequivalent effects of nonmatching grants and private income is generally referred as the "flypaper effect", i.e."money sticks where it hits".

A number of studies attempt to provide justifications for the common empirical finding that grants have a greater stimulative effect on local government spending than private income. While Hines and Thaler (1995) view the flypaper effect simply as an empirical anomaly, others argue that it may be caused by fiscal illusion by the local government (see for example Courant, et al (1979), Logan (1986), and Dollery and Worthington (1999)) or it is simply a result of politics (Inman (2008)).

Another strand of the literature attempts to explain the flypaper effect by alluding to the possible endogeneity of intergovernmental grants. For instance, Knight (2002) finds that the

[1] See Wilde (1968).

flypaper effect disappears or weakens once grants are treated as endogenous. As a result, he concludes that the endogeneity of grants, which is usually ignored in empirical studies, can explain the flypaper effect obtained in previous studies. Gordon (2004) and Dahlberg et al (2008) also address the potential endogeneity problems of grants by exploiting discontinuity in the grant system. Gordon (2004) investigates the effects of Title I funding (grant to schools) on schools revenues and spending. She finds that while such grants raise school spending initially, the effects of such grants on school spending becomes very minimal overtime. Dahlberg et al (2008) also examine the effects of federal grants on local government spending and tax rates in Sweden. Their empirical results confirm that the flypaper effect can persist even if grants are treated as endogenous.

Most theoretical models of the stimulative effects of grants assume that the subnational government uses lump-sum taxes even though such taxes are rarely used. Hamilton (1986) was the first to point out that a flypaper effect can arise when a subnational governments uses distortionary taxes to finance at least part of their expenditures. Becker and Mulligan (2003) and Volden (2007) have developed political economy models that exhibit a flypaper effect because recipient governments rely on distortionary taxes to finance part of their spending.[2] Dahlby (2011) has derived a model of the magnitude of the flypaper effect when a benevolent government finances part of its expenditures using a distortionary tax. Numerical simulations, using a range of reasonable parameter values for the income elasticities of demand for the tax base and the public services provided by the recipient government, indicate that flypaper effects that are similar to those observed in many empirical studies can arise even when the recipient government's marginal cost of public funds (MCF) is relatively low.

[2] For an alternative political economy model of the flypaper effect, see Roemer and Silvestre (2002).

Why is the use of distortionary taxes associated with a flypaper effect? Dahlby (2011) and Buettner and Fabritz (2011) show that a lump-sum intergovernmental transfer has a "price effect", as well as an "income effect", because it allows the recipient government to reduce its tax rate, which lowers its marginal cost of public funds, while still providing the same level of public service. This reduction in the effective price of providing the public service provides the additional boost to spending and helps to explain why a lump-sum grant has a much larger effect on spending than an increase in personal income. The conventional analysis of the impact of a lump-sum grant on the budget constraint of a recipient government assumed that it only had an "income effect" because it was implicitly assumed that public expenditures were financed by non-distortionary lump-sum taxes.

While there is a sound theoretical basis for a distortionary tax explanation of the flypaper effect, there has only been limited empirical testing of the key prediction of this model—that the stimulative effect of an intergovernmental grant will increase with the marginal cost of public funds of the recipient governments. Recently, Buettner and Fabritz (2011) show that the effects of unconditional grants on public good provisions are larger in smaller jurisdictions which have higher marginal cost of funds. Using municipal data from Germany, they found empirical evidence that small jurisdictions' expenditure response to unconditional grants is higher than those of larger jurisdictions. They use differences in local employment as a proxy to the MCF. Végh and Vuletin (2010) also test whether the flypaper effects are larger when the recipient governments' taxes are more distortionary using data on gross receipts tax rates and residential property tax rates for Argentinean provinces and 28 American cities. They split their samples into provinces/cities with tax rates above and below the median and they find that the flypaper effect is about 40 percent larger in the provinces/cities with higher tax rates. Aragón (2011) finds

that higher tax collection costs among municipalities in Peru may explain 4 to 18 percent of the flypaper effect.

The main objective of our study is to investigate whether the flypaper effect can be explained using a measure of the recipient governments' MCFs derived from Dahlby and Ferede (forthcoming). We first present a simple theoretical framework that shows how a lump-sum transfer stimulates the marginal expenditures of a recipient government through an income effect and a price effect. The latter effect arises because the effective price of providing a public service is the recipient government's MCF multiplied by the marginal cost of producing the public service. A lump-sum transfer allows the recipient government to fund any given level of spending at a lower tax rate, thereby reducing the recipient government's MCF and the effective price of its public services.

We test empirically the predictions of our simple model using aggregate data on Canadian provincial expenditures and federal transfers to the provinces over the period 1981 to 2008. Our econometric results are consistent with the existence of a flypaper effect because a one dollar increase in per capita lump-sum grants, measured at the mean MCF, is $0.39 while a one dollar increase in per capita personal income increases provincial spending by $0.17. The results also suggest that a $0.10 increase in a provincial government's MCF increases the stimulative effect of lump-sum grants on its expenditures by $0.32. The empirical results are robust to various sensitivity checks. The results of this paper have important policy implications. Studies which argue that the flypaper effect is based on voters' fiscal illusion, or the excessive influence that budget-maximizing bureaucrats have over spending, tend to argue for reduced intergovernmental transfers. Our results, on the other hand, indicate that a large flypaper effect arises when the recipient government has a high MCF. The implication of this is that higher

intergovernmental transfers may be welfare improving if the federal government has a lower MCF than the provinces.

The remainder of the paper is organized as follows. In Section 2 we provide a theoretical framework which is a basis for our empirical analysis. In Section 3 we provide background on the key fiscal variables in our empirical analysis. The econometric model and results are presented and discussed in Section 4. Section 5 concludes.

2. Theoretical framework

In this section we provide a theoretical framework that shows how the MCF influences the stimulative effects of grants on provincial government spending. Each provincial government is assumed to have a homogeneous immobile population that can be represented by the preferences of a single resident, $W = U(x, H) + \Gamma(g)$ where x is the consumption of a personal good, H is hours of labour supply, and g is a public service provided by the provincial government, where $U_x > 0$, $U_H < 0$, $\Gamma'(g) > 0$, and $\Gamma''(g) < 0$. We assume that U(.) is a quasi-concave function and that g is a purely consumptive public service which enters that utility function of individuals as an additively separable variable. The provincial government levies a tax on the individuals' wage income, $Y = wH$, at a constant tax rate τ. The representative individual's budget constraint is $px = (1 - \tau)wH + M$ where p is the price of the composite personal good, w is the wage rate, and M is the lump-sum income received by the individual. It is assumed that the demand for labour is perfectly elastic at an exogenously determined wage rate. For a given g, the individual maximizes utility by choosing x and H subject to this budget constraint, giving rise to the indirect utility function $V(p, w_n, g, M)$ where $w_n = (1 - \tau)w$ is the individual's net wage rate, and $V_\tau = -\lambda wH < 0$ where $\lambda = V_M > 0$ is the marginal utility of

income. For future reference, the marginal benefit from the public good is MB = $V_g/\lambda > 0$. In general, the marginal benefit from the public service will be a function of g, w_n, and M.

Let T be the per capita lump-sum grant received by the provincial government. Its budget constraint is:

$$cg = \tau wH + T \tag{1}$$

where c is the constant per unit cost of producing g. The provincial government is assumed to maximize the well-being of the representative individual through its choice of g and τ. The optimal expenditures on the public service, given the provincial government budget constraint in (1), will satisfy the following condition:

$$MB(g, w_n, M) = MCF \cdot c \tag{2}$$

where MCF is the provincial government's marginal cost of public funds, which in this context is equal to:

$$MCF = (1 + \tau\eta)^{-1} \tag{3}$$

where η is the semi-elasticity of hours of work with respect to the tax rate, $\eta = H^{-1}H_\tau$. It is assumed that a higher tax rate reduces the amount of labour supplied, i.e. $H_\tau < 0$. Therefore $\eta < 0$ and the marginal cost of public funds is greater than one for $\tau > 0$. We also assume that the government always operates on the upward-sloping section of its Laffer curve, and therefore $1 + \tau\eta > 0$.

We want to determine the effects of increases in T and Y on expenditures of the provincial government. Taking the total differential of equations (1) and (2), we obtain the following:

$$\begin{pmatrix} MB_g & -(wMB_{wn} + cMCF_\tau) \\ c & -(wH - tw^2H_{wn}) \end{pmatrix} \begin{pmatrix} dg \\ d\tau \end{pmatrix} = \begin{pmatrix} -(1-\tau)MB_{wn}dw \\ (\tau H + \tau w(1-\tau)H_{wn})dw + dT \end{pmatrix} \tag{4}$$

We assume that $MB_g < 0, MB_{wn} > 0, MCF_\tau > 0$. This system of equations can be simplified as follows. Note that $wH - \tau w^2 H_{wn} = wH \cdot MCF^{-1}$, and:

$$wMB_{wn} + cMCF_\tau = \left(\left(\frac{\tau}{1-\tau}\right) I + P\right) \tau^{-1} cMCF \tag{5}$$

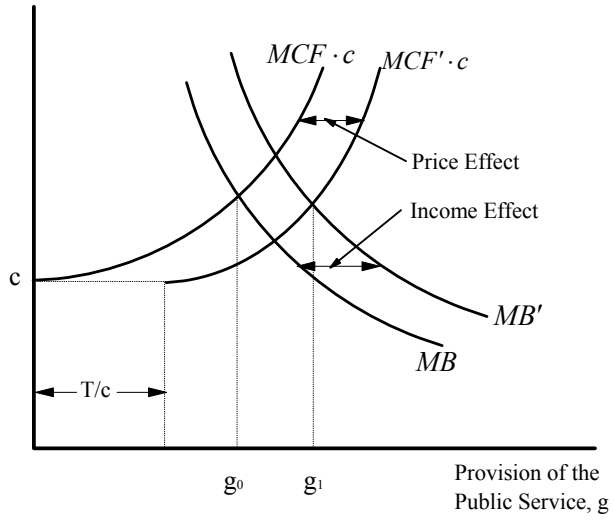
where I is the elasticity of the marginal benefit of the public good with respect to the net wage rate, i.e. $I = MB_{wn}(w_n/MB)$, and P is semi-elasticity of the marginal cost of public funds with respect to tax rate, i.e. $P = MCF_\tau \cdot MCF^{-1}$. As discussed in more detail below, $(\tau/(1-\tau))I$ can be interpreted as the income effect, and P as the price effect, of an increase in a lump-sum grant on expenditure on the public service.

Substituting the above expressions into (4), the following comparative static effects can be obtained:

$$\frac{dE}{dT} = \frac{\left(\left(\frac{\tau}{1-\tau}\right)I+P\right)MCF}{\left(\left(\frac{\tau}{1-\tau}\right)I+P\right)MCF-\gamma\left(\frac{\tau Y}{E}\right)} \tag{6}$$

where E = cg is the per capita expenditure on the public service by the provincial government and γ is the elasticity of the marginal benefit of the public service with respect to the level of the public service, i.e. $\gamma = MB_g(g/MB) < 0$. Under our assumptions, both the numerator and the denominator in (5) are non-negative and therefore $0 \leq dE/dT \leq 1$.

Figure 1 The Income and Price Effects of a Lump-Sum Grant



We can interpret the numerator in (6) as the income and price effects of an increase in a lump-sum grant with the aid of Figure 1. It is assumed that initially the provincial government does not receive any transfers from the federal government, and it provides the public service level g^0 where the marginal benefit of the public service equals its effective price, $MCF \cdot c$. When the provincial government receives a lump-sum grant of T, it can provide any given level of service at a lower tax rate. The lower tax rate increases the net wage rate in the province which, based on our assumption that $MB_{wn} > 0$, shifts the MB curve to right to MB'. A one percent reduction in the tax rate increases individuals' net wage rate by $\tau/(1-\tau)$ percent and this increases the marginal benefit from public services by $(\tau/(1-\tau))I$ percent. Therefore $(\tau/(1-\tau))I$ represents the stimulative effect of the grant through its effect on the real wage rate of the representative individual in the province. Note that this income effect will be relatively weak when the provincial government's tax rate is low. Similarly, an increase in T, by lowering the tax rate needed to finance any given level of provincial expenditures, reduces the effective price of public services from $MCF \cdot c$ to $MCF' \cdot c$ for any given level of the public service since

$MCF_\tau > 0$. This shift to the right in the $MCF \cdot c$ curve in Figure 1 is labeled the "price effect". The stimulative effects of both the income and price effects will be larger when the increase in g causes a relatively small reduction in the marginal benefit from the public service, i.e. when the (absolute value) of γ is low.

From (6) we can derive the following propositions:

Proposition 1: The stimulative effect of an increase in a lump-sum grant will be increasing in the marginal cost of public funds of the provincial government, i.e. $\frac{\partial(dE/dT)}{\partial MCF} > 0$.

Proposition 2: The stimulative effect of an increase in a lump-sum grant will be smaller when the provincial government finances a larger proportion of its expenditures from its own source tax revenues, i.e. $\frac{\partial(dE/dT)}{\partial(\tau Y/E)} < 0$.

We will test these propositions empirically in Section 4.

The stimulative effect of an increase in wage income is derived below. First, note that $\tau H + \tau w(1-\tau)H_{wn} = \tau H(1+\nu)$ where ν is the labour supply elasticity, $\upsilon = H_{wn}(w_n/H)$. Substituting this into the system of equations in (4), we can obtain the following comparative static effect of an increase in wage income:

$$\frac{dE}{dY} = \tau\left[\frac{\left(I+(1+\nu)\left(\left(\frac{\tau}{1-\tau}\right)I+\tau P\right)MCF\right)}{\left(\left(\frac{\tau}{1-\tau}\right)I+tP\right)MCF-\gamma\left(\frac{\tau Y}{E}\right)}\right] \qquad (7)$$

where dY = Hdw. The stimulative effects of an increase in wage income can also be described in terms of income and price effects. The first term in the numerator of (7) is the direct effect of an increase in wage income on the marginal benefit from g and hence on the demand for the provincial public service. The second term in the numerator arises because a one percent increase in the wage rate increases the provincial government's tax base by (1 + ν) percent. With the

larger tax base, any given level of expenditures can be financed with a lower tax rate. This gives rise to an additional income effect, $(\tau/(1-\tau))I$, and price effect of τP because of the reduction in the marginal cost of public funds. Note that the expression in square brackets is multiplied by the tax rate. If the provincial government's tax rate is low, the stimulative effect of an increase in wage income will also be low. Relatively low tax rates at the subnational government level help to explain the flypaper effect, i.e. why the stimulative effect of an increase in grant income is greater than an equivalent per capita increase in personal income. Note also that the provincial government's MCF has an ambiguous effect on the stimulative effect of an increase in wage. Finally note that:

Proposition 3: The stimulate effect of an increase in wage income will be lower when the provincial government finances a larger proportion of its expenditures from its own-source revenues. i.e. when (τY/E) is higher.

These propositions can be tested based on a linear equation of the following form:

$$E = \alpha_0 + \alpha_1 T + \alpha_2 (MCF \cdot T) + \alpha_3 \left(\frac{\tau Y}{E} \cdot T\right) + \alpha_4 Y + \alpha_5 \left(\frac{\tau Y}{E} \cdot Y\right) + \alpha_6 Z \qquad (8)$$

where $\alpha_1 > 0, \alpha_2 > 0, \alpha_3 < 0, \alpha_4 > 0, \alpha_5 < 0$, and Z represents the effects of all other variables.

3.0 A Description of the Key Fiscal Variables Background

Our model of the stimulative effects of lump-sum grants on a recipient government's expenditures focuses on four key variables—the per capita lump-sum grants, the marginal cost of public funds, the ratio of the recipient government's own-source revenue to its expenditures and the per capita personal income in the recipient subnational government. In this section we will describe the data for Canadian provinces that we use for each of these variables. We begin by

describing the dependent variable in our model, real per capita expenditures by the provincial and local governments in Canada, and how it has varied over time and across provinces.

3.1 Real Per Capita Expenditures

The Canadian constitution delineates the areas of federal and provincial expenditure responsibilities. While a few areas such as immigration and agriculture are shared areas of responsibility, most are exclusive to one level or the other, and the provincial governments exercise a great deal of autonomy in these areas. The provinces are responsible for health, education, social welfare and public infrastructure spending. These make up the bulk of the expenditure for modern governments and as such, require substantial amounts of revenue. Although these areas are exclusive provincial jurisdictions, the federal government assists in their funding through a variety of transfer payment programs that are described in the next section. It is also important to note that the provinces vary considerably in terms of economic conditions, geographic area, and population, with about 40 percent of the population residing in Ontario, followed by Quebec with around 25 percent, to less than 0.5 percent living in Prince Edward Island.

Local government does not have a constitutional status in Canada. The cities, counties, and municipalities are the "creatures of the provinces", which means that the provincial governments can create, abolish, or amalgamate local governments. Each provincial government determines the services that are provided by local governments and how they are financed. There are considerable differences in the expenditure responsibilities of the municipal governments across the country, with local governments in the Atlantic Provinces responsible for fewer services, whereas in Ontario local governments play a larger role in providing services such as social assistance and welfare. Because of the variation in spending local government expenditure

responsibilities and the corresponding differences in provincial governments' own expenditures, we have used consolidated provincial and local spending as the dependent variable in our regression models.

Table B1 shows the provincial-local total current expenditure per capita (net of interest payments and transfer payments to other governments) in 2002 dollars. Our measure of expenditures nets out transfers between provincial and local governments, to avoid double counting (these items are already included in the local government expenditure) and we exclude interest payments and transfer payments to the federal government as these expenditure items are non-discretionary payments that are least likely to be influenced by federal transfer payments. In all provinces, real per capita expenditure increased over the 1981 to 2008 period, but some provinces saw periods when real per capita spending declined, such as in Alberta from 1992 to 1996 period or in Ontario from 1992 to 1997. Mean per capita expenditures in 2008 varied from $8,950 in Quebec to $6,614 in Saskatchewan.

3.2 Federal Transfers to the Provinces

The Canadian federal government provides grants to provincial governments to assist them in the provision of various public programs and services. Table B2 shows the real per capita lump-sum federal grants to the provincial governments (in 2002 Canadian dollars) from 1981 to 2008. The main grant programs in 2008 were the Canada Health Transfer (CHT), the Canada Social Transfer (CST), and Equalization grants. The CHT and the CST grant programs had their origins in the Established Program Financing (EPF) grant which began in 1977, and Canada has had a formal Equalization grant program since 1957. Each of these major grant programs is briefly described below.

Canada Health Transfer

Although health care is an area of exclusive provincial jurisdiction, the federal government has played an important role in financing of hospital and medical services for over 50 years. The current CHT program has evolved out of a series of matching grant program from the 1950s and 60s when the federal government used its "spending power" to enable the provinces to provide expanded hospital services and adopt publicly-funded medical and hospital insurance. The current transfer program, which was previously part of the EPF grant and the Canada Health and Social Transfer (CHST), is a block grant. Entitlement to the funds means that the provinces' health insurance programs must adhere to the principles of the federal Canada Health Act—universal coverage of provincial residents, comprehensive coverage of medically necessary procedures; portability of coverage between provinces; general accessibility to coverage without regard to ability to pay; and public administration of the health insurance programs. While the CHT funds are nominally earmarked for provincial expenditures on health care, there is no direct accounting for the spending and the transfers go into the general revenues of the provinces. In fiscal year 2008-09, the federal government transferred $22.7 billion (current dollars) to the provinces under the CHT program, and the per capita transfer ranged from $796 for Newfoundland to $695 for Ontario and $498 for Alberta. The reason for the difference in per capita transfers is that the federal government also kept track of a notional "tax transfer" to the provinces based on the federal government's transfer of 13.5 percentage points of its personal income tax and one percentage point of its corporate income tax to provinces in 1977. These tax points provided Alberta and Ontario with above average revenue per capita and their per capita cash grants were reduced based on this notional tax transfer in 2008. In this paper, we only use

data on the actual cash transfers, and do not consider the tax point transfers relevant for calculating the actual support that the federal government provides to the provinces.

Canada Social Transfer

The Canada Social Transfer is a lump-sum grant to help fund post-secondary education, social assistant programs and early childhood service programs. Constitutionally, these are also areas of exclusive provincial jurisdiction, but the federal government has used its "spending power" to provide grants to promote provincial spending in areas of important national concern. The CST has evolved out of matching grant programs that the federal government started in the 1960s to promote funding of universities and colleges and to support a basic social welfare system across the country. Only a few restrictions are imposed on these grants, and the funds are included in the general revenues of the provinces. In 2007-08, the CST became an equal per capita grant. Prior to that, the per capita transfer varied across the provinces based on the notional tax transfer described above.

Equalization Grants

The federal government implemented the first equalization program in 1957 to reduce the fiscal disparities of the provinces. The initial equalization program was based on three revenue sources—personal income tax, corporate income tax, and succession duties—and the standard of equalization was based on the average fiscal capacities of the two richest provinces at the time, Ontario and British Columbia. Since that time, the basis for calculating the grants has undergone many changes which are chronicled in the Annex 2 of the report of Expert Panel on Equalization and Territorial Formula Financing (2006). The federal government's obligation to provide equalization grants was enshrined in the Canadian constitution in 1982, but the wording of these provisions is sufficiently ambiguous that it gives the federal government a lot of flexibility in

determining the distribution and the level of the equalization payments. Although the equalization program has evolved over time and has undergone recent major changes, two key characteristics of the program have endured.

First, equalization payments are lump-sum grants determined within a representative tax system (RTS) framework, although the number of tax bases used in the calculation of equalization payments and the equalization standard has varied over time. Broadly speaking, the equalization program has been formula driven, with federal government determining the parameters of the formula. Limitations on the size of the equalization payments have occasionally been imposed. Equalization grants are paid to the provinces with relatively low fiscal capacities, and funded out of the general revenues of the federal government. Recipient provinces are equalized up to some standard level of fiscal capacity—the ability to raise a certain per capita revenue by levying average provincial tax rates—but provincial governments with relatively high fiscal capacities, such as Alberta, are not "equalized down" and they do not finance the equalization grants to the recipient provinces.

Second, equalization payments have not been based on measures of fiscal need, such as those used to determine equalization payments in Australia. The reasons for not incorporating a needs component in the equalization calculations include the conceptual and statistical problems in defining need, the potential distortions in provincial policies that might arise if the needs components could be affected by provincial policies, and the desire to limit federal interference in areas of provincial jurisdiction.

The grant variable in our regression analysis is the sum of the CHT, CST, and Equalization grants, expressed in per capita terms in 2002 dollars and converted to a calendar

year basis.[3] Table B2 shows that between 1981 and 2008, the real per capita grants increased for all provinces except Newfoundland, which received reduced grants because of a significant increase in its fiscal capacity from offshore oil revenues. Other provinces, such as Ontario, Saskatchewan and Alberta had total transfer cut-back in the mid-1990s when the federal government adopted fiscal austerity measures to reduce its chronic budgetary deficit. Table B6 shows that the mean real per capita grant over the period from 1981 to 2008 varied from $2,402 in PEI to $469 in Alberta.

3.3 The Provincial Governments' Marginal Cost of Public Funds

For our empirical analysis we use estimates of the provincial governments' MCFs for the personal income tax over the period 1981-2008. The calculations of the MCFs are based on the analysis in Dahlby and Ferede (forthcoming) which estimated the responsiveness of provincial tax bases to changes in tax rates using aggregate panel data from Canadian provinces over the period 1972 to 2006. Their econometric analysis indicated that a one percentage point increase in a province's top personal income rate was associated with a 0.76 percent reduction in its personal income tax base in the short-run and a 3.63 percent reduction in the long-run. They used these estimates of the semi-elasticities of the tax bases to calculate the MCF for each province using the formula:

$$MCF_{it} = \frac{s_{it}}{s_{it}+\tau_{it}\eta} \qquad (9)$$

[3] From 1981 to 1996, the federal government provided a matching grant for provincial expenditures on social assistance programs. Since the Canada Assistance Plan (CAP) grant was a matching grant, we do not include it in our lump-sum grant variable. For the sake of consistency with the other data sets from CANSIM, we transform the transfer payments which are recorded on a fiscal year basis into calendar years using the following equation: $CY_{it} = 0.25*FY_{it-1} + 0.75*FY_{it}$, where FY and CY denote fiscal and calendar years, respectively. See Kneebone and McKenzie (2001) for a similar methodology.

where MCF_{it} is the marginal cost of public funds for province i in year t, s_{it} is the share of revenue raised from personal income tax, τ_{it} is the provincial income tax rate, and η is the semi-elasticity of the personal income tax base with respect to a province's personal income tax rate. As our analysis in this paper is based on short-run responses of expenditures to grants, we use the estimates of the MCF based on the short-term responses of the personal income tax base to tax rate changes. We have chosen the MCF for the personal income tax to represent each province's MCF because the personal income tax is largest source of tax revenue for the Canadian provinces and the personal income tax rate is the tax rate that is most frequently changed in their annual budgets. Table B3 shows our estimates of the province's short-term MCFs for their personal income tax. In most provinces, the MCFs declined over the entire period in response to reductions in their top personal income tax rates. However, in some provinces, such as British Columbia and Newfoundland during the 1990s, the MCFs increased over a significant number of years. Table A6 shows the mean and standard deviation of the MCFs for each of the provinces. There is also substantial variation in the MCFs across provinces, reflecting variations in their tax rates and the share of personal income taxes in their tax revenues. In 2008, the Quebec's short-term MCF was 1.22 while in Alberta it was 1.08. Again we want to stress that these estimates of the MCFs are only based on the short-term responses of the personal income tax base to tax rate increases and the MCFs that reflect the long-term responses of the tax bases are much larger. However, we feel that the short-term MCFs are the appropriate ones for determining the short-term responses of spending to the changes in federal grants.

3.4 The Ratio of Own-Source Revenues to Expenditures

Our model indicates that the stimulative effect of an increase in grants or personal income depends on the ratio of the recipient government's own-source revenues to its expenditures. Table B4 shows these ratios for the 10 provincial governments for the years 1981 to 2008. In Newfoundland, Nova Scotia, Quebec, and Saskatchewan there has been an increase in the portion of their expenditures that are funded out of their own-source revenues. In the other provinces, the ratio has remained relatively constant, although it varies substantially between provinces. For example the average ratio of own-source revenue to expenditures over the 1981 to 2008 period varies from 0.584 in Newfoundland to 0.957 in Alberta. The ratios for Alberta were greater than one from 1981 to 1985, in 1997 and 1998, in 2000, and from 2004 to 2008 because Alberta's transfers from the federal government have been relatively low and it has run fiscal surpluses during these period when resource revenues have been high.

3.5 Real Per Capita Personal Income

Studies of the determinants of government spending have traditionally included the jurisdiction's average income. Health care, education and local public services such as the provision of parks and recreation facilities are "normal" goods and the demand for these services will increase with income. Positive coefficients on real per capita income are normally found in econometric studies of the determinants of government expenditures. See for example Winer (1983) and Ghamkar and Oates (1996). While a positive stimulative effect from an increase in real per capita income seems to be a well-established empirical regularity, the difference in the magnitudes of the stimulative effects of an increase in personal income and in grants has been labeled the flypaper effect. Table B5 shows our measure of the average real per capita personal incomes by province from 1981 to 2008. Ideally we would prefer to use personal income net of

federal taxes, however complete federal tax revenue from the provinces is not available. As would be expected, real per capita incomes increased in all provinces over the 1981 to 2008 period, although there are year over year reductions in some provinces. For example, in Alberta, average real per capita income declined sharply between 1998 and 2000. There is in addition, substantial variation in real per capita incomes across provinces. As shown in Table B6, the average real per capita income in Newfoundland over the 1981 to 2008 was 68 percent of the average in Ontario.

4. Empirical Specification and Results

4.1. Empirical specification

In line with our theoretical framework of Section 2, the empirical specification takes the following form:

$$E_{it} = \alpha_0 + \alpha_1 T_{it} + \alpha_2 (MCF_{it} \cdot T_{it}) + \alpha_3 (OWN_{it} \cdot T_{it}) + \alpha_4 Y_{it} + \alpha_5 (OWN_{it} \cdot Y_{it}) + \alpha_6 Z + \theta_t + \mu_i + \varepsilon_{it} \quad (10)$$

where E_{it} is the real per capita government expenditure in province i in year t, T_{it} is per capita federal lump-sum grants, MCF_{it} is the provincial government's marginal cost of public funds from its provincial income tax (PIT), Y_{it} is real personal income per capita, OWN_{it} is the provincial government's own-source revenue to expenditure ratio, and Z contains all other relevant control variables. θ_t captures a full set of year effects. The time effects control for those factors that may have a common effect on provinces such as business cycle conditions and federal grant policy changes. Time-invariant provincial effects are denoted by μ_{it}. The provincial fixed effects allow us to control any secular differences in government spending across the provinces. Since we are interested in assessing the response of government expenditure to

changes in grants and the effect of the MCF in this response, we use a linear specification as is commonly used in the literature. See for example Knight (2002) and Dahlberg, et al (2008) for a similar specification.

The above empirical specification allows the stimulative effects of grants on government spending to depend on the MCF and *OWN*. If the stimulative effect of grants on public spending increases with the MCF as predicted by the model in Section 2, we expect $\alpha_2 > 0$. Similarly if the effect of grants on spending decreases with *OWN*, as suggested in Proposition 2, we expect $\alpha_3 < 0$. Thus the implied effects of grants on government expenditure in our specification is given by $(\alpha_1 + \alpha_2 \text{MCF}_{it} + \alpha_3 OWN_{it})$ and it increases with MCF and decreases with *OWN*. The implied effect of personal income can also be determined using a similar approach. We can evaluate these implied effects of grants and personal income at the mean values of the MCF and *OWN*. Similarly, Proposition 3 implies that $\alpha_5 < 0$. The implied net effects of personal income on government spending can be obtained as $(\alpha_4 + \alpha_5 OWN_{it})$.

Our set of control variables includes population, the unemployment rate, the share of population who are young (less than 10 years of age), the share of population who are old (65 years and above), the number of new immigrants, and a dummy variable for the political party of the provincial government. These variables capture the various needs for social-assistance and public good provision needs and entail discretionary increases in government spending. These are standard variables that are often included in similar studies.

As in Knight (2002), Turnbull (1995, 1998), and others, we include population as a control variable to capture congestion effects or heterogeneity of preferences in public good provision. We expect the coefficient of this variable to be negative consistent with the presence of economies of scale in public good provision. Although unemployment insurance in Canada is

a federal program, an increase in the unemployment rate requires provincial governments to spend more on various social assistances for the unemployed. Thus we expect the coefficient of unemployment rate to be positive. Similarly, ageing and very young population necessitate various social and health care related spending by the government. To account for this, as in Dahlberg et al (2008), we include the shares of the population who are 65 years and above and below 10 years of age as control variables. We expect the coefficients of these variables to be positive.

A government's spending decision can often be influenced by the political ideology of the governing party. As discussed in Baker et al (1999), Kneebone and McKenzie (2001), and others, left-leaning governments generally have a tendency to be pro-spending. Thus, we further expand our set of control variables to capture this ideological effect on government spending. We include a dummy variable (*Left*) that is equal to one if the premier of the province belongs to the Liberal Party or the New Democratic Party (NDP)—which are the center-left political parties in Canada. We expect the coefficient of the dummy variable to be positive. All our regressions include time-invariant province-specific fixed effects. We also include yearly dummies to control for shocks that are common to all provinces.

The data for our empirical analysis come from various sources. Annual provincial and local government expenditures, personal income, prices, unemployment, population, the number of new immigrants, shares of the young and the old in the population come from Statistics Canada database (CANSIM). All these variables are in calendar year. This data set also provides the various components of government spending. The information on governing political parties is from the Canadian Parliamentary Guide. The data for the various federal grants to provincial

governments are obtained from Finance Canada. Table 1 presents the summary statistics for the various variables and Appendix 1 provides details on the definitions and sources of the data.

Table 1: Summary statistics of main variables, 1981-2008

Variable	Mean	Std.Dev	Min	Max
Provincial-local expenditure	6474	935	4298	9003
Grants	1373	744	298	2928
MCF	1.1677	0.0414	1.0825	1.3359
Own-source revenue to spending ratio (*OWN*)	0.2019	0.0481	0.1063	0.3495
Grants · MCF	1608	874	331	3518
Income	23878	3982	14282	33879
Grants · *OWN*	265	137	50	556
Income · *OWN*	4915	1677	1752	9181
Population(millions)	2.89	3.36	0.12	12.93
Old (%)[a]	12.16	1.82	7.15	15.38
Young (%) [b]	13.32	1.88	9.48	18.49
New immigrants	19366	32429	89	152823
Unemployment rate (%)	9.23	3.73	2.80	19.40

Observations: 280. All monetary values are in 2002 dollars (all deflated by GDP deflator). Provincial-local expenditure is the provincial and local governments' expenditure net of interest payments and transfer payments to other governments. Lump-sum grants are the sum of equalization payments, Canada health transfers (CHT), and Canada social transfers (CST) (the last two were formerly known as Canada health and social transfers (CHST)). We exclude Canada Assistance Plan (CAP) transfers. We include only cash transfers.

[a] The share of the population who are 65 and above years old.

[b] The share of the population who are younger than 10 years old.

4.2. Results

We begin our analysis by estimating the basic model with Ordinary Least Squares (OLS). The real per capita government expenditure is regressed on just lump-sum grants, real per capita personal income, and the various interaction terms that help us test the various propositions indicated in Section 2. The results are shown in Column (1) of Table 2. All the variables have their respective expected signs and are statistically significant. Note in particular that the coefficient of the interaction term between grants and the MCF is positive and statistically significant suggesting that the stimulative effects of grants increase with the MCF.

Table 2: Effects of grants on expenditure, 1981-2008
Dependent variable: Real per capita provincial-local expenditure

	(1)	(2)	(3)	(4)	(5)
	OLS	OLS	2SLS	2SLS	LIML
Grants	-1.821**	-1.501*	-3.446***	-3.401***	-3.415***
	(0.857)	(0.863)	(1.242)	(1.263)	(1.268)
Grants·MCF	1.544**	1.509**	3.274***	3.246***	3.258***
	(0.731)	(0.744)	(1.111)	(1.075)	(1.080)
Income	0.282***	0.265***	0.245***	0.244***	0.244***
	(0.040)	(0.035)	(0.039)	(0.036)	(0.036)
Grants·OWN	1.758*	0.529	0.050		
	(0.968)	(1.066)	(1.300)		
Income·OWN	-0.456***	-0.378***	-0.354***	-0.352***	-0.352***
	(0.073)	(0.067)	(0.067)	(0.057)	(0.057)
population		-459.340***	-466.255***	-466.510***	-466.509***
		(133.021)	(137.215)	(132.864)	(132.873)
old		191.778***	224.008***	224.156***	224.299***
		(59.291)	(62.913)	(62.791)	(62.806)
young		125.184***	152.777***	151.942***	152.098***
		(40.806)	(45.944)	(45.601)	(45.614)
unemployment		88.406***	87.667***	88.013***	87.968***
		(22.860)	(24.089)	(23.365)	(23.368)
New immigrant		0.013***	0.011***	0.011***	0.011***
		(0.004)	(0.004)	(0.004)	(0.004)
left2		50.354	40.754	40.783	40.694
		(45.203)	(46.546)	(46.150)	(46.160)
Implied effects of grants	0.337**	0.367***	0.387***	0.390***	0.390***
	(0.160)	(0.138)	(0.141)	(0.140)	(0.140)
Implied effects of income	0.189***	0.189***	0.173***	0.173***	0.173***
	(0.032)	(0.027)	(0.031)	(0.030)	(0.030)
Over-identification test (p-value)			0.250	0.373	0.373
Adjusted R-squared	0.861	0.887	0.877	0.877	0.877
No. of observations	280	280	270	270	270

Notes: robust standard errors in parentheses. Significance levels are indicated by *** for 1%, ** for 5%, and * for 10%. All regressions include provincial and time effects. In columns (3) to (5) grants and MCF are treated as endogenous. Grants are instrumented with their own one-period lagged values and relative GDP of the standard provinces. The MCF is instrumented with its own one-period lagged value. The interaction terms are also instrumented with the product of the relevant instruments.

The results indicate that a $0.10 increase in a provincial government's MCF increases the stimulative effect of a lump-sum grant on its expenditures by $0.15. Similarly in line with the theoretical hypothesis, the coefficients of the interaction terms between *OWN* and personal income is negative and statistically significant. The coefficient of the interaction term between grants and *OWN* has a positive sign, contrary to the prediction in proposition 2, but it is significant only at the 10 percent level.

Since the effect of grants on government spending varies with the MCF and *OWN*, we report the implied effects of grants evaluated at the mean values of MCF and *OWN*. We compute the implied effect of personal income on provincial-local spending in a similar way. As indicated before, the effect of grants on real per capita provincial-local expenditure can be obtained as the sum of the coefficients of grants and the interaction terms of grants with MCF and *OWN* (where the latter are evaluated at their respective mean values). Using the mean values of MCF, 1.17, and *OWN*, 0.2, the implied effects of grants on government spending is 0.337 (which is obtained as 1.544*1.17+1.758*0.2-1.821). Similarly, the implied effect of personal income is 0.189. These implied effects of grants and personal income on government spending are statistically significant. The numerical magnitudes of the coefficient estimates are also generally consistent with those of previous studies. Our results indicate that for every dollar of lump-sum grant per capita, provincial-local spending per capita rises by C$ 0.34. The results also suggest that a one dollar increase in personal income per capita raises provincial-local spending by about $0.28. Thus our results indicate that lump-sum grants have a higher stimulative effect on provincial-local spending than personal income which is consistent with the flypaper literature. Moreover, since the stimulative effects of grants increase with the MCF, the results suggest that the flypaper effect increases with the MCF as argued in Hamilton (1986) and Dahlby (2011).

In column (2), we control for other variables which are generally deemed to have effects on provincial-local expenditure. We control for the share of population who are young, the share of the population who are old, the unemployment rate, total population, the number of new international immigrants settling in the province, and a dummy variable for left-wing premiers. Following Baker et al. (1999) and Gamkhar and Oates (1996) we also use the unemployment rate as an additional control variable. The young, the old, new immigrants, and the unemployed require various public services and social assistances which increase the discretionary spending of the government. Thus as explained before we expect the coefficients of these variables to be positive. We also include the total population of the province as an additional control variable to account for the effects of congestion or economic scale in public good provision. We expect the coefficient of this variable to be negative. We also expect the coefficient of the dummy variable for center-left premiers to be positive.

The results in column (2) indicate that all the control variables have their respective expected signs and are statistically significant. The coefficient of the interaction term between grants and *OWN* has a positive sign, but it is statistically insignificant. More importantly, the coefficient of our main variable of interest—grants interacted with the MCF— is as expected positive and statistically significant. The implied effect of grants on provincial-local expenditure is also statistically significant with a coefficient estimate slightly higher than what we found before. Again looking at the implied effects of grants and personal income, the results are consistent with the presence of the flypaper effect. Thus the results indicate that there is a flypaper effect and it increases with the MCF. All the other control variables, with the exception of the political dummy, have the expected sign and are statistically significant at 1 percent level. The political dummy *left* has the expected positive sign but it is statistically insignificant.

So far we have assumed that grants are exogenous. However, as argued in Dahlberg et al (2008), there are some reasons why even formula-driven grants may be endogenous. One possibility is related to the case of omitted variable bias. There may be some unobserved characteristics that are related to both provincial expenditure and the lump-sum grants that the provinces receive. Furthermore, some actions of the province may affect both the tax base of the province (on which the grant allocation formula is based on) and its spending. As discussed in Dahlberg et al (2008), it may not be possible to control for all of these factors. Consequently, the lump-sum grant variable may be endogenous. Furthermore, as discussed in Dahlby and Ferede (forthcoming), the MCF depends on tax rates, tax bases and tax shares all of which can be influenced by the governments' actions. Thus MCF may be also endogenous. If the problem of endogeneity is not addressed it will bias our coefficient estimates. Thus as in Knight (2002), Gordon (2004), and Dahlberg et al (2008) we treat the federal grant as an endogenous variable. We also treat the MCF as endogenous.

Finding relevant instruments for endogenous variables is a common challenge in empirical analysis. It is known that a valid instrument should be highly correlated with the endogenous variable but not with the dependent variable. Note that in Canada to a large extent all of the lump-sum grants are formula-driven and there are fewer roles for politics and politicians to influence the amount of grants to be provided to the provinces. Thus instruments based on governing federal political parties or the number of members of parliament (MPs) representing a province in the majority party, as in Gamkhar and Oates (1996) and Knight (2002), will not be appropriate in the Canadian context.[4] Rather, relevant instruments for the

[4] Gordon (2004) and Dahlberg et al (2008) exploit the discontinuity in the specific grant system to obtain valid instruments.

lump-sum grants must somehow reflect the fact that the grant formula depends on the fiscal capacity of the province relative to the national standard average.

The federal government provides equalization payments, one of the largest components of unconditional grants, using a formula that is based on the per capita fiscal capacity of the province and that of the standard provinces. As discussed previously, if the standard provinces' per capita tax base yield is greater than that of the province, the province is entitled to equalization payments. Thus generally, given tax rates, the higher the per capita tax base of the standard provinces relative to the province's own tax base, the higher will be the equalization payments to the province. Our instrument makes use of this relationship. We use the relative GDP of the standard provinces (net of government spending) and the province as an instrument. The instrument is obtained by dividing the total real GDP of the five standard provinces (less their government expenditure) by the real GDP of the province (net of its own government spending). Thus the GDP measure we use as an instrument excludes government spending and as a result it is less related with our dependent variable. The higher the relative GDP of the standard provinces (which is a proxy for tax base), the higher is the equalization payments that the province receives. Thus the lump-sum grant and the instrument are positively correlated. Moreover, as in Winer (1983) we also use one period-lagged values of grants as instruments. The MCF is instrumented with its own one period-lagged value and the interaction terms are also instrumented with the product of the relevant instruments.

In order to address the potential endogeneity problem, in column (3) of Table 2, we treat grants and MCF as endogenous and use the two-stage least squares (2SLS) estimation method. We use one period lagged values of the relative GDP of the five standard provinces and grants as instruments for grants. In addition to grants, we also instrument for the interaction terms, grants

X *MCF* and grants X *OWN,* using the products of the relevant instruments. Table A-2 in the appendix shows the first stage regressions. The results indicate that most of the excluded instruments are statistically significant. There is a very strong correlation between the instruments and the endogenous variables. Most importantly, the F-test suggests that the instruments are jointly significant in the first stage regressions. One may still be concerned with the potential problem of weak instruments as this can pose problems to 2SLS estimates. The problem of weak instruments arises when the instruments are weakly correlated with the endogenous explanatory variables. Staiger and Stock (1997) have shown that the performance of 2SLS can be poor in the presence of weak instruments. The recent weak instrument literature provides statistical tests for the problem. The common way of testing for weak instruments is to compare the Kleibergen-Paap Wald F-statistic with the critical-values obtained in Stock and Yogo (2005). If the statistic is greater than the relevant critical value, the null hypothesis of weak instruments is rejected. In our analysis, we check for the presence of weak instruments using this common statistical test. We also check the validity of the instruments using the standard over-identification restriction test.

The results in column (3) indicate that all of our key variables, with the exception of the interaction term between grants and *OWN*, are statistically significant with their respective expected signs. The coefficient estimates of grants and the interaction term between grants and MCF are now higher in absolute value. However, the implied effect of grants is somewhat close to what we obtained in the previous regression. The Hansen test for over-identifying restriction does not reject the validity of our overidentification restrictions. The Kleibergen-Paap Wald F-statistic also rejects the null hypothesis of weak instruments. Furthermore, all our control variables, with the exception of the political dummy, are statistically significant with their

respective expected signs. More importantly, the coefficient of the grant interaction term with MCF is positive and statistically significant at one percent level. This indicates that indeed the stimulative effect of grants on government spending increases with the MCF even when grants are treated as endogenous. The implied effect of grants on provincial-local expenditure is statistically significant but higher than what we obtained before. As before, our results suggest the presence of flypaper effect and that this effect increases with the MCF.

Regressions results in columns (2) and (3) indicate that the coefficient of the interaction term between grants and *OWN* is statistically insignificant. Including this variable in the regression seems to have no effect on the explanatory power of the model. Thus in column (4), we drop this variable and re-estimate the model. The explanatory power of the model, as indicated by the adjusted R-squared, has not changed once we drop the model validating the exclusion of the variable from the regression. The Hansen over-identification test does not reject the validity of our instruments. The null hypothesis of weak instruments is rejected at the five percent significance level. Thus, the results are not also affected by the presence of weak instruments. This is our preferred regression. The results in column (4) show that the variables of interest are still statistically significant with their expected signs. The results suggest that, after controlling all the relevant variables, the stimulative effects of grants on provincial-local expenditure depends on the MCF. The implied effect of grants on government expenditure is about 0.39 and it is statistically significant at one percent level. That means, for every dollar of lump-sum grants received, provincial-local spending increases by about 39 cents. This estimate of grants is well within the estimates of previous studies. See for example Gamkhar and Oates (1996). The estimated effect of personal income on spending is much lower than that of grants. Our result indicates that for every dollar increase in personal income, provincial-local spending

rises by about 17 cents. More importantly, comparing the effect of grants on government expenditure with that of personal income, we can see that there is indeed a flypaper effect in Canada. The difference in stimulative effects of grants and income is also statistically significant at 10% level. This flypaper effect increases with the MCF lending an empirical support for the hypothesis indicated in Section 2. See also Hamilton (1986) and Dahlby (2011).

Our results in column (4) show that the overidentification restrictions are valid as indicated by the Hansen J-statistic. The null hypothesis of weak instruments is also rejected at the five percent significance level. Thus, our results do not appear to be affected by the problem of weak instruments. However, one may still be concerned with the potential problem of weak instruments as this can pose problems to 2SLS estimates. As a robustness check, we explore this issue further by using the limited information maximum likelihood (LIML) estimation method as an alternative to 2SLS. While the two estimation methods are asymptotically equivalent, LIML can be less susceptible to the potential presence of weak instruments and have better small sample properties. Thus in order to check the robustness of our results to the estimation method, as in Knight (2002), we report results using LIML in column (5). The LIML results are strikingly similar to those of column (4) indicating the robustness of our findings. Once again the results are consistent with the presence of flypaper effects. Furthermore, our main finding that the stimulative effect of grants on government spending increases with the MCF continues to hold.

4.3. Robustness Checks

In this section, we subject our preferred regression of column (4) of Table 2 to various sensitivity checks to assess if our central finding—that the stimulative effects of grants on government spending increases with the MCF—is robust. Specifically, we use an alternative definition for our dependent variable, expand the definition of grants to include tax-point

transfers, exclude Quebec from the analysis, control for potential spending spill-over effects from neighbouring provinces, and employ a dummy variable approach. The results of the robustness checks are shown in Table 3.

Table 3: Robustness Checks (2SLS), 1981-2008

Dependent variable: Real per capita provincial-local expenditure (*pcrexp7*)

Variable	(1)	(2)	(3)	(4)	(5)
	Alternative dependent variable (pcrexp9b)	Using cash and tax-point grants	Excluding Quebec	Controlling for Spill-over effects	Dummy variable approach
Grants	-3.771***	-4.507***	-3.648*	-3.066**	0.476***
	(1.339)	(1.180)	(1.851)	(1.254)	(0.151)
Grants · MCF	3.560***	4.169***	3.465**	2.938***	
	(1.134)	(0.995)	(1.610)	(1.074)	
Grants · MCFdummy					0.210***
					(0.059)
Implied effects of grants at mean	0.386***	0.361**	0.365**	0.365***	0.687***
	(0.131)	(0.166)	(0.144)	(0.135)	(0.173)
Implied effects of income at mean	0.132***	0.176***	0.176***	0.162***	0.163***
	(0.026)	(0.031)	(0.031)	(0.029)	(0.030)
No. of observations	270	270	243	270	270

Notes: robust standard errors in parentheses. Significance levels are indicated by *** for 1%, ** for 5%, and * for 10%. The robustness check is based on column (5) of Table 2. We use 2SLS and all other control variables, provincial, and year dummies are included but not reported for the sake of brevity. In columns (1) to (4) the instruments are similar to those of our preferred regression of Table 2. In column (5), the instruments include: one-period lagged values of grants, relative GDP of standard provinces, and an interaction term between *MCFdummy* and grants.

The definition of government expenditure used in empirical studies can vary from one study to other. For example a commonly cited study on the relationship between grants and spending by Winer (1983) used total provincial government spending net of conditional grants as a dependent variable. To check if our finding is robust to the use of an alternative dependent variable, in column (1) we use total provincial (rather than provincial-local) government spending net of conditional grants as a dependent variable as in Winer (1983). The coefficient

estimate of grants and the interaction term are only slightly higher than our preferred results. The magnitude of the estimated effect of grants is well with the range of estimates obtained in Winer (1983) and close to those of Shaw (2005). The implied effects of grants are close to what we found before and the main finding that the stimulative effects of grants increase with the MCF still holds.

We also check the robustness of our results to the use of an alternative definition of grants in column (2) of Table 3. Instead of using just cash grants, we use total federal lump-sum transfers that include both cash and tax-point transfers. While the individual coefficient estimates are now slightly larger in absolute value, the net implied effect of grants is only slightly lower than what we obtained before. More importantly, the use of an alternative grant definition does not affect our main key findings.

In Canadian fiscal federal arrangement the province of Quebec is different than other provinces in some aspects. For example, it is the only province that receives federal tax abatement in lieu of some cash transfers as the province opted-out of the Federal-Provincial Fiscal Arrangements Act. It is also the only province which administers its own personal income tax system. For these and other reasons, previous studies such as Winer (1983) exclude Quebec from their analysis. We check the robustness of our results by excluding Quebec from our analysis in column (3). Again our main results are qualitatively and quantitatively the same.

Studies by Case, et al. (1993) and Acosta (2010) among others, suggest that in interdependent jurisdictions such as ours, the government spending of one jurisdiction may well depend on the spending of its neighbours. One may be concerned that our results can be biased if this neighbouring provincial interdependence is not controlled for.[5] We check the robustness of

[5] Using county-level data for Argentina, Acosta (2010) for example finds that while the flypaper effect still holds, it may be overestimated in the presence of spatial interdependence.

our main results to the control of provincial spending spill-over effects in column (4). We include the weighted-average per capita expenditure of neighbouring provinces as an additional explanatory variable to control for the spending-spill over effect. The weight is based on the inverse of the distance between the main population centres of the neighbouring provinces. While the coefficients of our key variables of interest are slightly lower in absolute value, they are still statistically significant at 1 percent level. The implied effect of grants is also statistically significant but the magnitude of the coefficient is now slightly lower. Thus our main finding that the effect of grants on spending increases with the MCF is robust. There is still evidence of flypaper effect even though the magnitude is slightly lower. Acosta (2010) also found a similar result.

In our empirical analysis, consistent with the theoretical framework, we use an interaction term between the MCF and grants to assess the impacts of the MCF on the stimulative effects of grants on spending. An alternative way of assessing the effects of MCF on the grant-expenditure nexus is to use a dummy variable approach. We use a dummy variable (*MCFdummy*) which is equal to one if the province's MCF is greater than the median MCF, and zero otherwise. Thus instead of interacting lump-sum grant with the MCF, we interact it with *MCFdummy.* If the effect of grants on provincial-local expenditure increases with the MCF, we expect the coefficient of the interaction term between grants and *MCFdummy* to be positive. This approach basically differentiates the effects of grants on government expenditure between low and high MCF provinces. [6] See Buettner and Fabritz (2011) for a somewhat similar approach. Note that for the high MCF provinces (those above the median value), the effect of grants is obtained as the sum of the coefficients of grants and the interaction term. For low MCF provinces, the effect

[6] Another alternative approach would be to divide the sample into low and high MCF groups and estimate the effects of grants separately for the two groups as in Buettner and Fabritz (2011). However, given the small sample size (just 10 provinces over 28-year period) and the many covariates to be estimated, this approach is not feasible in our case.

of grants is shown simply by the coefficient of grants alone. The results are shown in column (5) of Table 3. As expected, the results indicate that the effect of grants on provincial-local expenditure is higher in high MCF provinces. This suggests that the finding—that the stimulative effect of grants on spending increases with the MCF— is robust to the use of an alternative approach. Note that this alternative approach also confirms that there is a flypaper effect and this effect increases with the MCF.

5. Conclusions

The issue of whether an increase in federal lump-sum grants stimulates subnational government's spending much more than an equal increase in private income has been hotly debated in the literature for a long time. Previous studies generally found evidence in support of the presence of the flypaper effect—the empirical observation that a lump-sum grant has a much larger effect on a recipient government's spending than an increase in its residents' average personal income. However, there is no general consensus why the flypaper effect exists. The justifications provided to explain the flypaper effect range from dismissing it as an empirical anomaly to fiscal illusion and bureaucrats' influence over spending. Some studies, on the other hand, indicated that the flypaper effect can be explained by the presence of distortionary taxes—an issue largely ignored by most of previous studies. While the theoretical foundation for this dates back to Hamilton (1986), recent theoretical works also suggest that indeed distortionary taxes can explain the presence of flypaper effects. These recent theoretical works indicate that the flypaper effect can increase with the MCF. However, there has been little empirical work to check if this is indeed the case.

The main objective of this paper is to investigate whether the flypaper effect can be explained by distortionary taxation. We begin our analysis by presenting a simple theoretical model that shows how a lump-sum transfer from the federal government stimulates the marginal expenditures of a recipient subnational government through income and price effects. In the simple model, the price effect arises because the effective price of providing a public service is the recipient government's MCF multiplied by the marginal cost of producing the public service. A lump-sum transfer allows the recipient government to fund any given level of spending at a lower tax rate, thereby reducing the recipient government's MCF and the effective price of its public services.

We use aggregate panel data from Canadian provinces over the period 1981 to 2008 to examine whether the stimulative effects of lump-sum federal grants on provincial government spending rises with the Marginal Cost of Public Funds (MCF) as suggested in the theoretical model. Our preferred empirical result indicates that a one dollar increase in per capita lump-sum grants raises provincial spending by about $0.39 while a one dollar increase in per capita personal income increases provincial spending by $0.17. Thus our empirical results are consistent with the presence of the flypaper effect. In fact, the results also indicate that the flypaper effect increases with the MCF providing an empirical support for the predictions of the theoretical framework. The results suggest that a $0.10 increase in a provincial government's MCF increases the stimulative effect of lump-sum grants on its expenditures by $0.32. The empirical results are robust to various sensitivity checks and pass various batteries of diagnostic tests.

The results of this paper have important policy implications. Previous studies which argue that the flypaper effect is based on voters' fiscal illusion, or the excessive influence that

budget-maximizing bureaucrats have over spending, tend to argue for reduced intergovernmental transfers. Our empirical results, on the other hand, indicate that a large flypaper effect arises when the recipient government has a high MCF due to the use of distortionary taxation. The implication of this is that higher federal lump-sum transfers may be welfare improving if the federal government has a lower MCF than the provinces.

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Appendix Table A1: Definitions of Variables and Data Sources

Variable	Description	Source
Grants	Lump-sum federal cash grants to the provinces. This is obtained as the sum of equalization payments and Canadian Health and Social Transfers (CHST)	Finance Canada
MCF	The provincial short-run Marginal Cost of Funds (MCF) for personal income tax rate	Computations based on Dahlby and Ferede (forthcoming)
Income	Personal income	Statistics Canada, CANSIM Table 384-0013
Real GDP	Provincial GDP in 2002 dollars	Statistics Canada, CANSIM Table 384-0002
Provincial-local expenditure	Provincial and local expenditure net of interest payment and transfers to other governments	Statistics Canada, CANSIM Table 384-0004
Personal income tax revenue	Provincial government direct tax revenue from persons	Statistics Canada, CANSIM Table 384-0004
OWN	The ratio of provincial own-source revenue to provincial-local expenditure	Statistics Canada, CANSIM Table 384-0004.
Population	Total provincial population	Statistics Canada, CANSIM Table 051-0001
Old	The share of population who are 65 and above years of age	Statistics Canada, CANSIM Table 051-0001
Young	The share of population who are less than 10 years of age	Statistics Canada, CANSIM Table 051-0001
New immigrants	The number of new immigrants settling in the province	Statistics Canada, CANSIM Table 051-0011
GDP deflator	Gross domestic product, implicit price index (2002 = 100)	Statistics Canada, CANSIM Table 384-0013
Left	Dummy variable if the premier of the province belongs to the Liberal or New Democratic parties.	Canadian Parliamentary Guide
Unemployment rate	Provincial annual unemployment rate	Statistics Canada, CANSIM Table 282-0002

Appendix Table A2: First stage regressions of 2SLS, 1981-2008

Variable	Dependent variable		
	Grants	Grants · *MCF*	Grants · *OWN*
Income	0.052***	0.062***	0.010***
	(0.011)	(0.013)	(0.002)
Income · *OWN*	-0.071***	-0.081***	-0.013***
	(0.019)	(0.023)	(0.003)
Population	2.687	3.250	0.618
	(19.273)	(22.594)	(3.278)
Old	-67.348***	-82.082***	-9.931***
	(18.813)	(22.272)	(3.273)
Young	23.778**	22.713	4.551**
	(11.645)	(14.392)	(2.042)
Unemployment rate	3.2526	5.271	1.400
	(5.630)	(6.683)	(0.979)
New immigrants	0.001**	0.001**	0.0002*
	(0.0005)	(0.0006)	(0.0001)
Left	-4.512	-1.256	0.016
	(12.952)	(15.412)	(2.439)
	Instruments		
$RelativeGDP_{it-1}$	-12.305**	-8.682	-1.610*
	(5.355)	(6.163)	(0.938)
$Grants_{it-1}$	1.318***	0.656*	0.055
	(0.324)	(0.368)	(0.060)
$MCF_{it-1} \cdot Grants_{it-1}$	-0.440*	0.224	-0.080*
	(0.250)	(0.282)	(0.048)
$MCF_{it-1} \cdot RelativeGDP_{it-1}$	11.830***	8.958*	1.628**
	(4.213)	(4.822)	(0.738)
$OWN \cdot Grants_{it-1}$	0.805**	1.041**	1.140***
	(0.412)	(0.496)	(0.071)
$OWN \cdot RelativeGDP_{it-1}$	-3.152	-3.340	-0.580
	(4.225)	(4.840)	(0.699)
Instruments F-test[a]	79.99***	77.34***	158.44***
(p-value)	(0.000)	(0.000)	(0.000)
No. of observations	270	270	270

Notes: robust standard errors in parentheses. Significance levels are indicated by *** for 1%, ** for 5%, and * for 10%. All regressions include provincial fixed and year effects.

[a] This is an F-test for the joint significance of the instruments. The null hypothesis is that the instruments are jointly insignificant.

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Table B1: Provincial-local Per Capita Expenditure (in 2002 Canadian dollars), 1981-2008

Year	NFL	PEI	NS	NB	QB	ON	MB	SAS	AB	BC
1981	4674	4824	5361	4298	6032	4782	4734	4986	5112	5716
1982	5073	4861	5266	4799	6124	5029	5352	5401	5426	6055
1983	5503	4939	4920	4747	6173	5078	5493	5645	6139	6086
1984	5340	5213	5179	4594	6168	5167	5467	5872	6181	5795
1985	5374	5104	5362	4781	6390	5290	5726	5838	6442	5826
1986	5186	4883	5215	4733	6295	5329	5814	6417	7386	5884
1987	5399	5171	5146	4886	6078	5459	5982	6153	7461	5831
1988	5938	5514	5329	5122	6190	5601	5976	6369	7806	5995
1989	6320	5750	5466	5285	6268	5790	6089	6437	7915	5870
1990	6683	5949	5594	5572	6530	6223	6431	7339	7733	6065
1991	6471	6001	5562	5815	6732	6601	6604	7577	8024	6575
1992	6633	6172	5669	5849	7087	6929	6719	7388	8297	6732
1993	6544	5851	5683	5775	7142	6806	6629	7031	7917	6591
1994	6774	5749	5578	5891	7129	6688	6355	6648	7129	6510
1995	6633	5823	5619	5657	6906	6497	6187	6443	6809	6367
1996	6485	5972	5376	5687	6794	6130	6103	6236	6534	6477
1997	6641	5956	5692	5883	6617	5976	6164	6359	6603	6509
1998	6947	6550	5900	6284	6724	6204	6392	7172	7309	6698
1999	7064	6711	6120	6511	6869	6157	6806	7218	6985	6586
2000	6978	6900	5818	6256	7146	6355	6910	7113	6708	6726
2001	7466	7016	5924	6379	7513	6565	7055	7819	7926	7056
2002	7674	7131	6144	6767	7648	6604	7167	8319	7614	7280
2003	7935	7578	6051	6862	7993	7036	7516	8308	7275	7079
2004	7526	7341	6209	7049	7917	7107	7543	8049	6922	6778
2005	7024	7500	6517	7279	8139	7344	7782	7921	6677	6626
2006	9003	7703	6869	7688	8420	7589	7698	7802	7165	6882
2007	7770	8137	7170	7775	8770	7819	7678	7724	6915	7018
2008	6764	8470	7435	8164	8950	8249	7811	6614	6685	7205

Notes: This is provincial-local government expenditure net of interest payments and transfer payments to other level of governments. NFL=Newfoundland, PEI=Prince Edwards Island, NS=Nova Scotia, NB=New Brunswick, QB=Quebec, ON=Ontario, MB=Manitoba, SAS=Saskatchewan, AB=Alberta, and BC= British Columbia

Source: Authors' calculations based on data sources indicated in the data appendix

Table B2: Per capita Federal Lump-sum Cash Grant (in 2002 Canadian dollars), 1981-2008

Year	NFL	PEI	NS	NB	QB	ON	MB	SAS	AB	BC
1981	1770	2170	1724	1647	1197	468	1154	440	347	424
1982	1830	2265	1710	1690	1232	475	1199	470	298	454
1983	2001	2266	1667	1707	1279	495	1218	521	340	508
1984	2095	2343	1662	1667	1282	503	1222	545	373	541
1985	2242	2320	1601	1750	1206	494	1164	577	415	582
1986	2177	2207	1546	1780	1157	474	1164	887	530	579
1987	2351	2331	1623	1823	1139	439	1374	970	555	562
1988	2430	2368	1710	1810	1135	410	1407	1080	581	537
1989	2511	2411	1737	1894	1096	389	1533	1290	573	504
1990	2510	2347	1729	1850	1089	383	1519	1257	521	475
1991	2356	2197	1568	1923	1034	394	1410	1173	519	469
1992	2334	2026	1576	1826	1032	412	1404	1137	520	455
1993	2325	1934	1564	1720	1064	410	1424	1118	504	436
1994	2415	2089	1685	1766	1066	399	1536	1003	473	410
1995	2383	2123	1760	1669	1071	374	1487	783	452	399
1996	2677	2262	1939	1898	1247	440	1609	749	471	482
1997	2840	2486	2030	2016	1283	388	1532	711	396	470
1998	2830	2482	1947	2013	1223	356	1521	944	385	480
1999	2928	2596	1986	2103	1299	410	1645	975	477	556
2000	2707	2636	2062	2174	1332	445	1740	793	440	584
2001	2666	2583	2052	2190	1299	531	1829	847	466	674
2002	2404	2401	1892	2190	1204	563	1783	767	502	710
2003	2125	2373	1798	2154	1167	598	1806	711	496	744
2004	1985	2628	1962	2341	1245	661	1974	1249	495	850
2005	2032	2789	2095	2478	1426	785	2113	1070	502	955
2006	1655	2866	2149	2565	1516	807	2106	890	451	929
2007	1364	2822	2175	2549	1653	843	2080	972	530	874
2008	838	2924	2191	2646	1787	897	2199	717	515	857

Notes: NFL=Newfoundland, PEI=Prince Edwards Island, NS=Nova Scotia, NB=New Brunswick, QB=Quebec, ON=Ontario, MB=Manitoba, SAS=Saskatchewan, AB=Alberta, and BC= British Columbia

Source: Authors' calculations based on data sources indicated in the data appendix

Table B3: Short-run Marginal Cost of Funds of Personal Income Tax, 1981-2008

Year	NFL	PEI	NS	NB	QB	ON	MB	SAS	AB	BC
1981	1.235	1.208	1.208	1.208	1.336	1.177	1.215	1.233	1.144	1.188
1982	1.180	1.157	1.171	1.168	1.336	1.142	1.202	1.174	1.111	1.143
1983	1.184	1.157	1.171	1.177	1.336	1.150	1.202	1.174	1.111	1.143
1984	1.184	1.157	1.171	1.177	1.336	1.159	1.202	1.174	1.127	1.150
1985	1.184	1.157	1.171	1.177	1.336	1.142	1.202	1.172	1.127	1.157
1986	1.184	1.157	1.171	1.177	1.271	1.154	1.202	1.170	1.127	1.157
1987	1.184	1.166	1.171	1.177	1.271	1.154	1.202	1.170	1.150	1.154
1988	1.153	1.149	1.143	1.153	1.247	1.142	1.139	1.141	1.125	1.128
1989	1.156	1.161	1.143	1.153	1.224	1.145	1.133	1.141	1.125	1.128
1990	1.159	1.161	1.169	1.153	1.224	1.148	1.133	1.141	1.125	1.128
1991	1.159	1.164	1.169	1.171	1.224	1.151	1.133	1.146	1.125	1.143
1992	1.166	1.169	1.169	1.171	1.224	1.159	1.133	1.146	1.123	1.160
1993	1.180	1.169	1.169	1.174	1.252	1.191	1.133	1.146	1.122	1.178
1994	1.180	1.169	1.246	1.180	1.252	1.200	1.133	1.160	1.122	1.211
1995	1.180	1.169	1.169	1.180	1.252	1.200	1.133	1.160	1.122	1.211
1996	1.202	1.169	1.169	1.180	1.252	1.197	1.133	1.160	1.122	1.211
1997	1.202	1.169	1.166	1.177	1.252	1.183	1.133	1.160	1.122	1.211
1998	1.202	1.169	1.162	1.170	1.248	1.169	1.130	1.157	1.117	1.211
1999	1.202	1.166	1.162	1.167	1.248	1.158	1.123	1.153	1.117	1.195
2000	1.189	1.162	1.162	1.162	1.235	1.153	1.118	1.153	1.108	1.188
2001	1.176	1.163	1.162	1.157	1.230	1.153	1.153	1.139	1.082	1.146
2002	1.176	1.163	1.162	1.157	1.224	1.153	1.153	1.134	1.082	1.126
2003	1.176	1.163	1.162	1.157	1.224	1.153	1.153	1.129	1.082	1.126
2004	1.176	1.163	1.172	1.157	1.224	1.153	1.153	1.129	1.082	1.126
2005	1.176	1.163	1.172	1.157	1.224	1.153	1.153	1.129	1.082	1.126
2006	1.176	1.163	1.172	1.157	1.224	1.153	1.153	1.129	1.082	1.126
2007	1.176	1.163	1.154	1.158	1.224	1.153	1.153	1.129	1.082	1.126
2008	1.144	1.163	1.172	1.158	1.224	1.153	1.153	1.129	1.082	1.126

Note: This is the short-run Marginal Cost of Funds (MCF) estimate for personal income tax rate computed as discussed in Dahlby and Ferede (forthcoming).
Source: Authors' calculations based on empirical estimates from Dahlby and Ferede (forthcoming) and data sources indicated in the data appendix

Table B4: Provincial Own-source Revenue to Expenditure Ratio, 1981-2008

Year	NFL	PEI	NS	NB	QB	ON	MB	SAS	AB	BC
1981	0.538	0.551	0.461	0.632	0.643	0.708	0.636	0.751	1.248	0.731
1982	0.499	0.532	0.485	0.537	0.660	0.664	0.576	0.672	1.063	0.720
1983	0.503	0.546	0.539	0.592	0.652	0.679	0.629	0.782	1.013	0.749
1984	0.547	0.604	0.545	0.649	0.669	0.729	0.630	0.725	1.071	0.775
1985	0.564	0.581	0.571	0.641	0.671	0.725	0.640	0.703	1.014	0.791
1986	0.583	0.614	0.599	0.692	0.704	0.762	0.656	0.600	0.753	0.778
1987	0.593	0.627	0.633	0.699	0.753	0.771	0.719	0.730	0.769	0.805
1988	0.568	0.624	0.630	0.689	0.787	0.810	0.738	0.731	0.787	0.841
1989	0.558	0.605	0.607	0.681	0.771	0.795	0.731	0.855	0.747	0.898
1990	0.567	0.597	0.629	0.670	0.762	0.748	0.702	0.791	0.807	0.911
1991	0.594	0.609	0.609	0.663	0.728	0.648	0.678	0.673	0.746	0.824
1992	0.572	0.600	0.594	0.662	0.691	0.589	0.675	0.707	0.683	0.812
1993	0.579	0.638	0.589	0.714	0.684	0.608	0.704	0.806	0.751	0.882
1994	0.602	0.701	0.642	0.758	0.693	0.667	0.801	0.906	0.961	0.946
1995	0.653	0.704	0.638	0.788	0.750	0.703	0.800	0.863	0.989	0.943
1996	0.657	0.699	0.686	0.796	0.772	0.773	0.802	0.923	1.067	0.944
1997	0.608	0.684	0.650	0.741	0.826	0.812	0.844	0.927	1.112	0.912
1998	0.599	0.654	0.653	0.698	0.865	0.800	0.854	0.838	0.960	0.903
1999	0.613	0.661	0.679	0.704	0.890	0.851	0.814	0.817	0.995	0.907
2000	0.621	0.648	0.723	0.742	0.906	0.835	0.843	0.857	1.213	0.930
2001	0.573	0.614	0.696	0.713	0.849	0.785	0.798	0.743	0.912	0.779
2002	0.606	0.619	0.715	0.727	0.816	0.761	0.780	0.693	0.859	0.758
2003	0.567	0.603	0.738	0.722	0.799	0.741	0.707	0.729	0.949	0.787
2004	0.585	0.635	0.702	0.710	0.835	0.753	0.699	0.758	1.020	0.848
2005	0.639	0.641	0.678	0.696	0.835	0.762	0.708	0.799	1.134	0.892
2006	0.457	0.645	0.666	0.668	0.871	0.751	0.716	0.837	1.122	0.866
2007	0.598	0.614	0.633	0.673	0.847	0.729	0.721	0.822	1.036	0.829
2008	0.711	0.590	0.619	0.655	0.838	0.681	0.704	0.950	1.020	0.774

Notes: This is the provincial own-source revenue to expenditure ratio. Provincial own-source revenue is the provinces' total revenue from their own sources.

Source: Authors' calculation based on data sources indicated in the Appendix.

Table B5: Personal Income Per capita (in 2002 Canadian dollars), 1981-2008

Year	NFL	PEI	NS	NB	QB	ON	MB	SAS	AB	BC
1981	14282	16636	19035	16760	20592	23759	19549	17288	21222	24798
1982	14748	17604	19042	17224	20250	24196	20477	18623	20601	24742
1983	14775	17610	18416	17115	19980	24135	19464	17963	20051	24066
1984	14919	18477	19106	17149	20811	25256	20871	18088	20275	23934
1985	15553	18662	20082	17695	21479	25836	21959	18716	22342	25175
1986	15485	19376	20033	18414	21343	26021	22181	22003	25631	24823
1987	16538	19603	20574	18764	21699	26475	22029	20431	25723	25407
1988	17481	20257	21108	18989	22184	27380	21669	20493	28511	26104
1989	18407	20479	21615	19338	22531	27813	22173	20814	28889	26900
1990	19525	20905	22072	19924	23334	27908	23683	23073	29099	27982
1991	19673	20877	21747	20338	22952	27108	23237	23769	30188	27704
1992	19862	21020	21947	20687	22953	27309	23514	22736	29908	27075
1993	19972	20837	22072	20682	23255	26857	23432	22804	30217	26573
1994	20442	21197	21910	20713	23350	26980	23606	22612	29742	25962
1995	20808	22050	22010	20714	23466	27147	23564	22581	30137	25858
1996	20246	21500	21940	20743	23625	26894	23669	22384	29308	25800
1997	20574	22187	22762	21125	23935	27347	24020	22620	30837	25735
1998	21431	22589	23634	21978	24518	28334	25096	24279	33879	26155
1999	21826	23177	24339	22707	25186	29372	25255	24283	32070	26514
2000	21193	23654	24501	23045	26271	30740	25905	23647	29686	26887
2001	22264	23414	24905	23296	26779	31012	25986	24601	31277	27049
2002	22957	23832	25425	24424	26808	30553	25974	24238	32308	27683
2003	23061	24110	24802	24586	27108	30582	26323	25016	30313	27585
2004	22024	24323	25100	25044	27620	31148	26440	25272	30675	27793
2005	20639	24801	25494	25164	28006	31795	26704	24793	30027	28336
2006	21674	25679	26286	25700	28553	32609	26805	24900	32317	29471
2007	21098	25911	26869	26162	29179	33270	26919	25166	32800	30121
2008	19709	26160	27342	27130	29743	33468	27578	23128	30679	29904

Source: Authors' calculation based on data sources shown in the appendix

Table B6: Profile of Canadian provinces (Summary Statistics) by Province, 1981-2008

	NFL	PEI	NS	NB	QB	ON	MB	SAS	AB	BC	Canada
	Per Capita federal lump sum cash grant (2002 Canadian dollars)										
Mean	2242	2402	1826	1994	1242	509	1577	880	469	589	1373
Standard Deviation	461	255	207	300	178	153	313	244	72	167	744
Minimum	838	1934	1546	1647	1032	356	1154	440	298	399	298
Maximum	2928	2924	2191	2646	1787	897	2199	1290	581	955	2928
	Provincial-local Per Capita Expenditure (in 2002 Canadian dollars)										
Mean	6565	6242	5792	5942	7027	6300	6507	6864	7039	6458	6474
Standard Deviation	995	1054	609	1041	847	891	819	899	766	471	935
Minimum	4674	4824	4920	4298	6032	4782	4734	4986	5112	5716	4298
Maximum	9003	8470	7435	8164	8950	8249	7811	8319	8297	7280	9003
	Short-run Marginal Cost of Funds of Personal Income Tax										
Mean	1.180	1.165	1.170	1.168	1.255	1.161	1.155	1.153	1.112	1.158	1.168
Standard deviation	0.018	0.010	0.019	0.012	0.041	0.018	0.030	0.022	0.021	0.032	0.041
Minimum	1.144	1.149	1.143	1.153	1.224	1.142	1.118	1.129	1.082	1.126	1.082
Maximum	1.235	1.208	1.246	1.208	1.336	1.200	1.215	1.233	1.150	1.211	1.336
	Personal Income Per capita (in 2002 Canadian dollars)										
Mean	19327	21676	22649	21272	24197	28261	23860	22369	28525	26648	23878
Standard Deviation	2735	2620	2531	3040	2860	2758	2325	2413	4038	1627	3982
Minimum	14282	16636	18416	16760	19980	23759	19464	17288	20051	23934	14282
Maximum	23061	26160	27342	27130	29743	33468	27578	25272	33879	30121	33879
	Provincial Own-source Revenue to Expenditure Ratio										
Mean	0.584	0.623	0.629	0.690	0.770	0.737	0.725	0.785	0.957	0.841	0.734
Standard Deviation	0.051	0.044	0.067	0.054	0.080	0.065	0.074	0.087	0.154	0.070	0.132
Minimum	0.457	0.532	0.461	0.537	0.643	0.589	0.576	0.600	0.683	0.720	0.457
Maximum	0.711	0.704	0.738	0.796	0.906	0.851	0.854	0.950	1.248	0.946	1.248

Note: Canada shows the summary statistics for the panel of the 10 provinces.