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The Marginal Cost of Public Funds and the Flypaper Effect

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Abstract

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 helps to explain the "flypaper effect"—the empirical observation that a lump-sum grant has a much larger effect on spending than an increase in personal income. Contrary to the assertions of Mieszkowski (1994) and Hines and Thaler (1995), a model of a benevolent local government financing its expenditures with a distortionary tax predicts flypaper effects from lump-sum grants that are similar to those observed in many econometric studies.

The traditional theory of intergovernmental transfers implicitly assumed that sub-national governments financed their discretionary expenditures with lump-sum taxes, and it drew three conclusions about the expenditure effects of grants:

> First, general lump-sum and specific lump-sum grants have the same effects on grantee spending because they have only an income effect. Second, open-ended matching grants have a greater stimulatory effect on grantee spending than equivalent lump-sum grants because they have both income and substitution effects. Third, general lump-sum grants have similar (or the same) stimulatory effects on grantee spending as an equivalent rise in income in the community.[1]

The first conclusion—lump-sum transfer do not have a price effect—and the third conclusion—equivalent spending effects from lump-sum grant and personal income increases—are not valid when a recipient government uses distortionary taxes to finance its expenditures, while the second conclusion—"a greater expenditure stimulative effect from matching grants"—continues to hold.

Demonstrating that lump-sum grants have a "price effect" is important because much of the literature on intergovernmental grants continues to describe lump-sum intergovernmental transfers as only having an "income effect". See, for example, the recent survey paper by Shah (2007, Table 1.1, p.10). We show that a lump-sum grant has a price effect when a recipient government uses distortionary taxes to finance its spending because the effective price of its public services is the product of its marginal cost of public funds (MCF) and the marginal production cost of the service. When a subnational government receives a lump-sum transfer, it can reduce its tax rate and still provide the same level of service. At the lower tax rate, the MCF will, under plausible assumptions, be lower, and therefore the effective price of providing the public service is

[1]Bailey and Connolly (1998, p.336).

reduced. The price effect of a lump-sum grant will be greater when the ratio of the lump-sum transfers to the own-source tax revenues collected by the subnational government is higher and when the subnational government's MCF is higher. We show that while lump-sum grants have a price effect as well as an income effect, a revenue-neutral switch from a lump-sum grant to a matching grant would increase the provision of the public service by the subnational government.

For plausible parameter values, the reduction in the effective price of public services caused by lump-sum grants can be quite large and can explain the *flypaper effect*—the empirical observation that a lump-sum grant has a much larger effect on spending than an increase in personal income. As noted above, the conventional model of intergovernmental grants assumes that a benevolent subnational government uses lump-sum taxes to finance its expenditures and predicts that lump-sum grants should have the same impact on spending as an equivalent increase in personal income. See Bradford and Oates (1971). Therefore, the flypaper effect was labeled an "anomaly" in a widely cited paper by Hines and Thaler (1995), and various alternative explanations have been put forward to account for it, including fiscal illusion on the part of voters and the control exerted by expenditure-maximizing bureaucracies. See Dollery and Worthington (1996), Bailey and Connolly (1998), and Gamkhar and Shah (2007) for surveys of the empirical evidence on the flypaper effect and the various attempts that have been put forward to explain it.

Hamilton (1986) was the first to point out that a flypaper effect can arise because subnational governments typically use distortionary taxes to finance at least part of their expenditures. More recently, 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] However, neither of these papers shows that distortionary taxes can explain the magnitude of the flypaper effect. This is important because Hines and Thaler (1995, p.221) dismissed distortionary taxation as an explanation of the flypaper by asserting that "the marginal deadweight losses from taxes are typically far too small to reconcile the large differences between propensities to spend out of changes in grants and changes in private incomes." Mieszkowski (1994) also expressed scepticism about the ability of distortionary taxes to account for flypaper effect. He argued that MCF would have to exceed four in order for distortionary taxes to generate the observed flypaper effects. (We will show that Mieszkowski's conjecture is not correct, and that the flypaper effects of the magnitude observed in many econometric studies can be generated with MCFs around 1.5.)

Perhaps because of the scepticism expressed by Hines and Thaler and Mieskowski, Hamilton's explanation of the flypaper effect has not received the attention that it deserves. Oates (1999), in his comprehensive review of the literature on fiscal federalism, does not refer to Hamilton's paper in discussing the flypaper effect. Shah (2007) only provides a passing reference to Hamilton's explanation and focuses on bureaucratic power or voter myopia as explanations of the flypaper effect. We believe that distortionary taxation should receive more attention in the analysis of the effects of intergovernmental grants because the distortionary effects of taxation is a key problem at all levels of government, and it has a large influence on intergovernmental fiscal relations. Our model predicts that the flypaper effect will be larger if (a) the subnational government's taxes are a small share of personal income, (b) the income elasticities of

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

the tax base and the demand for the public service are low, (c) the subnational government's marginal cost of public funds is high, or (d) the tax base becomes more tax sensitive as the tax rate increases. Contrary to the assertions of Hines and Thaler and Mieszkowski, we show that given reasonable parameter values the model predicts flypaper effects that are similar to those observed in many econometric studies. Therefore the flypaper effect should not be viewed as an "anomaly", to be explained by politicians' or bureaucrats' failure to implement policies that benefit taxpayer. The flypaper effect is an "intrinsic" aspect of most subnational government's fiscal behaviour. It is a predictable consequence of the use of distortionary taxes to finance a subnational government's spending.

In Section 1, we show that when subnational governments levy distortionary taxes lump-sum transfers have a substitution or "price effect" as well as an "income effect". In Section 2, matching grants are shown to have a greater stimulative effect than lump-sum grants. In Section 3, we show that the model can predict "flypaper effects" of the same magnitude as those found in most econometric studies for plausible values of the MCFs for state and local governments in many countries. We review a number of econometric studies and conclude that they only yield ambiguous results concerning the model's prediction that the size of the flypaper effect should vary directly with the subnational government's MCF. In part, this is because there are few empirical studies of the MCFs of state and local governments. Section 4 summarizes our main results and suggests another way of testing the distortionary tax model's predictions concerning the expenditure effects of intergovernmental grants.

1. The Price Effects of Lump-Sum Intergovernmental Transfers

The conventional analysis of intergovernmental transfers usually assumes that unconditional grants only have an "income effect" for the recipient government, whereas matching grants have both a "price effect" and an "income effect". Alternatively, it has been argued by Oates (1979), Borge (1995), and others that lump-sum grants have price effects because of fiscal illusion. In their view, voters' desired spending levels are based on the average price of the public service, and lump-sum grants reduce the average price of the service, but not the marginal price. In this section, we show that lump-sum grants can reduce the marginal price of public services for a recipient government that relies on distortionary taxation, and that "fiscal illusion" is not required for lump-sum grants to generate a price effect.

Each subnational government is assumed to have a homogeneous immobile population that can be represented by the income and preferences of a single resident. The subnational government levies a tax rate t on its per capita tax base, B, and provides a public service, g, at a constant per capita unit production cost of c. We assume that g is a purely consumptive public service and that it enters that utility function of individuals as an additively separable variable. Let T be the per capita lump-sum transfer received by the subnational government. Its budget constraint is $tB + T - cg = 0$. The utility function of the representative resident is $U = u(x, B) + \Gamma(g)$ where x is a composite private consumption good, with price equal to one, $u(\cdot)$ is a quasi-concave function, and $\Gamma' > 0$, and $\Gamma'' < 0$. The price of the taxed good, B, is 1 + t. It will be convenient to represent the well-being of the representative resident by the reduced-form indirect utility function $V = V(t, g, Y)$ where Y is the lump-sum income of the representative resident of

the subnational government and the resident's marginal utility of income is $V_Y = \lambda > 0$. Given our assumption that the tax burden is not shifted to the residents of other jurisdictions, $V_t = -\lambda B < 0$. The marginal benefit from the subnational government's public service will be defined as $MB = \lambda^{-1} V_g$. In general, the marginal benefit from the public service will be a function not only of g, but also of Y and t because they will affect the marginal utility of income, λ.

The government's marginal cost of public funds, which represents the cost to the private sector of raising an extra dollar of tax revenue through a tax rate increase, plays key role in our analysis and is given by: [3]

$$MCF = \frac{B}{\frac{d(tB)}{dt}} = \frac{B}{B + t\frac{dB}{dt}} = \frac{1}{1 + t\eta} \qquad (1)$$

where $\eta = \partial ln B / \partial t < 0$ is the semi-elasticity of the tax base with respect to the tax rate which is a measure of the shrinkage of the tax base because of tax avoidance or tax evasion. The numerator in (1) reflects the fact that the harm to the representative household from a small tax rate increase is proportional to the tax base. The denominator is the rate of increase in the government's tax revenues from a small tax rate increase, and therefore the ratio represents the marginal cost to residents of raising an additional dollar of tax revenue through a tax rate increase by their subnational government. We assume that the government is always on the upward-sloping section of its Laffer curve and therefore $1 + t\eta > 0$. At the revenue-maximizing tax rate, $t = -1/\eta$, the MCF would be infinite because a small tax rate increase would impose a burden on households without

[3] There is a very large literature on the interpretation and measurement of the MCF. See Dahlby (2008a) for comprehensive treatment of the concept and measurement of the MCF.

raising any additional revenues. For this reason it is assumed that $t < -1/\eta$. Note also that $MCF = 1$ if $t = 0$.

A key assumption that we make is that the MCF increases as the local government increases its tax rate. The effect of a tax rate increase on the MCF, holding public expenditures constant, is:

$$\frac{\partial MCF}{\partial t} = -\eta(1 + E)MCF^2 \qquad (2)$$

where $E = (d\eta/dt)(t/\eta)$ is the elasticity of the semi-elasticity of the tax base with respect to the tax rate. Consequently, the MCF will be increasing in the tax rate if $-1 < E$. In other words, as the tax rate increases, the tax base might become less tax sensitive, i.e. $E < 0$. For example, as the tax rate on increases the demand for a taxed commodity might become less price elastic as individuals consume less of it. However, the MCF will increase as the tax rate increases as long as the reduction in tax sensitivity is not too great. This is expressed in the condition $-1 < E$. Although we have limited knowledge about how the tax sensitivity of tax bases changes with the tax rate, it seems plausible to assume that $-1 < E$ and that the MCF increases as the government raises more revenue. Throughout the rest of this paper, we assume that this characterizes a local government's fiscal situation.

The subnational government will maximize the well-being of its residents by providing the public service up to the point where its marginal benefit, MB, equals its effective price, or $P \equiv MCF \cdot c$. Figure 1 shows the impact of an unconditional transfer on a subnational government's provision of a public service. Initially, it is assumed that the subnational government does not receive any transfers, and it finances its expenditures by levying a distortionary tax. While the cost of producing the service is

assumed to be constant, the MCF increases with the tax rate, and therefore P increases with the level of service provided. A benevolent subnational government would provide g^0 units of the public service where the marginal benefit of the public service is equal to its effective price.

Now consider the effect of an unconditional lump-sum transfer, T, from a higher level of government. This displaces the effective price schedule to the right by T/c units of the public service, and the subnational government would increase its provision of the service to g^1 units. Three things should be noted about the effects of the lump-sum grant shown in Figure 1. First, it has been assumed that the MB curve does not shift with the introduction of a lump-sum grant in order to focus on the price effect of the grant. In Section 3, we will show how a lump-sum grant may shift the MB curve. Second, the increase in spending on the service will be less than the amount of the transfer unless the marginal benefit of the public service is constant. If the marginal benefit from the public service declines as more of the service is provided, which is assumed to be the case in Figure 1, the transfer will result in a reduction in the recipient government's own-source tax revenues as well as an increase in its provision of the public service. Third, the unconditional transfer reduces the effective price of the public good. In particular, at the initial level of the public service, g^0, the effective price of the service will decline because, with the lump-sum transfer, the government can reduce its tax rate and still provide the same level of service. At the lower tax rate, the MCF is lower, and therefore the effective price of providing the public service is reduced.

Holding spending on the public service constant, $\partial t / \partial T = -B^{-1} \cdot MCF$ and $\partial P / \partial t = -c \cdot \eta \cdot MCF^2 \cdot (1 + E)$. Therefore, the elasticity of the effective price of the public service with respect to a lump-sum transfer is:[4]

$$\frac{\partial P}{\partial T}\frac{T}{P} = \left(\frac{T}{tB}\right) \cdot (1 - MCF) \cdot MCF \cdot (1 + E) \qquad (3)$$

Lump-sum transfers do not have a price effect if MCF = 1, i.e. when a subnational government only use lump-sum taxes to finance its expenditures, or if E = -1, i.e. the tax base becomes sufficiently less tax sensitive to exactly offset the effect of the increase in the tax rate on the MCF. Given our assumptions that MCF > 1 and -1 < E, a lump-sum grant will have a price effect which will be larger the higher the ratio of the lump-sum transfers to the tax revenues collected by the subnational government and the higher the subnational government's MCF. In some contexts, the price effects of lump-sum transfers can be quite large. For example, in Brazil, the ratio of transfers to own-source revenues for municipal governments is 3.0.[5] If a Brazilian municipal government's MCF is 1.50 and η is constant (E = 0), the elasticity of the tax price of its public services with respect to lump-sum transfers is -2.25, indicating a potentially large price reduction from an increase in a lump-sum grant.

2. The Expenditure Effects of Lump-Sum and Matching Grants

Given that a lump-sum grant has a price effect, it is interesting to compare its expenditure stimulation effect with that of an equivalent matching grant. The effect of an

[4] Details of the derivations of the key results in this paper are contained in the appendix.
[5] See Mendes and Boueri Miranda (2008, Table I.1).

open-ended matching grant on provision of the public service is shown in Figure 2. (As in Figure 1, we maintain the assumption that the MB curve does not shift.) The introduction of the matching grant shifts down the line representing the effective price of public services, and it also reduces the slope of the effective price line because now the subnational government can finance a given level of the public service at a lower tax rate. To compare the expenditure effects of a revenue-neutral switch from a lump-sum tax to a matching grant, we use equation (4), the optimality condition for the provision of the public service by the subnational government and equation (5), its budget constraint:

$$MB(g,t,Y) = \frac{(1-m)c}{1+t\eta} \tag{4}$$

$$t\,B(t,Y) + T = (1-m)c\,g \tag{5}$$

We will assume that the marginal benefit of the public service declines as more of the service is provided, $MB_g < 0$, that the "demand" for the public service may increase with income $MB_Y \geq 0$, and that an increase in the tax rate does not increase the demand for the public service, $MB_t \leq 0$. (The conditions under which the latter assumption holds will be derived in next section.) The matching rate for a matching grant is m with $0 \leq m < 1$. We also make a number of specific assumptions about the effects of the key variables on the government's tax base. First, it assumed to be decreasing in the tax rate because of tax avoidance and tax evasion effects, $B_t < 0$. Second, the tax base may be increasing in household income, $B_Y \geq 0$. For example, the value of the property tax base of a subnational government will usually increase if residents have higher incomes because they will live in larger and more expensive dwellings or the value of industrial and commercial property will be higher. Third, we assume that provision of the public service does not affect the size of the tax base, $B_g = 0$.

Taking the total differential of equations (4) and (5), we can obtain the following expressions for the effects of higher lump-sum transfers or a higher matching rate on the provision of the public service:

$$\frac{dg}{dT} = \frac{\eta(1 + E)MB + MB_t}{D} > 0 \tag{6}$$

$$\frac{dg}{cgdm} = \frac{\eta(1 + E)MB + MB_t - B(1 + t\eta)g^{-1}}{D} > 0 \tag{7}$$

$$D = (1 - m)c\left(\eta(1 + E)MB + MB_t\right) + \left[B(1 + t\eta)^2\right]MB_g < 0 \tag{8}$$

The model predicts that the provision of the public service will increase if there is an increase in lump-sum transfers or the matching rate for an open-ended matching grant. Combining (6) and (7), we can compare the expenditure effects of an increase in a matching grant with an equivalent increase in a lump-sum transfer:

$$\frac{dg}{cgdm} = \frac{dg}{dT} + \frac{(-B)\cdot(1 + t\eta)}{g \cdot D} \tag{9}$$

Since the second term on the right-hand side of (9) is positive, the model predicts that a revenue-neutral switch from a lump-sum grant to a matching grant would increase the provision of the public service by the subnational government.[6] This is also the prediction of the conventional analysis of intergovernmental grants, which assumes that the subnational government only imposes lump-sum taxes.

3. Distortionary Taxes and the Flypaper Effect

Our model can help to explain Hamilton's key insight that distortionary taxes give rise to a flypaper effect, i.e. an additional dollar in the hands of the subnational

[6] Econometric evidence in support of this prediction is found in studies using Canadian data by Coyte and Landon (1990) and Baker, Payne, and Smart (1999).

government, received through a lump-sum grant, has a much larger effect on its expenditures than an additional dollar in the pockets in its residents. As noted above, the conventional model, which predicts that an increase in personal income and an increase lump-sum transfers should have equivalent effects on a subnational government's spending, is based on the assumption that the subnational government uses lump-sum taxes to finance their expenditures. Once the assumption of lump-sum taxes is replaced with the more realistic assumption that the recipient government's expenditures are financed, at least in part, by distortionary taxes, then the "equivalence result" no longer holds.[7]

As noted in the previous section, an increase in the incomes of the residents of a subnational government can affect the provision of a public service in two ways. First, an increase in income will usually increase a government's tax base, and therefore a given level of spending can be financed at a lower tax rate, resulting in a lower MCF. The reduction in the effective price of public services from an increase fiscal capacity induced by an increase in residents' incomes is shown in Figure 3 as the downward shift in the effective price line from $MCF \cdot c$ to $\mathrm{MCF}' \cdot \mathrm{c}$.

An increase in residents' incomes may also increase the demand for public services. In other words, at higher income levels, households may place a higher value on public services such as education or cleaner streets. In Figure 3, this is shown as an upward shift in the marginal benefit schedule to MB'. As a result of the increase in the demand for the public service and the increase in fiscal capacity arising from an increase

[7] There is a parallel between the equivalence of personal income increases and lump-sum transfers on subnational governments' spending and Ricardian equivalence. Both are based on the assumption that governments finance their expenditures with lump-sum taxes. When governments resort to distortionary taxes, both equivalence results break-down.

in income, the provision of the public service would increase from g^0 to g^1. Comparing Figure 1 with Figure 3, we can see that equal per capita increases in lump-sum grants and personal incomes will almost invariably have different effects because they produce different shifts in the key relationships that determine the provision of the public service by the subnational government. Therefore, the non-equivalence of these effects should not come as a surprise or be viewed as an anomaly. Again, taking the total differential of (4) and (5), we obtain an expression for the stimulative effect of an increase in household income:

$$\frac{dg}{dY} = \frac{(\eta MB(1+E) + MB_t)tB_Y - B(1+t\eta)^2 MB_Y}{D} > 0 \qquad (10)$$

What can this simple model say about the relative sizes of the stimulative effects of lump-sum grants and personal income? Does the model predict that the former will be substantially greater than the latter as many empirical studies have shown?

In order to compare the stimulative effects of a lump-sum grant and an increase in personal income, we need to parameterize the changes in fiscal capacity and the demand for public services arising from an increase in personal incomes and the change in the demand for public services as the tax rate changes. To this end, let the elasticity of the subnational government's tax base with respect to average personal income be $\theta = B_Y(Y/B)$. We expect θ to be positive, reflecting the income elasticity of demand for the tax base. Similarly, let the income elasticity of the marginal benefit of the public service be $\nu = (Y/MB)MB_Y$. If residents place a higher value of public services as income rises, then we expect ν to be positive. Finally, let the elasticity of the marginal benefit from the public service with respect to the tax rate be $\phi = (t/MB)MB_t$.

To examine the relationship between t and MB in more detail, recall that MB is equal to V_g/λ, and therefore:

$$MB_t = \frac{V_{gt}}{\lambda} - \frac{V_g}{\lambda^2}\frac{\partial \lambda}{\partial t} = -\frac{MB}{t}\left(\frac{t}{\lambda}\frac{\partial \lambda}{\partial t}\right) \tag{11}$$

because $V_{gt} = 0$ given our assumption that utility function is additively separable in g. Consequently, ϕ is the negative of the elasticity of the marginal utility of income with respect to the tax rate. This implies that if a reduction in the tax rate (induced by an increase in a lump-sum grant) causes the marginal utility of income to decline, then the marginal benefit from the public service will increase. In terms of Figure 1, this would imply that the MB curve would shift up with an increase in a lump-sum grant, and its stimulative effect would be enhanced. To determine the conditions under which $\phi < 0$, note that an increase in the tax rate increases the price of the taxed good B. The impact of a tax rate increase on the marginal utility of income is therefore equal to $\partial\lambda/\partial t = -B(\partial\lambda/\partial Y) - \lambda(\partial B/\partial Y)$. With some manipulation of this condition, it can be shown that $\phi = \tau[\rho + \theta]$ where $\rho = (Y/\lambda)(\partial\lambda/\partial Y)$ is the elasticity of the marginal utility of income with respect to household income and $\tau = tB/Y$ is the subnational government's taxes as a proportion of the household's income. Since we are assuming that B is a normal good and $\theta > 0$, a necessary condition for ϕ to be negative is diminishing marginal utility of income. It is possible that ϕ will be positive, and the MB curve will shift down with an increase in a lump-sum grant if $\rho + \theta > 0$, but we expect any shifts in the MB curve, up or down, from tax rate changes to be relatively small because subnational governments' taxes as a share of personal income are typically quite low.

With this background, we can now compare the stimulative effects of a lump-sum grant with an increase in personal income using (6) and (10):

$$\frac{dg}{dY} = \left[\tau \left(\theta + \frac{\nu}{(1+E)(MCF-1)MCF - \phi \cdot MCF^2} \right) \right] \frac{dg}{dT} \qquad (12)$$

In other words, the model predicts a flypaper effect—a lump-sum grant increase has a larger effect on spending than an increase in personal income—if the expression in square brackets is less than one. Given our assumption that $\phi \leq 0$, the flypaper effect will be larger if the subnational government's taxes are a small share of personal income, if the income elasticities of the tax base and the demand for the public service are low, if the subnational government's taxes are highly distortionary, or if the tax base becomes more tax sensitive as the tax rate increases. When the MCF is very high, the ratio of the expenditure effects of personal income and a lump-sum transfer approaches $\tau\theta = tB_Y$, which in most cases will be substantially below one.

A numerical example can shed some light on the predicted flypaper effect. If the tax base and the valuation of public services have unitary income elasticities ($\theta = \nu = 1$), if the MCF = 1.50, E = 0, $\phi = 0$, and $\tau = 0.10$, (a relatively high value for most countries), then $dg/dY = 0.233\, dg/dT$. In other words, the effect of a lump-sum grant on subnational government's public spending would be four to five times as large as the effect of an equivalent increase in average incomes.

Our model predicts that the MCF has an important impact on the size of the flypaper effect, but unfortunately there are few studies of the MCF at the state and local government level. However, one well-known study of the Laffer curves, or "revenue hills", for four large U.S. cities by Haughtwout et al. (2004) indicates that the MCFs for

property taxes in 2001 were 1.56 in Minneapolis, 5.00 in Philadelphia, 10.00 in New York and undefined in Houston because it was on the downward sloping section of its Laffer curve for property tax revenue.[8] Given these high MCFs, we would expect that these cities would exhibit large flypaper effects.

Figure 4 shows the relative impacts of lump-sum transfers and personal income for a range of values of the MCF for $\theta = 1$, $\upsilon = 1$, $E = 0$, and $\tau = 0.10$ with and $\rho = 0$, -1, and -2 ($\phi = 0.10$, 0, and -0.10). The figure indicates that the MCF must be close to one for a personal income increase to have a larger stimulate effect than a lump-sum grant increase and that substantial flypaper effects are generated with relatively low values for the MCF even if $\rho = 0$ and therefore $\phi = 0.10$. Thus the model predicts, given plausible values for the MCF and the other parameter values, flypaper effects which are similar to those observed in many empirical studies. Given on these calculations, it is difficult to see on what basis Hines and Thaler (1995, p.221) dismissed the effects of distortionary taxes as "far too small to reconcile the large differences between propensities to spend out of changes in grants and changes in private incomes."

Another way to illustrate the potential size of the flypaper effect is to consider a specific example where individuals have the following Cobb-Douglas utility function defined over two private goods, x_1 and x_2, and the locally-provided public service g:

$$U = \alpha\ln(x_1) + \beta\ln(x_2) + \gamma\ln(g) \qquad \alpha > 0, \beta > 0, \gamma > 0, \alpha + \beta = 1 \tag{13}$$

It is assumed that the producer prices of all three goods are constant and equal to one. The local government imposes a per unit tax of t_1 on x_1 and therefore the consumer price

[8] The MCF can be calculated as $(1 + \varepsilon_{Bt})^{-1}$ where ε_{Bt} is the elasticity of the tax base with respect to the tax rate. Note that $\varepsilon_{Bt} = t\eta$. These elasticities for the four cities in 2001 were -0.36 for Minneapolis, -0.80 for Philadelphia, -0.90 for New York, and -1.13 for Houston. See Haughwout et al. (2004, Table 1, p.547).

of x_1 is $1 + t_1$. The demands for the two private goods are $x_1 = \alpha Y/(1 + t_1)$ and $x_2 = \beta Y$ where Y is the representative taxpayer's income. The local government's budget constraint is therefore:

$$g = \frac{t_1}{1 + t_1}\alpha Y + T \tag{14}$$

Substituting x_1 and x_2 into (13) yields the indirect utility function:

$$V = \alpha \ln\left(\frac{\alpha Y}{1 + t_1}\right) + \beta \ln(\beta Y) + \gamma \ln(g) \tag{15}$$

Maximizing (15) with respect to t_1 and g subject to the government's budget constraint in (14) yields the following equation for the optimal tax rate:

$$t_1 = \frac{\gamma Y - T}{\alpha Y + T} \tag{16}$$

Substituting the optimal tax rate in (16) into the budget constraint in (14) yields the following equation for the optimal provision of the public service:

$$g = \frac{\gamma}{\alpha + \gamma}(\alpha Y + T) \tag{17}$$

and therefore:

$$\frac{dg}{dY} = \alpha \frac{dg}{dT} \tag{18}$$

Since α is the budget share of taxed good, the flypaper effect will be inversely related to the relative size of the local government's tax base.[9] Local governments often have relatively narrow tax bases, such as property taxes on residential housing or a sales tax on a restricted range of goods and services, and therefore α may be quite low.

[9] With the Cobb-Douglas utility function, $\lambda = 1/Y$, $MB = \gamma Y/g$ and therefore $\upsilon = 1$. Also, $\theta = 1$, $\rho = -1$, and therefore $\phi = 0$. In addition, $\eta = -(1 + t_1)^{-1}$, $E = -t_1(1 + t_1)^{-1}$ and $MCF = 1 + t_1$. Substituting these expressions plus $\tau = \alpha t_1(1 + t_1)^{-1}$ into (12) also yields (18).

Consequently, local governments with narrow tax bases will tend to exhibit large flypaper effects.

Although we have stressed the effects of increased transfers on the recipient governments' expenditures, the model is symmetric and predicts that the grantor government will reduce its expenditures on the public services that it provides when it increases its transfers to another level of government.[10] Increasing transfers forces the grantor government to increase its tax rate and/or cut its own expenditures. Our model predicts that the grantor government will reduce its expenditures because of the increase in its marginal cost of public funds from a tax rate increase, but that it will cut its own expenditures by less than the amount of the increase in the transfer. The reduction in the grantor government's per capita spending on its own services may be greater than or less than the increase in per capita spending by the recipient governments because of differences in the MCFs and the price elasticities of demand for services between the two levels of government.

A number of econometric studies of the flypaper effect can be interpreted in light of the prediction that the flypaper effect will be larger when the recipient government's MCF is higher. Winer (1982) estimated a model of the effects of grants on Canadian provincial government spending between 1952 and 1970 and found that the stimulative effects of the grants were twice as large for the poor Atlantic provinces as for the richer provinces. This result is consistent with the view that the small Atlantic provinces, with relatively low tax bases, have difficulty raising additional tax revenue, and therefore have

[10] Logan (1986) developed a model which also predicts that a reduction in expenditures by the grantor government based on the hypothesis that such an increase in transfers creates the fiscal illusion that the price of the grantor government's own services have increased. Logan's model does not explain why the politicians in the grantor government would want to foster the fiscal illusion that the prices of the public services that they provide have increased by transferring funds to other levels of government.

higher MCFs than the richer provinces. However, the Canadian fiscal equalization program may have reduced the MCFs of the Atlantic provinces by compensating them for reduction in their tax bases when they raise their tax rates,[11] and therefore it not clear that their perceived MCFs are lower than the other provinces' MCFs.

More recently, Shaw (2005, p.62) has estimated the expenditure effects of federal transfers to the Canadian provinces, based on data for the period 1981 to 2001, and he found that "federal grants tend to stimulate provincial-local expenditures by much more than increases in private income, though there exists substantial variation in marginal responses across provinces. The impact of grants on spending tends to be relatively low for provinces receiving large equalization payments whereas grants to Ontario, and especially Alberta, are very stimulative." Shaw's results are consistent with the predictions of our model if Alberta and Ontario, the two non-equalization receiving provinces, have higher MCFs than the equalization-receiving provinces. Therefore these Canadian studies lead to conflicting conclusion regarding which provinces exhibit larger flypaper effects, and the relative size of their MCFs is ambiguous because of the incentive effects produced by the equalization formula.

Blanco (2006) found that the flypaper effect in Brazil was stronger in municipalities with larger geographic areas. He interpreted this result as consistent with a budget-maximizing bureaucracy explanation of the flypaper effect because residents of larger municipalities would find it harder to move to other municipalities that might spend less on public services and offer lower taxes. However, there is an alternative interpretation of Blanco's finding. The municipalities which have large geographic areas

[11] See Smart (1998, 2006) and Dahlby (2002).

are concentrated in the North and North East of Brazil, which are areas of poverty and low levels of economic development where the municipal governments have very low fiscal capacity. We would expect such municipalities to have high MCFs and therefore our model would predict that these municipalities would exhibit relatively large flypaper effects. The evidence from the Blanco study, while confirming the existence of substantial flypaper effects, does not resolve the question of the primary source of these effects.

Volden (2007)'s political economy model predicts that the flypaper effect will be larger when the difference in the MCFs of the recipient and donor governments is larger. He has argued that the sizes of estimated values of stimulative effects of grants in the US studies reviewed by Hines and Thaler (1996) follow this predicted pattern with the largest effect, $1.06 of additional spending per grant dollar, "for a federal grant to West Virginia school districts. The smallest effect was for state and federal grants to large urban governments. Clustered between 0.40 and 0.65 are grants from the federal government to the states or from state governments to localities, as we might expect." Volden (2007, p.225). Note however that these result may conflict with the estimates by Haughwout et al. which indicate that the MCFs for at least four large U.S. cities are very high and with the study by Buettner and Wildasin (2006, Table 7, p.1129) which found that a permanent one dollar per capita increase in grants results in a 70.2 cent increase in spending by large U.S. cities compared to a 52.5 cent increase in spending for small cities.

With regard to the expenditure effects on grantor governments, Logan (1986) found that an additional dollar of federal transfers to the state governments in the United

States reduced federal spending in other areas by $1.53 to $2.12. While Logan's estimate of the reduction in grantor government spending exceeds the amount predicted by our model, Hammes and Wills (1987) found that a one dollar increase in the Canadian federal government's transfers to the provinces reduced its spending in its own areas by 0.81 to 1.33, depending on the specification of the model. Similarly, Dollery and Worthington (1995) and Stewart (1996) found that increases in grants to the state governments in Australia reduced the Commonwealth government's expenditures on its own services. The former study did not give an estimate of the displacement effect, but the point estimate in the Stewart (1996) study was -0.99.

In summary, the empirical evidence on the magnitude, direction, and variations in the flypaper effect is somewhat contradictory and neither confirms nor rejects the predictions of the distortionary tax model of the flypaper effect. Formulating testable models of the flypaper effect based on the distortionary tax model and comparing the results with the alternative models based on fiscal illusion or bureaucratic power would be very valuable addition to the empirical literature.

4. Conclusion

Understanding the factors that cause the flypaper effect is important for developing policies with regard to intergovernmental finances. Those who think 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 transfers and more reliance on subnational government taxation in financing their expenditures. Or, as Oates (1994, p.135) expressed it, "Taken at face value, the flypaper effect has some rather

damning implications for the functioning of democratic institutions. It suggests that the representatives of the populace in state and local government do not follow, in budgetary terms at least, the will of the electorate." On the other hand, in our model a large flypaper effect indicates that subnational governments have high MCFs and provide correspondingly low levels of public services. Under these circumstances, higher transfers to subnational governments may be welfare improving if the central government has a lower MCF than the subnational governments.[12] Therefore, resolving the source of the flypaper effect is important for deriving policy conclusions regarding the appropriate level of transfers to subnational governments.

The model of the flypaper effect that we have outlined in this paper may help researchers test for the underlying cause of the high rate of spending out of lump-sum transfers. In an earlier version of this paper, we showed that a subnational government will reduce its tax collection effort when it receives a lump-sum transfer, and this prediction seems to set the distortionary tax explanation of the flypaper effect apart from the other explanations of the flypaper effect. Models of the flypaper effect based on the bureaucrats' desire to maximize its budget or voters' fiscal illusion are unlikely to predict reduced tax collection effort with higher grants. Thus any empirical evidence that subnational governments cut tax collect effort in response to grants would provide strong support for the marginal cost of public funds explanation of the flypaper effect.

[12] See Dahlby (2008b) for a model of optimal intergovernmental transfers based on equalizing the MCFs between levels of government.

Appendix: Derivation of the Key Results

Derivation of Equation (3)

From the definition of the effective price of the public service and the formula for the MCF, we have:

$$P \equiv MCF \cdot c = c\left(1 + t\eta\right)^{-1}$$

Taking the derivative of P with respect to t and noting that $E = (1/\eta)\eta_t$, we obtain:

$$\frac{dP}{dt} = -c\left(1 + t\eta\right)^{-2}\left(\eta + t\eta_t\right) = -c\eta\left(1 + E\right)\left(1 + t\eta\right)^{-2}$$

Taking the total differential of the budget constraint and holding g constant, we obtain $Bdt + tB_t dt + dT = 0$, which yields $dt/dT = -B\left(1 + t\eta\right)^{-1}$. The price effect of an increase in a lump-sum transfer is therefore equal to:

$$\frac{dP}{dT} = \frac{dP}{dt}\frac{dt}{dT} = -c\eta\left(1 + E\right)\left(1 + t\eta\right)^{-2}\left[\frac{-1}{B\left(1 + t\eta\right)}\right] = \frac{c\eta}{\left(1 + t\eta\right)^3}\frac{1 + E}{B}$$

From the above, we can express the elasticity of P with respect to T as:

$$\frac{dP}{dT}\frac{T}{P} = \frac{c\eta}{\left(1 + t\eta\right)^3}\frac{1 + E}{B}\frac{T}{c\left(1 + t\eta\right)^{-1}} = \left(\frac{T}{tB}\right)\left[\frac{t\eta}{\left(1 + t\eta\right)^2}\right]\left(1 + E\right)$$

Substituting $1 - MCF = t\eta/\left(1 + t\eta\right)$ and $MCF = \left(1 + t\eta\right)^{-1}$ into the above equation yields equation (3).

Derivations of Equations (6) to (12)

Since $MCF = (1 + t\eta)^{-1}$, the optimality condition and the government's budget constraint can be written as:

$$(1 + t\eta) \cdot MB(g, Y, t) = (1 - m)c$$

$$t\,B(t, Y) + T = (1 - m)c\,g$$

where we assume $MB_g > 0$, $MB_Y \geq 0$, $MB_t \leq 0$, $B_t < 0$, $B_Y > 0$, and $-1 < t\eta_t$.

Taking the total differential of the above equations we obtain:

$$\eta\, MB\, dt + MB\, t\, \eta_t\, dt + (1 + t\eta)(MB_g\, dg + MB_Y\, dY + MB_t\, dt) = -c\, dm$$

$$B\, dt + t\, B_t\, dt + t\, B_Y\, dY + dT = (1 - m)c\, dg - c\, g\, dm$$

Setting dY and dm equal to zero, we can solve the above system of equations to obtain:

$$\frac{dg}{dT} = \frac{\eta(1 + E)MB + MB_t}{D} > 0 \qquad \text{This is equation (6)}$$

Similarly, setting dT and dY equal to zero, we can obtain:

$$\frac{dg}{c\,g\,dm} = \frac{\eta(1 + E)MB + MB_t - B(1 + t\eta)g^{-1}}{D} > 0 \qquad \text{This is equation (7)}$$

Finally, setting dT and dm equal to zero, we can obtain:

$$\frac{dg}{dY} = \frac{(\eta\, MB\,(1 + E) + MB_t)tB_Y - B(1 + t\eta)^2 MB_Y}{D} > 0 \qquad \text{This is equation (10)}$$

where:

$$D = (1 - m)c\,(\eta(1 + E)MB + MB_t) + \left[B(1 + t\eta)^2\right]MB_g < 0 \qquad \text{This is equation (8)}$$

Equation (9) follows directly from the above expressions for dg/dT and dg/(cgdm).

Let $\kappa = (dg/dY)/(dg/dT)$. Dividing (10) by (6) we obtain:

$$\kappa = tB_Y - \frac{(1+t\eta)^2 B MB_Y}{\eta(1+E)MB + MB_t} = tB_Y \frac{Y}{B}\frac{B}{Y} - \frac{(1+t\eta)^2 tB MB_Y Y MB^{-1}}{tY\left(\eta(1+E) + \frac{MB_t}{MB}\right)}$$

With $\tau = (tB)/Y$, $\theta = (Y/B)B_Y$, $\nu = (Y/MB)MB_Y$, and $\phi = (t/MB)MB_t$, we can re-write the above equation as:

$$\kappa = \tau\left[\theta - \frac{(1+t\eta)^2\ \nu}{t\eta(1+E)+\phi}\right] = \tau\left[\theta - \frac{\nu}{\frac{t\eta(1+E)+\phi}{(1+t\eta)^2}}\right]$$

$$= \tau\left[\theta + \frac{\nu}{(1+E)(MCF-1)MCF - \phi \cdot MCF^2}\right]$$

since tη/(1 + tη) = 1 – MCF. Equation (12) is $dg/dY = \kappa dg/dT$.

Derivation of the Expression $\phi = \tau[\rho + \theta]$

Taking the partial derivative of $V_t = -\lambda B$ with respect to Y yields $V_{tY} = -B\frac{\partial\lambda}{\partial Y} - \lambda\frac{\partial B}{\partial Y}$.

By Clairaut's theorem, $V_{tY} = V_{Yt} = \partial\lambda/\partial t = -B(\partial\lambda/\partial Y) - \lambda(\partial B/\partial Y)$. From equation (11):

$$\phi = -\left(\frac{t}{\lambda}\frac{\partial\lambda}{\partial t}\right) = \frac{tB}{Y}\left(\frac{Y}{\lambda}\frac{\partial\lambda}{\partial Y} + \frac{Y}{B}\frac{\partial B}{\partial Y}\right) = \tau(\rho + \theta).$$

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Figure 1
The Effect of a Lump-sum Transfer on Provision of a Public Service

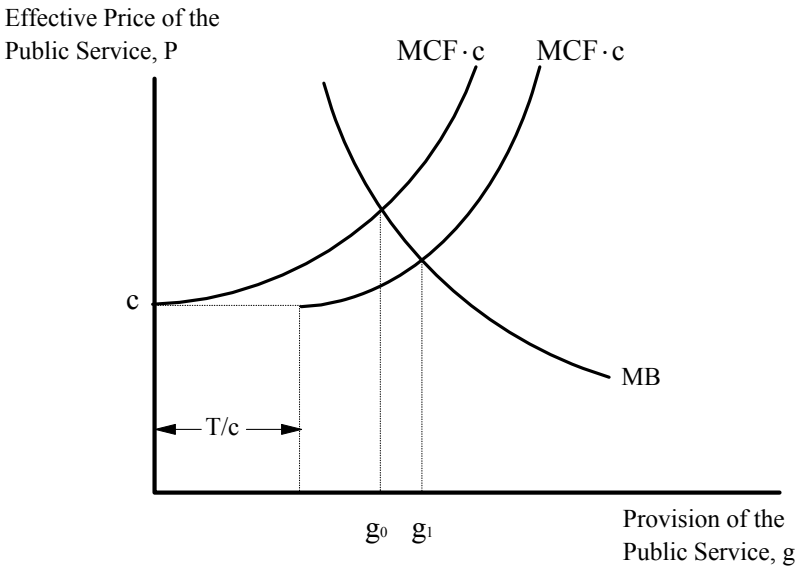

Figure 2
The Effect of a Matching Grant on Provision of a Public Service

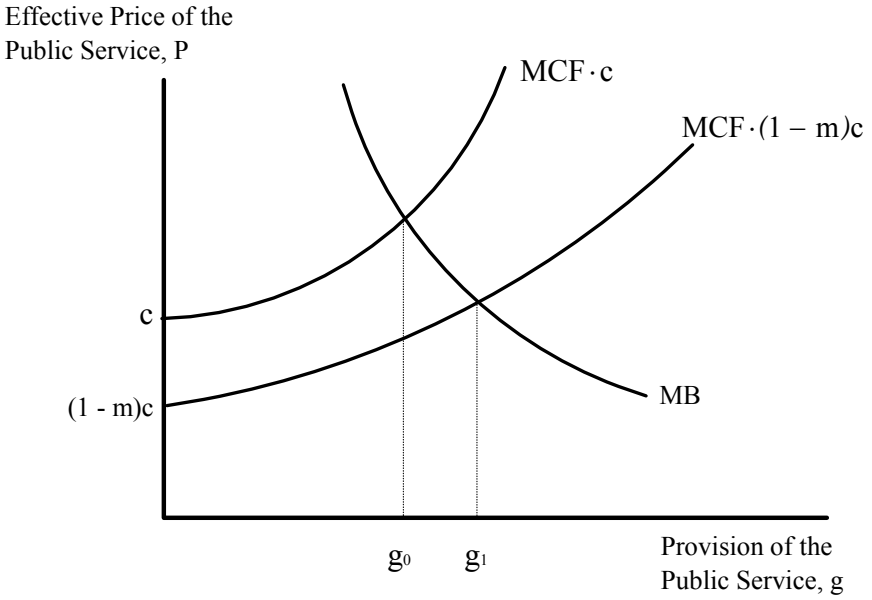

Figure 3
The Effect of a Personal Income Increase on the Provision of a Public Service

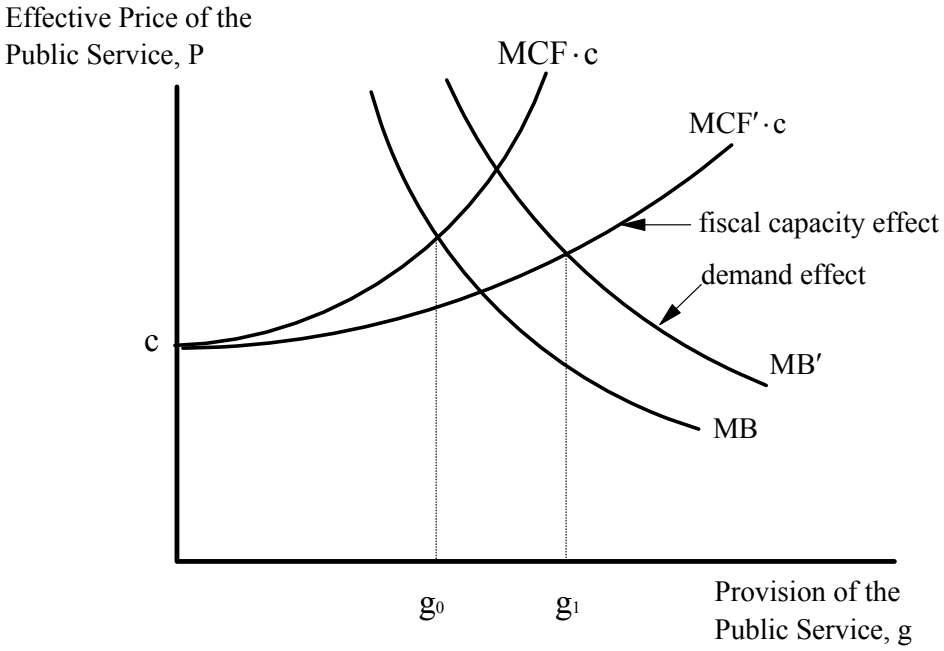

Figure 4
The Ratio of dg/dT to dg/dY