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ABSTRACT

The flypaper effect is a widely-documented puzzle whereby the propensity of sub-national governmental units to spend out of unconditional transfers is higher than the propensity to spend out of private income. Building on previous insights in the literature that rationalize this puzzle using costly taxation, we develop a simple optimal fiscal policy model with distortionary taxation that generates two novel and testable implications: (i) there should be a positive association between the size of the flypaper effect and the level of the tax rate, and (ii) the flypaper effect should be larger the lower the elasticity of substitution between private and public spending and, in fact, should vanish for very high degrees of substitution. We show that these hypotheses hold for Argentinean provinces and Brazilian states.

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"The flypaper effect results when a dollar of exogenous grant-in-aid leads to significantly greater public spending than an equivalent dollar of citizen income: Money sticks where it hits. Viewing governments as agents for a representative citizen voter, this empirical result is an anomaly."
Robert Inman (2008)

1 Introduction

The flypaper effect is a well-known empirical regularity that refers to the greater responsiveness of subnational (i.e., state, provincial, city, or municipal) government spending to increases in unconditional intergovernmental grants than to increases in local income. According to Inman (2008), over 3,500 research papers document this stylized fact for many countries and levels of government in the world. Specifically, these papers find that an extra dollar in personal income increases public spending by \$0.02 to \$0.05, while an equivalent increase in intergovernmental transfers triggers a rise in spending that lies between \$0.25 and \$1.1.[1] The term "flypaper effect" was originally coined in early papers (Henderson, 1968; Gramlich, 1969) that uncovered this empirical regularity. This catchy expression captures the idea that money sticks where it hits: money in the private sector – from private income – tends to remain in the private sector rather than being taxed away, while money in the public sector – from intergovernmental transfers – tends to be spent by the public sector rather than being rebated to citizens.

As Inman's quote illustrates, the flypaper effect has been regarded as a puzzle or an anomaly. This is indeed the case if one thinks in terms of a model in which a representative citizen's utility is maximized subject to his/her "full income" – composed by the sum of personal income and his/her share of unconditional fiscal transfers. Such a model would predict an identical propensity to spend out of citizen's income or unconditional intergovernmental transfers. After all, money is fungible and the source of financing should not affect the optimal allocation of resources.

Explanations for the flypaper effect have abounded and can be divided into five different groups, two of them pointing to potential specification errors and the remaining three based on theoretical arguments. A first group of explanations argues that non-fungible conditional

[1] Dollery and Worthington (1996), Bailey and Connolly (1998), and Gamkhar and Shah (2007), provide detailed surveys of the empirical evidence on the flypaper effect.

transfers, like the ones American states receive from matching grants, are misclassified as unconditional ones. A second group holds that omitted variables could also falsely support the flypaper effect if unobserved community's characteristics, which affect the technology or effective cost of public spending, were systematically related with citizens' income (Hamilton, 1983). The flypaper puzzle, however, remains after using truly unconditional grants (Inman, 1971; Gramlich and Galper, 1973; Bowman, 1974) or controlling for population characteristics. A third group holds that the standard model of a citizen's fiscal choice might be misspecified because either the citizen confuses the income effect generated by unconditional transfers with a price effect that reduces the average effective cost of public spending (Courant et al, 1979; Oates, 1979), he/she is not fully informed and fails to see the public budget (Filimon et al, 1982) or, even when fully informed, he/she might not behave completely rationally (Hines and Thaler, 1995). A fourth group uses political science arguments that exploit the role that inefficient political institutions have in revealing citizens' preferences (Chernick, 1979; Knight, 2002; Roemer and Silvester, 2002). Our paper relates to a fifth (much less discussed) group which relies on distortionary taxation (Hamilton, 1986; Aragón, 2009; Dalhby, 2011).[2]

Hamilton (1986) was the first to point out theoretically that the flypaper effect can arise because subnational governments typically use distortionary taxes to finance at least part of their expenditures. An increase in private income will lead to a greater demand for both public and private spending. Public spending, however, requires larger tax revenues which can only be raised by increasing the tax rate (i.e., distorting private sector's choices). In contrast, an increase in transfers provides the government with a source of income that is (from the point of view of the subnational unit) distortion-free. Hence, an increase in transfers will naturally lead to higher public spending than will the same increase in private income. Since Hamilton's (1986) contribution, however, there has been little work on the possible role of distortionary taxation in explaining the flypaper effect. Dalhby (2011) suggests that this might be in part due to the early scepticism expressed by Hines and Thaler (1995) and Mieszkowski (1994) and, implicitly, by Oates (1999). For example, Hines and Thaler (1995, page 221) argued that "the marginal deadweight losses from taxes are typically far too small to reconcile the large differences between propensities to spend." In turn, Oates (1999), in "his comprehensive review of the literature on fiscal federalism, does not refer to Hamilton's paper in discussing

[2] Aragón (2009) builds upon Hamilton's framework using real collection costs arguments.

the flypaper effect" (Dalhby, 2011, page 4).

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. However, neither of these papers shows that distortionary taxes can explain the magnitude of the flypaper effect. More closely related to our work, Dalhby (2011) presents a model in which the emphasis is on the marginal cost of public funds and finds that, given reasonable parameters values, the model can explain considerable part of the flypaper effect. Unfortunately – and in sharp contrast to other explanations developed in the flypaper literature – there is little empirical evidence on the validity of the distortionary taxation channel.

The main focus of our paper is precisely to present empirical evidence on the relevance of the distortionary taxation channel. We develop a simple optimal fiscal policy model that generates two novel and testable implications. First, there is a positive correlation between the flypaper effect and the level of the tax rate. In other words, when tax rates are high the flypaper effect is large and viceversa. This occurs because tax rates are positively associated with the degree of tax distortion. When tax rates are low, the willingness to spend out of transfers and local income is relatively similar because the tax distortion is low. As tax rates increase so does the tax distortion, which increases the incentives to spend out of transfers relative to local income. In other words, the size of the flypaper effect follows directly from the level of the tax distortion, which is positively associated with the level of the tax rate.

Second, the lower (higher) the elasticity of substitution between private and government spending, the higher (lower) the flypaper effect. If the elasticity of substitution is low, policymakers are much more willing to bear the tax distortion by imposing high tax rates, precisely because government spending is not easily substitutable for private spending. Therefore, an extra dollar of transfers will trigger an increase in government spending larger than an equivalent increase in income because the desire to allocate part of such extra dollar to government spending is strong and because the tax distortion already borne is high. As the substitutability between public and private spending increases, the willingness to bear tax distortions decreases because most resources could be more easily allocated to private spending without any tax distortion cost. As a result, tax rates will decrease. Hence, as the substitutability between private and public spending increases, the size of the flypaper effect will shrink because the willingness to allocate part of such an extra dollar in government spending weakens and, more importantly, because the willingness to bear tax distortions also diminishes. In the extreme case of perfect substitutability between private and public spending, the flypaper effect vanishes.

We test the two predictions of the model by using two different datasets for Argentinean provinces and Brazilian states. Unlike the American system of intergovernmental transfers that are typically conditional on states' spending in particular areas (mainly health and social programs), Argentinean provinces and Brazilian states rely mostly on a tax-sharing system regulated by laws that rarely change and whereby transfers are directly linked to federal tax revenues. As it will become clearer later, Argentinean provinces and Brazil states receive fiscal transfers that are, in essence, unconditional and exogenous to government spending.

Using a novel dataset on gross receipts from taxes that we put together from primary sources in Argentinean provinces, we find that the flypaper effect is high when tax rates are relatively high and significantly weakens as tax rates fall. We show this by splitting the sample into provinces with tax rates above and below the median. While present in both samples, the flypaper effect is about 40 percent larger in the sample with higher tax rates.

We then test whether the flypaper effect decreases with the degree of substitutability between private and government spending by using different government spending categories. To this effect, we first follow a standard methodology in public finance that allows us to estimate the degree of "publicness" of different spending categories. Specifically, we classify different public spending categories for Argentinean provinces and Brazilian states into (i) pure public goods, (ii) impure public goods, (iii) private goods, and (iv) undetermined. For Argentina, for instance, we find that police and housing/urban renewal are pure public goods, while education and public welfare are private goods. We then test the degree of the flypaper effect for these different categories and find that, by and large, the flypaper effect is much larger for pure public goods than for private goods, as predicted by our model.

The paper proceeds as follows. To set the stage for the discussion, Section 2 develops a simple Ramsey model to illustrate the flypaper effect as an anomaly. In a world with lump-sum taxes, the propensity of the Ramsey planner to spend out of private income or outside transfers is the same. We then introduce distortionary taxation to illustrate the argument put forward by Hamilton (1986) and show how the mere presence of distortionary taxation is enough to generate the flypaper effect. Section 3 develops a more general version of the distortionary taxation model in which we identify two key testable empirical implications: (i) there should be a positive correlation between the flypaper effect and the level of the tax rate, and (ii) the flypaper effect should be larger (smaller) the lower (higher) the elasticity of substitution between public and private spending. Section 4 briefly describes fiscal federalism in Argentina and Brazil and emphasizes the unconditional and exogenous nature of their fiscal transfers. We then turn to the regression analysis. Section 5 establishes the strong presence of the flypaper effect. We then test our two key empirical implications in Sections 6 and 7 and find strong support for them. Final thoughts are presented in Section 8.

2 Benchmark model

This section develops a simple Ramsey model of optimal fiscal policy model that allows us to rationalize the flypaper effect and understand the role of distortionary taxation. To keep the model as simple as possible, we will think of a static economy inhabited by a benevolent fiscal authority (FA) and a representative citizen or private agent (PA) blessed with perfect foresight.[3] There are two possible tax systems: (i) a non-distortionary lump-sum tax, and (ii) a distortionary consumption tax.[4] There are three (perishable) goods: a publicly-provided good (g), a consumption good subject to taxation (c^T), and a consumption good not subject to taxation (c^{NT}).[5] These three goods are perfect substitutes in production and therefore the two relative prices are one. Production is exogenous (i.e., there is an endowment).

Under a non-distortionary taxation system, the private agent's budget constraint is given

[3] Since this is a static model, it can be thought of as a closed economy.

[4] Of course, solving the Ramsey's planner problem with lump sum taxation is equivalent to solving the social planner's problem. (We set it up as a Ramsey problem to keep the symmetry with the distortionary taxation case.) The social planner's problem is the typical approach used in this literature (Henderson, 1968; Gramlich, 1969; Knight, 2002; Inman, 2008). Specifically, these papers maximize the representative citizen's utility subject to that citizen's "full income" constraint specified as the sum of personal income and the citizen's share of his/her government's unconstrained fiscal transfers. In other words, resources are assumed to be fungible.

[5] There are different ways of introducing a tax distortion into the model. The most obvious alternative would be to add leisure to the model, in which case a consumption tax would distort the consumption/leisure choice. We prefer this alternative specification (with one good being taxed and the other not) because it enables us to isolate the distortionary effects stemming from (exogenous) income shocks. While not modeled, the good that is non-taxed could be thought of as the underground economy. In a monetary model, our distinction between taxable and non-taxable goods would correspond to the standard cash versus credit goods specification, wherein inflation taxes only cash goods.

by

$$y = c^T + c^{NT} + \tau, \tag{1}$$

where y is the exogenous level of output and τ is the lump sum tax. Under a distortionary consumption tax, the private agent's budget constraint is given by

$$y = c^T (1 + \theta) + c^{NT}, \tag{2}$$

where θ is the consumption tax rate on c^T.

Without loss of generality, and in order to obtain analytical solutions, we use log preferences:[6]

$$W = \ln(g) + \ln\left(c^T\right) + \ln\left(c^{NT}\right). \tag{3}$$

Under a non-distortionary taxation system, the fiscal authority's budget constraint is given by

$$f + \tau = g, \tag{4}$$

where f denotes unconditional exogenous fiscal transfers. Under a distortionary consumption tax system, the fiscal authority's budget constraint is given by

$$f + \theta c^T = g. \tag{5}$$

Combining (1) and (4) or (2) and (5) we obtain the economy's constraint

$$y + f = c^T + c^{NT} + g. \tag{6}$$

2.1 Results

In this section, we solve the Ramsey planner's problem under (i) non-distortionary and (ii) distortionary taxation. This strategy allows us to understand the flypaper as an "anomaly" (case 1) and the role of distortionary taxation (case 2).

For further reference, let us define three measures. The first measure (FP) captures the

[6] We assume equal weights on each good for simplicity. Similar results would hold if we allowed different weights.

flypaper effect itself:

$$FP \equiv \frac{dg}{df} - \frac{dg}{dy}. \tag{7}$$

A positive value of this measure, which means that $dg/df > dg/dy$, would rationalize the flypaper effect typically observed in the data. Conversely, a negative or zero value of this measure would contradict the empirical regularity.

To measure any potential distortion, we define tax distortion (TD) as

$$TD \equiv \frac{c^{NT} - c^{NT*}}{c^{NT}}, \tag{8}$$

where c^{NT*} is the level of c^{NT} associated with non-distortionary taxation.

2.1.1 The flypaper effect viewed as an "anomaly"

Under a non-distortionary (i.e., lump sum) tax system the flypaper effect commonly observed in reality is an "anomaly;" that is to say, it cannot be rationalized.[7] Solving the Ramsey planner's problem, we obtain

$$FP = 0, \tag{9}$$

because

$$\frac{dg}{df} = \frac{dg}{dy} = \frac{1}{3}. \tag{10}$$

These results correspond to the ones obtained in traditional papers in the literature (e.g., Henderson (1968) and Gramlich (1969)). Without distortionary taxation, the model is clearly not able to explain why the source of financing should matter for expenditure decisions. Naturally, this case achieves the first best in which there is no distortion (i.e., $TD = 0$). Moreover, the source of the shock (y or f) does not affect the changes in private consumption allocations:

$$\frac{dc^{NT}}{df} = \frac{dc^{T}}{df} = \frac{dc^{T}}{dy} = \frac{dc^{NT}}{dy} = \frac{1}{3}. \tag{11}$$

[7] Appendix 9.2.1 shows all derivations.

2.1.2 The flypaper rationalized through distortionary taxation

We now show that the flypaper effect can be rationalized just by using distortionary taxation.[8] Solving the Ramsey planner's problem, we obtain

$$FP = \frac{1}{4}, \tag{12}$$

because

$$\frac{1}{2} = \frac{dg}{df} \geqslant \frac{dg}{dy} = \frac{1}{4}. \tag{13}$$

We also obtain

$$\frac{1}{2} = \frac{dc^T}{df} = \frac{dc^{NT}}{dy} > \frac{1}{4} = \frac{dc^T}{dy} > \frac{dc^{NT}}{df} = 0. \tag{14}$$

Unlike the non-distortionary case (section 2.1.1) the source of financing does matter. An increase in fiscal transfers increases government spending (private consumption) by a larger (lower) magnitude than in the non-distortionary case, while an increase in income increases government spending (private consumption) by a smaller (larger) magnitude than in the non-distortionary case (see equations (10), (11), (13) and (14)). That is to say, money sticks where it hits.

An increase in income (y) increases the demand for both public and private consumption. In order to finance the increase in government spending, the FA must increase tax collection. Under distortionary taxation, any attempt to increase revenues by increasing the tax rate would induce the PA to partially shift away from c^T towards c^{NT}. In fact

$$TD = \frac{y - 2f}{y + 2f} = \theta, \tag{15}$$

that is to say, the tax distortion is equivalent to the tax rate. This distortion partially offsets the desire to increase government spending. The change in the tax rate θ and tax distortion TD given an income shock is given by

$$\frac{dTD}{dy} = \frac{d\theta}{dy} = \frac{4f}{(y + 2f)^2} > 0. \tag{16}$$

[8] Appendix 9.2.2 shows all derivations.

As a result, most of the increase in income is allocated to private consumption (see equation (14)).

An increase in fiscal transfers (f) also increases the demand for both public and private consumption. However, in order to finance the increase in government spending, the FA does not need to increase tax collection. Quite to the contrary, the FA decreases the tax rate in order to allow part of those new resources to be allocated to private consumption

$$\frac{dTD}{df} = \frac{d\theta}{df} = -\frac{4y}{(y+2f)^2} < 0. \tag{17}$$

In other words, distortionary taxation generates the flypaper effect by making it more costly (in distortionary terms) to use funds that have accrued to the private sector than funds that have been given to the government via fiscal transfers. While the assumption of fungibility rules out the flypaper effect in a non-distortionary world, it is actually consistent with the flypaper effect in a distortionary world (and, is in fact, the second-best).

As in Hamilton (1986), while this model rationalizes the flypaper effect, it does not provide clear testable implications. The next section modifies the model's preferences in order to obtain some testable implications that we can take to the data.

3 General model

This section generalizes the Ramsey planner's problem from Section 2.1.2 by assuming more general preferences. The rest of the model remains the same. As will become clear below, these more general preferences will allow us to isolate the critical role of the elasticity of substitution between public and private spending. Formally, let preferences be given by

$$\begin{aligned} U &= \left[\phi g^{\frac{\sigma-1}{\sigma}} + (1-\phi)\, z^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \\ z &= \left[q {c^T}^{\frac{\rho-1}{\rho}} + (1-q)\, {c^{NT}}^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}}, \end{aligned} \tag{18}$$

where z represents a composite consumption good. The parameter ρ captures the elasticity of substitution between taxable (c^T) and non-taxable (c^{NT}) goods, with a low ρ indicating little substitution. As ρ becomes larger, taxable and non-taxable goods become more substitutable.

In the same vein, the parameter σ captures the elasticity of substitution between public (g) and private spending (z). Low values of σ are associated with a low degree of substitution between government and private spending. Moreover,[9]

$$\rho = \frac{d\left(\frac{c^{NT}}{c^{T}}\right) / \left(\frac{c^{NT}}{c^{T}}\right)}{d\left(1+\theta\right) / \left(1+\theta\right)}. \tag{19}$$

When $\rho \to 0$ (i.e., c^{NT} and c^{T} tend to be consumed in fixed proportions) the ratio c^{NT}/c^{T} is highly inelastic to tax rate changes; while if $\rho \to \infty$ (i.e., c^{NT} and c^{T} tend to be perfect substitutes) then the ratio c^{NT}/c^{T} is extremely elastic to tax rate changes. The log case corresponds to the case where the change in c^{NT}/c^{T} is proportional to changes in the tax rate ($\rho = 1$). The parameter ρ will thus capture how distortionary is the consumption tax system.

3.1 Results

Since the model cannot be solved analytically, we solve it numerically. To this end, we formulate the Ramsey planner's problem in very general terms. Specifically, the Ramsey planner chooses g, c^{T} and c^{NT} to maximize the PA's utility, given by (18), subject to the implementability conditions derived from the PA's maximization problem, the PA's constraint (2) and the FA's constraint (5).[10]

While our numerical exercise is *not* a calibration exercise, we choose the following parameterization that is consistent with the Argentinean case.[11] We normalize output to one hundred; i.e., $y = 100$. Some studies (Amano and Wirjanto, 1997; Chiu, 2001; Okubo, 2003; Auteri and Constantini, 2010) estimate that the elasticity of substitution between private (z) and government spending (g) ranges between 0.6 and 1.4; for this reason, we select $\sigma = 1$ in our benchmark parameterization.[12] Unfortunately, there are no estimates for the degree of substitutability between taxable and non taxable goods (ρ). Since c^{T} is the observed taxable private consumption, we could think of c^{NT} as the informal (i.e., underground) economy.

[9] Appendix 9.2.3 shows this derivation.

[10] Appendix 9.2.4 shows the Ramsey planner problem.

[11] Similar results are obtained when calibrating the model for the Brazilian economy. Results are not shown for brevity.

[12] Using U.S. data, Amano and Wirjanto (1997) estimate an elasticity of substitution of 0.9, while Chiu (2002) and Okubo (2003) find values of 1.1 and 1.4 using Taiwanese and Japanese data, respectively. Based on 15 Eurpean countries, Auteri and Constantini (2010) find that this elasticity ranges between 0.59 and 0.76.

The informal economy comprises about 40 percent of actual Argentinean output (Schneider and Enste, 2000; Vuletin, 2009).[13] We also know that provincial government spending and fiscal transfers represent about 16 and 7 percent of official output, respectively. Therefore, government spending represents about 10 percent of actual output (i.e., $\phi = 0.10$) and taxable consumption represents about 54 percent of total consumption (i.e., $q = 0.54$). We set the value of ρ such that it matches 2 ratios: $c^{NT}/y = 0.4$ (i.e., the informal economy represents 40 percent of income) and $g/\left(y - c^{NT}\right) = 0.16$ (i.e., provincial government spending represents about 16 percent of official output). The elasticity of substitution between c^T and c^{NT} consistent with these two ratios is about 3; i.e., $\rho = 3$. This value seems reasonable since the elasticity between private and public spending is much lower than the one between private taxable and non taxable consumption. We then use this parameterization and allow σ to vary between 0 and 4. We do so because even though the elasticity of substitution between private consumption and overall government spending seems to be close to unity, the elasticity across several categories of goods varies. We should expect σ to be close to zero in the case of pure public goods and relatively high in the case of private goods that could potentially be publicly provided.

Figure 1 (panel A) shows that an extra dollar of fiscal transfers increases government spending by a larger magnitude than an equivalent increase in citizen's income.[14] This version of the model also rationalizes the flypaper effect (panel B). More importantly, we find that the flypaper effect is more important for low levels of σ (i.e., when private and government spending is hardly substitutable) and becomes less relevant as σ increases (i.e., private and government spending become more substitutable). This occurs because the tax distortion (TD) and tax rate (θ) observed for low levels of σ are quite high and tend to decrease as σ increases (panels C and D). In other words, for low levels of σ, the fiscal authority needs to spend a relatively large amount because public spending is not easily substitutable for private one. To finance this spending, the FA sets a high tax rate and hence imposes a large tax distortion. As suggested by equation (15), tax rates are positively associated with the tax distortion. Under such circumstances, an increase in citizen's income by a dollar increases government spending by a smaller magnitude than an equivalent increase in fiscal transfers.

[13] Estimates for the informal economy range between 8 and 30 percent for OECD countries and 13 and 76 percent for developing countries.

[14] We would replicate the results obtained in section 2.1.2 if we assumed $\sigma = 1$, $\rho = 1$, $\phi = 1/3$ and $q = 1/2$.

While a fiscal transfer shock decreases the tax distortion, an income shock increases it (panel E). These last results also coincide with equations (16) and (17). As σ increases, private and government spending become more substitutable. The fiscal authority thus becomes more willing to allow most spending to be allocated to private consumption, which reduces the tax distortion. As a result, the flypaper effect is positively related to the tax rate (panel F).

In contrast to our benchmark model (section 2), this alternative model yields two key implications that we can take to the data. First, if the source of variation is the degree of substitutability between government and private spending, the size of the flypaper effect and the tax rates will be positively related. Second, the flypaper effect is larger when the degree of substitutability between private and government spending is lower.

4 Fiscal federalism in Argentina and Brazil

In order to test the two key implications of our theoretical model, we use data corresponding to Argentinean provinces and Brazilian states for the period 1963-2006 and 1985-2005, respectively. There are several detailed studies of the fiscal federalism arrangements in Argentina and Brazil.[15] Hence, we just provide a brief account and instead focus on characterizing two key features that are useful for our purposes; namely, the unconditional and exogenous (to public spending) nature of federal transfers to provinces/states.

Argentina and Brazil are both federal republics. Argentina is a federation of 23 provinces and an autonomous city, Buenos Aires. Brazil comprises 26 states and a federal district. The size of the government, measured by the ratio of government expenditure to GDP, averages 35 percent for Argentina and 45 percent for Brazil. Both countries have highly decentralized government spending. On average, Argentinean provinces and Brazilian states are responsible for about 40 percent of overall fiscal spending. On the other hand, tax collection is highly centralized at the federal level. This implies a particularly high vertical imbalance measured as the ratio of intergovernmental fiscal transfers to subnational expenditure, which averages 40 percent (column 1, Tables 1 and 2).

The cornerstone of Argentina's and Brazil's intergovernmental fiscal transfer system is a

[15] See for example, Núñez Miñana (1998), Gomez Sabaini and Gaggero (1997), Tommasi *et al* (2001), Porto (2004), and Vegh and Vuletin (2011) for Argentina, and Ter-Minassian (1997), Afonso and Mello (2000), and Sturzenegger and Werneck (2006) for Brazil.

tax-sharing arrangement whereby the federal government transfers to provinces/states some share of federal tax revenues. Indeed, this source of transfers represents (as a percentage of total federal transfers) about 70 percent for Argentinean provinces and more than 60 percent for Brazilian states.

While Argentina and Brazil differ in the specifics regarding the mechanisms of the intergovernmental fiscal transfers, both tax-sharing systems exhibit two key features that prove to be particularly useful for our study. First, they are mandated either by the constitution (Brazil) or by law (in Argentina), as opposed to being discretionary. In essence, these laws regulate how shared tax collection (which includes most domestic taxes, such as VAT and income taxes) is distributed between the central government and provinces/states (which is referred to as primary distribution) and how provincial/state funds are distributed among provinces/states (which is referred to as secondary distribution). These transfers are unconditional in the sense that, by constitution/law, provinces/states are entitled to them based on their mere existence. This is in sharp contrast to the American federal fiscal system which mainly relies on the federal government sharing with states the cost of some selected programs such as Medicaid, Food Stamp Program, State Children's Health Insurance Program expenditures, Temporary Assistance for Needy Families Contingency Funds, the Federal share of Child Support Enforcement collections, and Child Care Mandatory and Matching Funds of the Child Care and Development Fund.[16] By design, then, American federal transfers are conditional and endogenous to current state spending on those particular programs.

Second, Argentinean and Brazilian tax-sharing systems are characterized by institutional rigidity. The primary and secondary distributions rarely change. For example, the secondary distribution shares for Argentinean provincial governments have changed only four times since 1963 and changes have been minor (Table 3).[17] Indeed, the variability of within-province secondary distribution shares represents less than one percent of overall variability. Given the intrinsic unconditional and rigid nature of the Argentinean and Brazilian tax-sharing systems, fiscal transfers are, in essence, unconditional and exogenous (to public spending); a critical property assumed in our theoretical models of Sections 2 and 3.

[16] Medicaid alone represented around 45 percent of total federal transfers to states and local governments in 2008.

[17] Province's/state's historical secondary distribution shares reflect both contributions to the federal coffers as well as redistributive considerations.

In addition to collecting subnational output, total spending, and tax-sharing based fiscal transfers data, we also gathered government spending by main categories including police, fire, water, sewer and sanitation systems, housing and urban renewal, parks and recreation, health and hospitals, education, science and technology, public welfare and spending on economic services (Tables 1 and 2).[18] Moreover, we also constructed a novel dataset from primary sources which includes general gross receipt tax rates for the period 1963-2006 for 13 provinces.[19] A gross receipts tax, sometimes referred to as a gross excise tax, is a tax on the total gross revenues of a company, regardless of their source. It is similar to a sales tax, but it is levied on the seller of goods or services rather than on the consumer. General gross receipt tax revenues represents about half of provinces' own tax collection and is followed in importance by the legal documentation tax with less than 20 percent in terms of total tax collection. Moreover, unlike other provincial/state taxes that have several tax rates and fees, the general gross receipt tax rate has a single rate that makes it easier to assess the stance on taxation policy. This tax rate dataset is quite balanced covering more than 90 percent of potential observations.

5 Flypaper effect. Benchmark results

Tables 4 and 5 show the basic flypaper regressions for Argentinean provinces and Brazilian states, respectively. We consider the following specification:

$$g_{it} = \beta_0 + \beta_y y_{it} + \beta_f f_{it} + \sum_h \beta_h x_{it}^h + \varepsilon_{it},$$

where g, y and f represent government spending, output, and fiscal transfers, respectively, all expressed in real and per capita terms. The x are h additional socio-economic/geographical control variables typically included in this literature. Column 1 in tables 4 and 5 reports basic OLS regressions without controls and assuming that the residuals are homoscedastic and have no autocorrelation. In both countries, the marginal propensity to spend out of fiscal transfers is clearly larger than for local output; that is, there is a flypaper effect. The regressions

[18] Economic services refer to activities that support, develop, control and enhance economic activities in the agricultural, industry, energy, and mining sectors.

[19] The 13 provinces are Catamarca, Chaco, Chubut, Córdoba, Entre Ríos, Formosa, La Pampa, Misiones, Neuquén, Río Negro, Salta, Santa Fe, and Tierra del Fuego.

reported in Column 2 relax the assumption of homoscedasticity and independence within groups by calculating robust variances and allowing the presence of error autocorrelation within subnational units. It should come as no surprise that these modifications increase the standard errors, reducing the t-statistics. The statistical significance of the flypaper effect, however, remains strong.

Like other papers in the literature, columns 3, 4 and 5 include, respectively, several geographic, demographic and political economy control variables including terrain roughness, share of water bodies, population density, and pre-electoral periods.[20] The results for Argentina consistently show that provinces with higher terrain roughness and share of water bodies have higher government spending per capita. Arguably, these features increase the cost of providing public goods. Pre-electoral periods are associated with higher government spending in Argentina and Brazil. Since there might exist other unobservable factors that affect government spending, column 6 also controls for subnational units fixed effect. Even after controlling for all these factors, the flypaper effect remains as a strong empirical regularity in the two countries. With all these controls in place, the size of the flypaper effect is 1.276 and 1.017 for Argentinean provinces and Brazilian states, respectively. That is to say, for the case of Argentina, an extra \$1 in personal income increases public spending by \$0.088, while an equivalent increase in intergovernmental transfers triggers a rise in spending of \$1.364. For the case of Brazil, an extra \$1 in personal income increases public spending by \$0.002, while an equivalent increase in intergovernmental transfers triggers a rise in spending of \$1.018. Moreover, for both countries we cannot reject the null hypothesis that the flypaper effect is equal to 1.[21]

6 Flypaper effect and tax rates

A key theoretical implication of the model developed in Section 3 is that the flypaper effect is positively related to tax rates. In Table 6, we estimate panel fixed effect regressions like the ones estimated in column 6 of Tables 4 and 5 but breaking down the Argentinean sample according to whether tax rates are above or below the median. The flypaper is present in

[20] See Appendix 9.1 for details regarding definition and sources of variables.

[21] The p-values are 0.1746 for Argentinean provinces and 0.9412 for Brazilian states.

both samples. However, while the marginal propensity to spend out of transfers is about 17 times as large as the one out of income when tax rates are high (i.e., above the median), it is only about 9 times as high when tax rates are low (i.e., below the median). Such difference is statistically significant at the 1 percent level.[22]

7 Flypaper effect and degree of substitutability between private and government spending

Another key theoretical implication of the model developed in Section 3 is that the flypaper effect falls with the degree of substitutability between government and private spending. We test this implication by analyzing whether the flypaper effect is stronger (weaker) in government spending categories which are hardly (easily) substitutable for private spending. Government spending is hardly (easily) substitutable for private spending when such goods are public (private) goods (Bergstrom and Goodman, 1973; Reiter and Weichenrieder, 1999).

A pure public good is conventionally characterized by being non-rivalrous (i.e., the marginal cost of an additional person consuming it is zero) and non-excludable (i.e., the cost of excluding an individual from its benefits is prohibitively costly). Archetypal examples include national defense and lighthouses. Because of these properties, consumers should not be excluded from the good's consumption. Since private markets are expected to exclude consumers by charging a positive price to cover intramarginal costs, some kind of government intervention – often via public provision – is needed to avoid market failure and provide these goods at the socially optimal level.

While conceptually attractive, pure public goods are rare since most goods realistically present congestion effects. Since seminal work by Borcherding and Deacon (1972) and Bergstrom and Goodman (1973), many studies have estimated the degree of "publicness" of public goods by measuring the strength of congestion or crowding out characteristics of these goods. These studies assume that the usefulness of a public good to a given individual, Z^*, is determined by the function $Z^* = N^{-\gamma} Z$, where N is the population size, Z is the quantity of the public good and γ is the congestion parameter. If Z were a pure public good, then $\gamma = 0$. Progres-

[22] We can reject the null hypothesis that the size of the relative flypaper effect from the high tax rate sample (17 times) is the same as the one of the low tax rate sample (9 times) (p-value 0.0013).

sively larger values of γ reflect larger congestion or crowding out effects, with $\gamma = 1$ indicating "congestion" equivalent to a private good. Following Bergstrom and Goodman (1973) most studies estimate the following equation:

$$\ln G_{it}^{j} = \omega_0 + \omega_1 \ln Y_{it} + \omega_2 \ln N_{it} + \omega_3 \ln tax\ share_{it} + \sum_h \beta_h x_{it}^h + \varepsilon_{it}, \tag{20}$$

where G^j, Y, and N represent the level of government spending in category j, output, and population, respectively. The variable *tax share* aims at capturing the perceived price of the public spending. Strategies to measure this variable vary according to available information. For example, Bergstrom and Goodman (1973) measure the share of tax on real property which is paid by a citizen with the median income for his/her community, while McMillan *et al* (1981) proxy the tax share of the average household by dividing residential and farm taxes per household by total municipal tax revenue. The variables x^h represent h additional socio-economic control variables. Following Bergstrom and Goodman (1973), the congestion or crowding out parameter γ is then determined as[23]

$$\gamma = \frac{\omega_2}{1+\omega_3}, \tag{21}$$

where ω_2 and ω_3 are the estimated elasticities of expenditures in category j with respect to population and tax share, respectively. If the null hypothesis that $\gamma = 0$ cannot be rejected, the category of spending can be rationalized as a *pure public* good with no congestion or crowding out effects. In other words, if a government spending category G^j were a *pure public* good, then larger populations would not increase such spending (i.e., $\omega_2 = 0$). In contrast, if the null hypothesis that $\gamma \geqslant 1$ cannot be rejected, the good is *private* because the citizen receives at most "his/her aliquot share." If $1 > \gamma > 0$, we are in the presence of a public

[23]This footnote follows Bergstrom and Goodman (1973) in order to derive the congestion or crowding out parameter γ. Defining X_i as the quantity of private goods, an individual maximizes her utility function $u_i(X_i, Z^*)$ subject to the intertemporal constraint $X_i + tax\ share_i Z = Y_i$ which is equivalent to $X_i + tax\ share_i Z^* N^\gamma = Y_i$. Therefore, the determination of her demand function for Z^* is formally equivalent to finding an ordinary demand function where the price is $tax\ share_i N^\gamma$. Assuming that there are constant income and price elasticities ω_3 and ω_1 for the good Z^*, then the demand function for Z^* is $\omega_0 \left[taxshare_i N^\gamma\right]^{\omega_3} Y_i^{\omega_1}$. The quantity of Z demanded is N^γ times the quantity of Z^* demanded. Hence, her demand for Z is $N^\gamma \omega_0 \left[taxshare_i N^\gamma\right]^{\omega_3} Y_i^{\omega_1} = \omega_0 taxshare_i^{\omega_3} N^{\gamma(1+\omega_3)} Y_i^{\omega_1}$. Thus the coefficient, ω_2, for the elasticity of demand with respect to the population could be interpreted to be $\gamma(1+\omega_3)$. That is to say, $\omega_2 = \gamma(1+\omega_3)$ and, consequently, the congestion or crowding out parameter γ can be estimated as follows $\gamma = \omega_2 / (1+\omega_3)$.

good with important congestion or crowding out effects. Following Reiter and Weichenrieder (1999) such good can be defined as *impure public*.

The empirical findings regarding the degree of congestion captured in γ vary depending on several factors including, among others, the spending category, the level of government used (city, municipality, county, state) and the year analyzed, as most studies use cross-sectional data to calculate these estimates.[24] Typically, these studies lay out two key findings. First, not all publicly provided goods are pure public goods, since the degree of congestion varies widely. In some cases they find moderate levels of congestion, which suggests impure public goods. On other occasions, however, severe congestion effects exist, which implies a strong degree of "privateness." This striking finding – that many of the goods and services publicly provided do not have the usual "publicness" properties of collective goods – generated strong reactions. For example, Bergstrom and Goodman (1973) in their original study ask: "Why, if there are not increasing returns in the municipal provision of the goods and services we study, is their provision in the public domain?" A second frequent finding is that, in many categories, standard errors of γ are large enough to imply that neither $\gamma = 0$ nor $\gamma = 1$ can be rejected. Some papers rationalize this as evidence that those goods show important degree of congestion since it cannot be rejected that $\gamma = 1$. However, the fact that $\gamma = 0$ cannot be rejected either actually reveals that not much can be said about these goods. For this reason, we will classify them as *undetermined*.

Our strategy consists of two steps. First, following the standard methodology captured in equation (20) above, we empirically determine the degree of "publicness" of several important spending categories including fire, police, education, housing and urban renewal, health and hospitals, parks and recreation, public welfare, economic services, science and technology and water, sewer and sanitation systems.[25] The categories used represent about 60 percent and 50 percent of total spending in Argentinean provinces and Brazilian states, respectively. After classifying these spending categories into (i) pure public, (ii) impure public, (iii) private or (iv) undetermined, we test whether there is a positive relationship between the degree of "publicness" – which we take as a proxy for the degree of substitutability between private and

[24] Most papers analyze American subnational units; only McMillan *et al* (1981) study Ontario's municipalities for 1976. To the best of our knowledge, no equivalent studies exist for Argentinean provinces or Brazilian states.

[25] We do not include spending categories when data are considerably incomplete or when services offered are not final products (such as general and financial administration).

public goods – and the size of the flypaper effect. In other words, we test whether the size of the flypaper is larger for pure public good categories than for impure public or private goods.

7.1 "Publicness" of public spending

In order to classify a spending category, we estimate regression (20) and use equation (21) to test whether the good or service provided is pure public ($\gamma = 0$ and $\gamma < 1$), impure public ($\gamma > 0$ and $\gamma < 1$), private ($\gamma > 0$ and $\gamma \geqslant 1$) or undetermined ($\gamma = 0$ and $\gamma = 1$). We estimate these regressions using panel fixed effects and allowing errors to have heterocedasticity as well as autocorrelation. Allowing for a fixed effect per subnational unit is very important in this particular context in order to control for the very well known "zoo effect" introduced by Oates (1988). Oates argues that high levels of congestion, like the ones frequently found in the literature, may not reflect congestion or crowding out effects but rather the fact that some type of goods and services are provided only when population reaches certain high levels (e.g., expenditure on a zoo). By including fixed effects per subnational unit, we reduce such bias as the population elasticity coefficient is estimated exploiting only the population variation within each subnational unit. Including fixed effects also partially controls for preferences for public spending, as long as they remain constant over time. In this sense, fixed effects act as an imperfect substitute for socio-economic control variables typically included in regression (20). As discussed in great detail in Bergstrom and Goodman (1973) measuring the tax share variable presents some conceptual and practical difficulties. We measure *tax share* of the average individual dividing the most important tax collection category revenue per individual by total subnational unit tax revenue. The most important tax collection category is gross receipt tax for Argentinean provinces and state value-added tax for Brazilian states.

Tables 7 and 8 show our findings for Argentinean provinces and Brazilian states, respectively, including population density as control variable. Table 7 shows that total public spending in Argentinean provinces is an impure public good with a congestion parameter of 0.499. Police as well as housing and urban renewal are pure public goods, while public welfare and education are private goods. The degree of "publicness" of water and sewer systems, science and technology, and economic services cannot be determined. Table 8 does not show precise results regarding the degree of congestion of total expenditure for Brazilian states. Economic services are found to be a pure public good, while police, public welfare, and education are private goods. Housing and urban renewal as well as spending in health and hospitals show big standard errors which does not allow us to classify them as either public or private goods. It is not surprising that both public welfare as well as education are found to be private goods. As discussed by Stiglitz (1974) in the context of education "there seems to be little question that the marginal cost of educating an additional individual is substantial (probably close to the average cost, at least for large school systems)."

7.2 Size of flypaper effect as a function of the substitutability between public and private spending

As discussed in section 7, high (low) levels of "publicness" are expected to be associated with low (high) levels of substitutability between public and private spending. In other words, in the case of pure public goods, private spending can be hardly rationalized as a substitute for government spending. On the contrary, in the case of private goods, private spending could act as a substitute for government spending. Considering the theoretical model described in Section 3, we should expect to find that the size of the flypaper effect is bigger for spending categories that involve pure public goods than for those associated with private goods.

Tables 9 and 10 show the results for panel fixed effect regressions like the ones estimated in tables 4 and 5, column 6 for different categories of government spending. The results obtained are fully consistent with the theoretical implications. In particular, pure and impure public good categories imply the existence of a flypaper effect at the 1 percent level. In contrast, public spending categories associated with private goods do not show the flypaper effect; in all cases we cannot reject that the marginal propensity to spend out of own subnational income equals the one from fiscal transfers. Since each spending category represents only a proportion of total spending, we should expect that the absolute size of the flypaper effect, defined as the difference between β_f and β_y, is bigger for total expenditure than for individual categories. For this reason, we define the concept of relative size of flypaper effect as the percentage difference between β_f and β_y. This measure provides for more accurate comparisons between spending categories that represent different proportions of total spending (tables 1 and 2). For example, for Argentinean provinces, the marginal propensity to spend out of fiscal transfers is about 9 times as high as the one from own subnational income (Table 9). However, such relative size of the flypaper effect increases to about 23 and 147 times for police and housing and urban renewal, both pure public goods that are hardly substitutable for private spending. On the other hand, the flypaper effect vanishes for private goods that are more easily substitutable for private spending such as public welfare and education. Table 10 shows similar results for Brazilian states. While the marginal propensity to spend out of fiscal transfers is about 43 times as large as the one from own subnational income for economic services (pure public good), these differences vanish for police, public welfare and education (private goods).

In conclusion, there is robust evidence across these two major federations that the magnitude of the flypaper effect is consistently large for government spending categories that are hardly substitutable for private spending and vanishes when those goods are more easily substitutable for private spending.

8 Conclusions

This paper has shown that the flypaper effect is essentially consistent with a simple model of optimal taxation, in which raising own local revenues is socially costly because of the need to resort to distortionary taxation (Hamilton, 1986; Aragón, 2009; Dalhby, 2011). In this context, it is more efficient, from the point of view of the local fiscal authority, to spend more out of intergovernmental transfers (which is distortion-free money) than from private income (which can only be spent after securing it through distortionary taxation).

More fundamentally, our model generates two key empirical implications. First, there should be a positive association between the size of the flypaper effect and the level of the tax rate. Second, the lower (higher) the elasticity of substitution between private and public spending, the higher (lower) the flypaper effect. We test these two implications using data for Argentinean provinces and Brazilian states.

The two predictions of the model are borne out by the data. The size of the flypaper effect is high when tax rates are relatively high and significantly weakens as tax rates fall. We also find that the flypaper effect decreases with the degree of substitutability between private and public spending by using different government spending categories associated with different degree of "publicness." For Argentina, for instance, we find that the marginal propensity to spend out of fiscal transfers in spending categories such as police and housing/urban renewal – which are identified as pure public goods – is much larger than the propensity to spend out of private income. In contrast, such difference in propensities to spend vanishes for spending categories such as education and public welfare, which are identified as private goods.

References

[1] Amano, R. and T., Wirjanto, 1997, "Intratemporal Substitution and Government Spending," *The Review of Economics and Statistics*, Vol. 79 (November), 605-609.

[2] Aragón, F., 2009, "The Flypaper Effect and Costly Tax Collection," mimeo (London School of Economics).

[3] Auteri, M. and M. Costantini, 2010, "A Panel Cointegration Approach to Estimating Substitution Elasticities in Consumption", *Economic Modelling*, Vol. 27 (May), 782-787.

[4] Bailey, S. and S. Connolly, 1998,"The Flypaper Effect: Identifying Areas for Further Research," *Public Choice*, Vol. 95, 335-361.

[5] Becker, G. and C. Mulligan, 2003, "Deadweight Costs and the Size of Government," *Journal of Law and Economics*, Vol. 46, 293-340.

[6] Bergstrom, T. and R., Goodman, 1973, "Private Demand for Public Goods," *American Economic Review*, Vol. 63 (June), 280-296.

[7] Bowman, J., 1974, "Tax Exportability, Inter-governmental Aid, and School Finance Reform," *National Tax Journal*, Vol. 27 (June), 163-73.

[8] Borcherding, T. and R., Deacon, 1972, "The Demand for Services of Non-Federal Governments," *American Economic Review*, Vol. 62 (December), 891-901.

[9] Bruackner, J., 1981, "Congested Public Goods: The Case of Fire Protection," *Journal of Public Economics*, Vol. 15 (February), 45-58.

[10] Chernick, H., 1979, "An Economic Model of the Distribution of Project Grants," in P. Mieszkowski and W. Oakland (eds.) *Fiscal Federalism and Grants-in-Aid*, Washington, D.C.: Urban Institute Press, 81-103.

[11] Chiu, R., 2001, "The Intratemporal Substitution between Government Spending and Private Consumption: Empirical Evidence from Taiwan", *Asian Economic Journal*, Vol. 15 (September), 313-323.

[12] Courant, P., E. Gramlich, and D. Rubinfeld, 1979, "The Stimulative Effects of Intergovernmental Grants: or Why Money Sticks Where It Hits," in P. Mieszkowski and W. Oakland (eds.) *Fiscal Federalism and Grants-in-Aid*, Washington, D.C.: Urban Institute Press, 5-21.

[13] Craig, S., 1987, "The Impact of Congestion on Local Public Good Production," *Journal of Public Economics*, Vol. 32 (April), 331-353.

[14] Dahlby, B., 2011, "The Marginal Cost of Public Funds and the Flypaper Effect," *International Tax and Public Finance*, Vol. 18 (June), 304-321.

[15] Dollery, B. and A. Worthington, 1996, "The Empirical Analysis of Fiscal Illusion," *Journal of Economic Surveys*, Vol. 10, 261-297.

[16] Filimon, R., T., Romer and H., Rosenthal, 1982, "Asymmetric Information and Agenda Control," *Journal of Public Economics*, Vol. 17 (February), 51-70.

[17] Gamkhar, S. and A. Shah, 2007, "The Impact of Intergovernmental Transfers: A Synthesis of the Conceptual and Empirical Literature," in R. Boadway and A. Shah (eds.) *Intergovernmental Fiscal Transfers: Principles and Practice*, Washington D.C.: The World Bank.

[18] Gramlich, E., 1969, "State and Local Governments and their Budget Constraint," *International Economic Review*, Vol. 10 (June), 163-182.

[19] Gramlich, E., and H., Galper, 1973, "State and Local Fiscal Behavior and Federal Grant Policy," *Brookings Papers on Economic Activity*, Vol. 1, 15-58.

[20] Hamilton, B., 1983, "The Flypaper Effect and Other Anomalies," *Journal of Public Economics*, Vol. 22 (December), 347-362.

[21] Hamilton, J., 1986, "The Flypaper Effect and the Deadweight Loss from Taxation," *Journal of Urban Economics*, Vol. 19 (March), 148-155.

[22] Henderson, J., 1968, "Local Government Expenditures: A Social Welfare Analysis," *Review of Economics and Statistics*, Vol. 50 (May), 156-163.

[23] Hines, J. and R., Thaler, 1995, "Anomalies: The Flypaper Effect," *Journal of Economic Perspectives*, Vol. 9 (Fall), 217-226.

[24] Inman, R., 1971, "Towards an Econometric Model of Local Budgeting," In *Proceedings of the 64th Annual Conference on Taxation*. National Tax Association, 699-719.

[25] Inman, R., 2008, "The Flypaper Effect," NBER Working Paper No. 14579.

[26] Knight, B., 2002, "Endogenous Federal Grants and Crowd-Out of State Government Spending: Theory and Evidence form the Federal Highway Aid Program," *American Economic Review*, Vol. 92 (March), 71-92.

[27] McMillan, M., W., Wilson and L., Arthur, 1981, "The Publicness of Local Public Goods: Evidence from Ontario Municipalities", *Canadian Journal of Economics*, Vol. 14 (November), 596-608.

[28] Oates, W., 1979, "Lump-sum Intergovernmental Grants Have Price Effects," in Peter Mieszkowski and William Oakland (eds.) *Fiscal Federalism and Grants-in-Aid*, Washington, D.C.: Urban Institute Press, 23-30.

[29] Oates, W., 1988, "On the Measurement of Congestion in the Provision of Local Public Goods," *Journal of Urban Economics*, Vol. 24 (July), 85-94.

[30] Oates, W., 1999, "An Essay in Fiscal Federalism," *Journal of Economic Literature*, Vol. 37, 1120-1149.

[31] Okubo, M., 2003, "Intratemporal Substitution Between Private and Government Consumption: the Case of Japan", *Economics Letters*, Vol. 79 (April), 75-81.

[32] Reiter, M. and A., Weichenrieder, 1999, "Public Goods, Club Goods, and the Measurement of Crowding," *Journal of Urban Economics*, Vol. 46 (July), 69-79.

[33] Roemer, J. and J. Silvestre, 2002, "The 'Flypaper Effect' Is Not An Anomaly," *Journal of Public Economic Theory*, Vol. 4, 1-17.

[34] Schneider, F. and D., Enste, 2000, "Shadow Economies: Size, Causes, and Consequences", *Journal of Economic Literature*, Vol. 38 (March), 77-114.

[35] Slemrod, J. and N., Sorum, 1984, "The Compliance Cost of the U.S. Individual Income Tax System," *National Tax Journal*, Vol. 37 (December), 461-474.

[36] Slemrod, J. and S., Yitzhaki, 2002, "Tax Avoidance, Evasion and Administration," in Alan J. Auerbach and Martin S. Feldstein (eds.) *Handbook of Public Economics*, Amsterdam, London: North Holland, 1423-1470.

[37] Stiglitz, J., 1974, "The Demand for Education in Public and Private School Systems," *Journal of Public Economics*, Vol. 3 (November), 349-385.

[38] Volden, C., 2007, "Intergovernmental Grants: A Formal Model of Interrelated National and Subnational Political Decisions," *Publius*, Vol. 37, 209-243.

[39] Vuletin, G., 2009, "Measuring the Informal Economy in Latin America and the Caribbean," *Money Affairs*, Vol. 21 (January), 161-191.

9 Appendices

9.1 Appendix of data

9.1.1 Geographic and demographic data

Terrain roughness equals (surface area/planar area)*100 − 100. The original dataset used to compute both planar and surface areas was provided by the Environmental Systems Research Institute (ESRI). It consists of the Global Digital Elevation Model acquired from the NASA/NGA Shuttle Radar Topography Mission (SRTM). The resolution is 3 arc seconds (or approximately 90 meters). The planar area (area as seen from above the earth surface) was computed from the aforementioned SRTM dataset. A "true" surface area (i.e., one where the surfaces along the slopes are accounted for) was calculated from the SRTM dataset by first computing the slope for each pixel, then multiplying the secant (reciprocal of the cosine) of the slope and multiplying this value by the planar area.

Water bodies represent the percentage of surface area covered with water bodies. The data are also from the Environmental Systems Research Institute (ESRI).

Population density is calculated as population/planar area.

9.1.2 Argentinean provinces

Original sources and definition of variables

Total expenditure and tax-sharing based fiscal transfers from federal government data for the period 1963-2000 is from Porto (2004) and from Dirección Nacional de Coordinación con las Provincias (Ministry of Economy, Argentina) for the period 2001-2006. Argentinean provinces do not receive intergovernmental transfers from municipalities.

Spending categories (police, housing and urban renewal, water and sewer systems, public welfare, education, science and technology and economic services) for the period 1991-2004 is from Dirección Nacional de Coordinación con las Provincias (Ministry of Economy, Argentina).

Gross subnational product data for the period 1963-2000 is from Porto (2004) and from Ministry of Economy, Argentina for the period 2001-2006.

CPI data are from IMF/WEO.

Population data for the period 1963-2000 is from Porto (2004) and from Instituto Nacional de Estadística y Censos (Ministry of Economy, Argentina) for the period 2001-2006.

Gross receipt tax rates data are from the following sources: Catamarca (Dirección de Información Parlamentaria, Cámara de Diputados de la Provincia de Catamarca), Chaco (Dirección de Información Parlamentaria, Legislatura de la Provincia del Chaco), Chubut (Biblioteca e Información Parlamentaria, Legislatura de la Provincia del Chubut), Córdoba (Dirección de Informática Jurídica, Fiscalía de Estado de la Provincia de Córdoba), Entre Ríos (Biblioteca del Consejo Profesional de Ciencias Económicas de Entre Ríos), Formosa (Legislatura de la Provincia de Formosa), La Pampa (Departamento Digesto, Informática Jurídica y Asesoramiento Parlamentario, Legislatura de la Provincia de La Pampa), Misiones (Dirección General de Coordinación Legislativa, Camara de Diputados de la Provincia de Misiones), Neuquén (Departamento de Información Parlamentaria, Legislatura de la Provincia de Neuquén), Río Negro (Informática Jurídica, Legislatura de la Provincia de Río Negro), Salta (Dirección General de Rentas, Provincia de Salta), Santa Fe (Camara Diputados de la Provincia de Santa Fe), Tierra del Fuego (Legislatura de Tierra del Fuego, Antártida e Islas del Atlántico Sur).

Elections is a dummy variable that equals one the previous and current year of governor election. Electoral data are from Andy Tow' Atlas Electoral and historical newspapers articles.

Online Sources

Porto, Alberto, 2004. Disparidades Regionales y Federalismo Fiscal. EDULP, Argentina. http://www.depeco.econo.unlp.edu.ar

Dirección Nacional de Coordinación con las Provincias (Ministry of Economy, Argentina). http://www.mecon.gov.ar/hacienda/dncfp/index.html

Instituto Nacional de Estadística y Censos (Ministry of Economy, Argentina). http://www.indec.mecon.ar

Tow, Andy, 2003. Atlas de elecciones en Argentina. http://towsa.com/andy

9.1.3 Brazilian states

Original sources and definition of variables

Total expenditure, fiscal transfers from federal government, spending categories (police, housing and urban renewal, health and hospitals, public welfare, education and economic services), population and gross subnational product and its deflator for the period 1985-2005 is from Institute of Applied Economical Research (Ministry of Strategic Issues, Brazil).

Elections is a dummy variable that equals one the previous and current year of governor election. Electoral data are from Institute of Applied Economical Research (Ministry of Strategic Issues, Brazil).

Online Sources

Institute of Applied Economical Research (Ministry of Strategic Issues, Brazil).
http://www.ipeadata.gov.br

9.2 Appendix of proofs

9.2.1 Proof 1. Benchmark model. Non-distortionary taxation

The PA chooses c^T and c^{NT} in order to maximize (3) subject to (1), taking as given g and τ. The first order conditions are given by

$$\frac{1}{c^T} = \lambda_{PA}, \tag{22}$$

$$\frac{1}{c^{NT}} = \lambda_{PA}, \tag{23}$$

$$y = c^T + c^{NT} + \tau, \tag{24}$$

where λ_{PA} is the Lagrange multiplier associated with the PA's budget constraint (1). First-order conditions (22) and (23) imply that $c^T = c^{NT}$.

The Ramsey planner chooses g, c^T, and c^{NT} subject to (4), (6), and $\tau = y - c^T - c^{NT}$.[26] Naturally, we do not need to impose the condition $c^T = c^{NT}$ because the Ramsey solution will satisfy it anyway. The first order conditions are given by

$$\frac{1}{c^T} = \lambda_E + \lambda_{FA}, \tag{25}$$

$$\frac{1}{c^{NT}} = \lambda_E + \lambda_{FA}, \tag{26}$$

$$\frac{1}{g} = \lambda_E + \lambda_{FA}, \tag{27}$$

$$y = c^T + c^{NT} + g - f, \tag{28}$$

$$g = f + \tau, \tag{29}$$

where λ_E and λ_{FA} denote the Lagrange multipliers associated with the economy's and FA's

[26] As remarked earlier, solving the Ramsey planner's problem with lump-sum taxes is, of course, equivalent to solving the social planner's problem.

constraints, respectively. Combining (25)-(29) we obtain the following analytical solutions

$$c^T = c^{NT} = \frac{1}{3}(y+f), \tag{30}$$

$$g = \frac{1}{3}(y+f), \tag{31}$$

$$\theta_{\text{implicit}} \equiv \frac{\tau}{c^T} = 1 - \frac{3}{1+\frac{y}{f}}. \tag{32}$$

From (30) and (31), it follows that

$$\frac{1}{3} = \frac{dg}{df} = \frac{dg}{dy} = \frac{1}{3}, \tag{33}$$

$$\frac{1}{3} = \frac{dc^T}{df} = \frac{dc^{NT}}{df} = \frac{dc^T}{dy} = \frac{dc^{NT}}{dy} = \frac{1}{3}. \tag{34}$$

Using (7) and (33) we obtain that

$$FP = 0.$$

9.2.2 Proof 2. Benchmark model. Distortionary taxation

The PA chooses c^T and c^{NT} in order to maximize (3) subject to (2) taking as given g and θ. The first order conditions are given by

$$\frac{1}{c^T} = \lambda_{PA}(1+\theta), \tag{35}$$

$$\frac{1}{c^{NT}} = \lambda_{PA}, \tag{36}$$

$$y = c^T(1+\theta) + c^{NT}, \tag{37}$$

where λ_{PA} is the Lagrange multiplier associated with the PA's budget constraint (2). The implementability condition that follows from (35) and (36) is $\theta = c^{NT}/c^T - 1$.

The Ramsey's planner chooses g, c^T, and c^{NT} subject to (5), (6), and $\theta = c^{NT}/c^T - 1$. The first order conditions are given by

$$\frac{1}{c^T} = \lambda_E + \lambda_{FA}, \tag{38}$$

$$\frac{1}{c^{NT}} = \lambda_E - \lambda_{FA}, \tag{39}$$

$$\frac{1}{g} = \lambda_E + \lambda_{FA}, \tag{40}$$

$$y = c^T + c^{NT} + g - f, \tag{41}$$

$$g = f + \theta c^T, \tag{42}$$

where λ_E and λ_{FA} denote the Lagrange multipliers associated with the economy's and FA's constraints, respectively. Combining (38)-(42), we obtain the following analytical solutions:

$$c^T = \frac{y+2f}{4}, \tag{43}$$
$$c^{NT} = \frac{y}{2}, \tag{44}$$
$$g = \frac{y+2f}{4}. \tag{45}$$

Moreover, using $\theta = c^{NT}/c^T - 1$, (43), and (44), we also obtain

$$\theta = \frac{y-2f}{y+2f}. \tag{46}$$

From (43)-(45), it follows that

$$\frac{1}{2} = \frac{dg}{df} > \frac{dg}{dy} = \frac{1}{4}, \tag{47}$$
$$\frac{1}{2} = \frac{dc^T}{df} = \frac{dc^{NT}}{dy} > \frac{1}{4} = \frac{dc^T}{dy} > \frac{dc^{NT}}{df} = 0. \tag{48}$$

Using (7) and (47), we obtain

$$FP = \frac{1}{4}.$$

Using (8), (43), (44), and (46), we obtain

$$TD = \frac{y-2f}{y+2f} = \theta. \tag{49}$$

From (49), it follows that

$$\frac{dTD}{df} = \frac{d\theta}{df} = -\frac{4y}{(y+2f)^2} < 0,$$
$$\frac{dTD}{dy} = \frac{d\theta}{dy} = \frac{4f}{(y+2f)^2} > 0.$$

9.2.3 Proof 3. General model. The role of ρ

The PA maximizes (18) subject to (2) taking as given g and θ. The first order conditions are given by

$$\frac{\partial U}{\partial z}\frac{\partial z}{\partial c^T} = \lambda_{PA}(1+\theta), \tag{50}$$
$$\frac{\partial U}{\partial z}\frac{\partial z}{\partial c^{NT}} = \lambda_{PA}, \tag{51}$$
$$y = c^T(1+\theta) - c^{NT}, \tag{52}$$

where λ_{PA} is the Lagrange multiplier associated with the PA's budget constraint (2). Combining (50) and (51), we obtain

$$\frac{q}{(1-q)}\left(\frac{c^{NT}}{c^{T}}\right)^{\frac{1}{\rho}}=1+\theta. \tag{53}$$

Totally differentiating and rearranging terms, we obtain

$$\rho=\frac{d\left(\frac{c^{NT}}{c^{T}}\right)/\left(\frac{c^{NT}}{c^{T}}\right)}{d\left(1+\theta\right)/\left(1+\theta\right)}.$$

9.2.4 Proof 4. General model. Distortionary taxation

The PA chooses c^T and c^{NT} in order to maximize (18) subject to (2), taking as given g and θ. The first order conditions are given by

$$r_1 \equiv \frac{\partial U}{\partial z}\frac{\partial z}{\partial c^{T}}-\left(1+\theta\right)\lambda_{PA}=0, \tag{54}$$

$$r_2 \equiv \frac{\partial U}{\partial z}\frac{\partial z}{\partial c^{NT}}-\lambda_{PA}=0, \tag{55}$$

$$r_3 \equiv y-c^{T}\left(1+\theta\right)-c^{NT}=0, \tag{56}$$

where λ_{PA} is the Lagrange multiplier associated with the PA's budget constraint (2).

We formulate the Ramsey planner's problem in very general terms. Specifically, the Ramsey planner chooses g, c^T and c^{NT} to maximize the PA's utility, given by (18), subject to the implementability conditions derived from the PA's maximization problem (equations (54)-(56)) and the FA's constraint (5). Therefore, the Lagrangean for the Ramsey problem can be formulated as

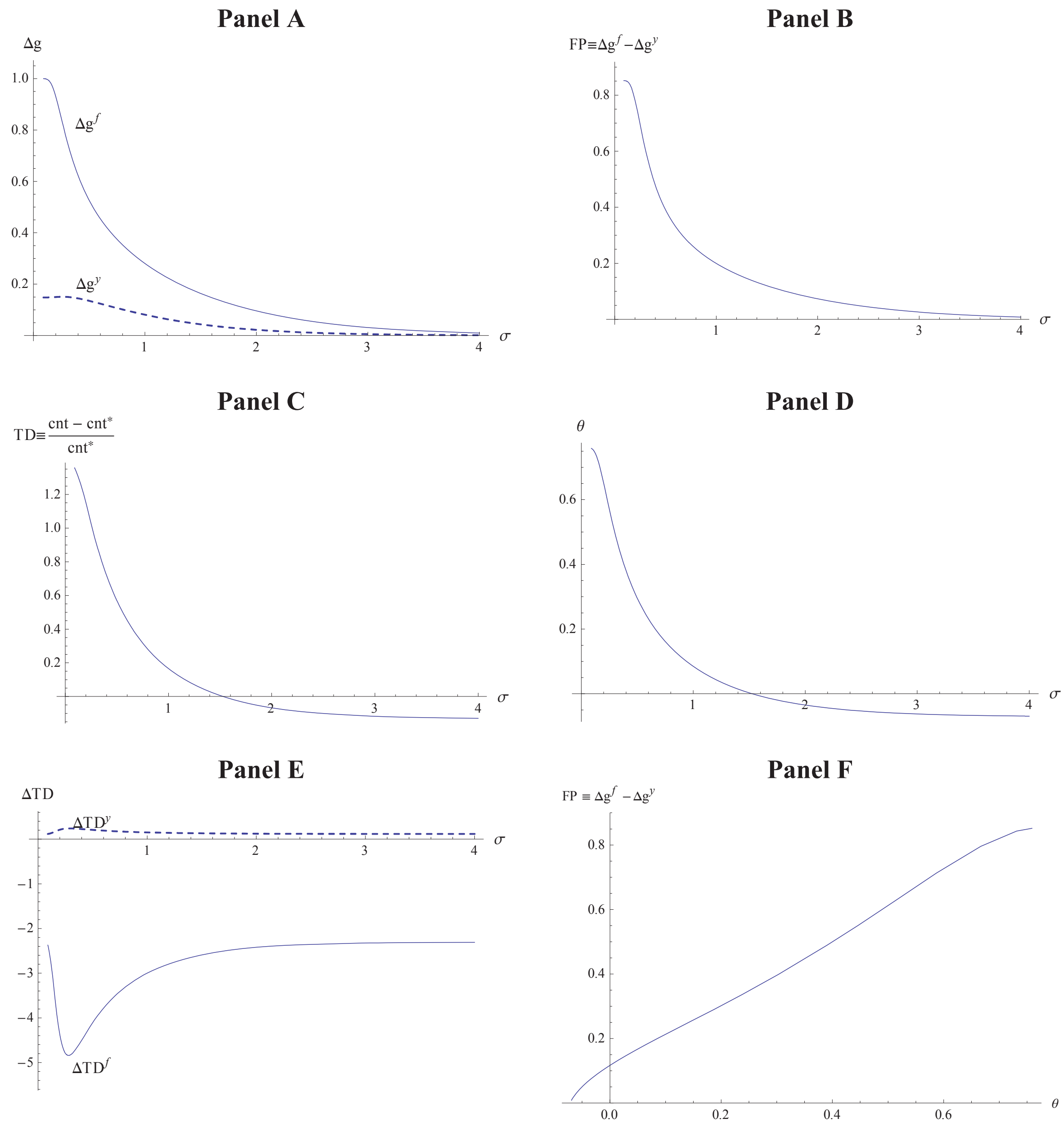
$$\mathcal{L}=U+\lambda_1 r_1+\lambda_2 r_2+\lambda_3 r_3+\lambda_4 r_4,$$

where $r_4 \equiv f+\theta c^T-g$. The first order conditions are given by the following 9 equations:

$$\frac{\partial \mathcal{L}}{\partial x}=0, \qquad x=c^{T},\, c^{NT},\, g,\, \theta,\, \lambda_{PA},\, \lambda_1,\, \lambda_2,\, \lambda_3,\, \lambda_4.$$

We solved this system of nine non-linear equations using Mathematica.

Figure 1. General model with distortionary taxation: Numerical solution.



Notes: Δg^f and Δg^y stand for change in government spending as a result of a dollar increase in fiscal transfers and citizen's income, respectively. ΔTD^f and ΔTD^y stand for change in tax distortion (TD) as a result of a dollar increase in fiscal transfers and citizen's income, respectively. σ is the elasticity of substitution between government and private spending. θ is the consumption tax rate. cnt is consumption not subject to taxation in a distortionary taxation model and cnt* represents consumption not subject to taxation in a non-distortionary taxation model.

Table 1. Fiscal transfers and government spending composition for Argentinean provinces.

	Fiscal transfers (as % of expenditures)	Government spending composition (as % of expenditures)						
		Police	Housing and urban renewal	Public welfare	Education	Water and sewer systems	Science and technology	Economic services
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Buenos Aires	28.6	11.2	2.1	4.8	31.6	1.1	0.13	6.6
Catamarca	48.5	7.1	4.6	7.2	26.1	3.1	0.11	10.3
Chaco	47.7	7.5	5.8	3.5	27.2	0.2	0.08	10.3
Chubut	29.3	8.7	7.1	2.5	24.4	0.8		16.4
Córdoba	33.3	9.9	2.4	5.8	28.3	0.6	0.23	5.3
Corrientes	48.2	9.7	8.8	3.3	28.5	0.4	0.01	7.1
Entre Ríos	40.8	8.9	3.3	3.8	27.0	0.7	0.03	11.0
Formosa	47.7	7.4	6.0	3.8	21.4	1.3	0.01	13.2
Jujuy	41.6	7.1	4.5	2.7	25.3	1.6		16.3
La Pampa	38.6	6.1	5.6	3.2	22.6	5.1	0.03	20.0
La Rioja	38.9	7.1	4.7	5.1	20.8	2.1	0.01	11.2
Mendoza	32.7	8.5	3.5	3.7	26.9	0.4	0.23	13.4
Misiones	47.5	6.9	6.5	2.5	24.4	2.4	0.02	19.2
Neuquén	24.0	7.5	4.4	5.0	25.3	2.5	0.02	16.7
Río Negro	33.1	8.1	5.7	4.3	25.8	2.0	0.06	9.0
Salta	41.8	8.5	4.6	4.1	22.9	1.6	0.29	12.4
San Juan	42.9	6.9	5.2	5.2	23.9	0.1	0.17	12.6
San Luis	46.2	6.2	10.1	5.1	26.3	0.4	0.14	18.3
Santa Cruz	25.0	7.7	6.1	2.2	21.2	0.7	0.03	22.6
Santa Fe	34.3	10.4	2.4	4.8	31.6	0.4	0.04	6.7
Santiago del Estero	50.7	9.4	6.8	1.3	28.1	1.7		10.2
Tierra del Fuego	19.1	7.6	9.2	6.4	21.2	0.8	0.27	9.5
Tucumán	41.7	7.5	4.1	3.5	25.8	0.6	0.40	8.1
Average	38.4	8.1	5.4	4.1	25.5	1.3	0.12	12.5
Min	19.1	6.1	2.1	1.3	20.8	0.1	0.01	5.3
Max	50.7	11.2	10.1	7.2	31.6	5.1	0.40	22.6

Notes: Size of government as well as relevance of fiscal transfers is calculated using data for the period 1963-2006. Government spending categories use data for the period 1991-2004. GSP stands for gross subnational product, in this case gross provincial product.

Table 2. Fiscal transfers and government spending composition for Brazilian states.

	Fiscal transfers (as % of expenditures)	Government spending composition (as % of expenditures)					
		Economic services	Police	Public welfare	Education	Housing and urban renewal	Health and hospitals
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Acre	77.5	5.0	6.3	4.4	20.3	1.29	14.2
Alagoas	47.8	3.3	9.4	9.4	17.2	1.44	10.6
Amapá	89.7	3.4	3.2	2.8	17.3	2.25	11.6
Amazonas	27.1	6.5	5.5	7.5	16.6	2.30	14.6
Bahia	26.6	6.5	6.8	9.0	16.6	1.73	13.4
Ceará	32.9	8.2	4.6	12.6	17.0	1.53	8.5
Espírito Santo	18.2	2.6	7.3	11.9	13.4	0.51	10.4
Goiás	17.5	2.2	6.6	13.1	15.5	0.50	6.6
Maranhão	62.0	4.3	4.9	8.3	18.9	1.26	6.9
Mato Grosso	22.5	3.9	5.9	7.3	15.0	0.82	6.1
Mato Grosso do Sul	19.4	3.0	7.4	7.5	16.1	0.26	5.1
Minas Gerais	15.9	3.4	8.1	9.4	17.6	0.38	7.5
Paraná	16.1	7.1	6.2	15.3	20.9	1.55	5.8
Paraíba	46.0	6.2	5.2	14.7	19.2	1.11	7.3
Pará	46.0	4.0	7.3	9.4	20.1	1.23	11.8
Pernambuco	31.2	6.5	9.1	14.5	13.6	1.89	9.3
Piauí	57.6	4.8	7.7	7.5	21.8	0.18	10.6
Rio Grande do Norte	45.8	7.0	5.2	7.2	19.9	0.60	13.2
Rio Grande do Sul	12.0	3.6	6.8	17.6	14.7	0.35	3.9
Rio de Janeiro	11.8	1.6	9.7	12.4	16.3	0.94	8.3
Rondônia	49.6	5.1	10.6	2.1	19.0	0.23	9.6
Roraima	81.5	8.9	3.1	3.0	16.4	2.85	10.6
Santa Catarina	14.8	6.5	7.7	11.2	16.6	0.41	7.1
Sergipe	47.7	6.4	5.6	8.9	17.0	2.46	12.1
São Paulo	7.4	2.7	6.8	11.1	17.8	1.14	9.5
Tocantins	62.6	3.5	5.2	4.0	17.6	6.21	10.2
Average	38.0	4.9	6.6	9.3	17.4	1.36	9.4
Min	7.4	1.6	3.1	2.1	13.4	0.18	3.9
Max	89.7	8.9	10.6	17.6	21.8	6.21	14.6

Notes: The data used correspond to the period 1985-2005. GSP stands for gross subnational product, in this case gross state product.

Table 3. Evolution of secondary distribution shares for provincial governments according to different Argentinean laws. 1963-2006

	1963-1972	1973-1980	1981-1984	1988-1991	1992-2006
Buenos Aires	29.7	28	28.3	21.9	24.8
Catamarca	2.1	1.9	1.9	2.7	2.6
Chaco	3.4	4.1	4	5	4.3
Chubut	1.9	1.9	1.9	1.6	1.9
Cordoba	8.6	8.9	9	8.8	8.1
Corrientes	3.5	3.8	3.6	3.7	3.5
Entre Rios	4.4	4.6	4.1	4.9	4.6
Formosa	1.8	2.3	2.3	3.6	3.3
Jujuy	2.3	2.2	2.2	2.8	2.8
La Pampa	2	1.8	1.7	1.9	1.9
La Rioja	1.7	1.7	1.7	2.1	2
Mendoza	5.5	4.7	4.8	4.1	4.1
Misiones	2.7	3	2.9	3.3	3.3
Neuquén	1.7	1.7	1.9	1.7	2
Rio Negro	2.2	2.3	2.5	2.5	2.5
Salta	3	3.5	3.8	3.8	3.7
San Juan	2.9	2.6	2.5	3.4	3.2
San Luis	1.8	1.7	1.7	2.3	2.2
Santa Cruz	1.8	1.4	1.6	1.6	1.7
Santa Fe	9.6	9.1	8.6	8.8	8.1
Santiago del Estero	2.8	4	4	4.1	3.8
Tierra del Fuego	0.3	0.3	0.3	0.7	1.1
Tucuman	4.3	4.4	4.7	4.7	4.5
Total	100	100	100	100	100

Source: Porto (2004) and several Argentinean laws.

Table 4. Basic flypaper regressions. Argentinean provinces.

Dependent variable	*Total exp. per capita* (1)	*Total exp. per capita* (2)	*Total exp. per capita* (3)	*Total exp. per capita* (4)	*Total exp. per capita* (5)	*Total exp. per capita* (6)
y	0.099***	0.099***	0.087***	0.086***	0.085***	0.088***
	[40.361]	[8.828]	[5.583]	[5.513]	[5.436]	[6.947]
f	1.961***	1.961***	1.895***	1.853***	1.796***	1.364***
	[33.873]	[10.364]	[9.554]	[9.138]	[8.968]	[6.770]
terrain roughness			46.067**	46.244**	47.127**	
			[2.200]	[2.307]	[2.335]	
water bodies			14.839*	15.028*	15.651*	
			[1.979]	[1.990]	[2.070]	
pop. density				-1.070*	-1.295**	5.415**
				[-1.729]	[-2.236]	[2.190]
governor pre-electoral period					89.227***	100.182***
					[3.345]	[3.155]
Flypaper effect						
test: $\beta_f = \beta_y$ (p-value)	0	0	0	0	0	0
absolute size = $\beta_f - \beta_y$	1.862	1.862	1.808	1.767	1.711	1.276
relative size = $(\beta_f - \beta_y)/\beta_y$	19	19	21	21	20	15
Statistics						
Econometric methodology	OLS	OLS	OLS	OLS	OLS	FE
Standard errors	standard	robust - cluster	robust - cluster	robust - cluster	robust - cluster	robust - cluster
Observations	1012	1012	1012	1012	1012	1012
Provinces	23	23	23	23	23	23
Period	1963-2006	1963-2006	1963-2006	1963-2006	1963-2006	1963-2006
Av. number of obs. per province	44	44	44	44	44	44
R^2	0.782	0.782	0.798	0.800	0.801	0.572

Notes: y, f, terrain roughness, water bodies, pop. density and governor pre-electoral period stand for GSP per capita, fiscal transfers per capita, terrain roughness, percentage of water bodies, population density, and governor pre-electoral period, respectively. Constant coefficient is not reported. FE stands for panel data fixed effect. R^2 for FE regression corresponds to within R^2. The value 0 is reported when the first three decimal digits are equal to zero. T-statistics in parenthesis.
*, ** and *** denote significance at 10%, 5% and 1% levels, respectively.

Table 5. Basic flypaper regressions. Brazilian states.

Dependent variable	*Total exp. per capita* (1)	*Total exp. per capita* (2)	*Total exp. per capita* (3)	*Total exp. per capita* (4)	*Total exp. per capita* (5)	*Total exp. per capita* (6)
y	0.093***	0.093***	0.107***	0.107***	0.107***	0.002
	[27.786]	[14.459]	[11.908]	[12.657]	[12.675]	[0.094]
f	0.888***	0.888***	0.872***	0.876***	0.875***	1.018***
	[48.161]	[17.814]	[20.981]	[21.604]	[21.419]	[32.947]
terrain roughness			-13.934	-25.708	-24.462	
			[-0.648]	[-0.907]	[-0.867]	
water bodies			-70.924**	-77.895***	-77.008***	
			[-2.626]	[-2.864]	[-2.817]	
pop. density				0.103	0.093	1.818***
				[0.853]	[0.778]	[3.300]
governor pre-electoral period					49.694***	37.617**
					[2.795]	[2.155]
Flypaper effect						
test: $\beta_f = \beta_y$ (p-value)	0	0	0	0	0	0
absolute size = $\beta_f - \beta_y$	0.795	0.795	0.765	0.769	0.768	1.016
relative size = $(\beta_f - \beta_y)/\beta_y$	9	9	7	7	7	508
Statistics						
Econometric methodology	OLS	OLS	OLS	OLS	OLS	FE
Standard errors	standard	robust - cluster	robust - cluster	robust - cluster	robust - cluster	robust - cluster
Observations	541	541	541	541	541	541
States	26	26	26	26	26	26
Period	1985-2005	1985-2005	1985-2005	1985-2005	1985-2005	1985-2005
Av. number of obs. per state	20.8	20.8	20.8	20.8	20.8	20.8
R^2	0.834	0.834	0.843	0.843	0.846	0.597

Notes: y, f, terrain roughness, water bodies, pop. density and governor pre-electoral period stand for GSP per capita, fiscal transfers per capita, terrain roughness, percentage of water bodies, population density, and governor pre-electoral period, respectively. Constant coefficient is not reported. FE stands for panel data fixed effect. R^2 for FE regression corresponds to within R^2. The value 0 is reported when the first three decimal digits are equal to zero. T-statistics in parenthesis. *, ** and *** denote significance at 10%, 5% and 1% levels, respectively.

Table 6. Flypaper regressions by tax rate levels. Argentinean provinces.

Tax rates	*All*	*Below median*	*Above median*
Dependent variable	*Total exp. per capita*	*Total exp. per capita*	*Total exp. per capita*
	(1)	(2)	(3)
y	0.084***	0.098***	0.069***
	[12.491]	[19.194]	[14.347]
f	1.252***	0.934***	1.233***
	[9.714]	[4.708]	[7.397]
Flypaper effect			
test: $\beta_f = \beta_y$ (p-value)	0	0.001	0
absolute size = $\beta_f - \beta_y$	1.168	0.836	1.164
relative size = $(\beta_f - \beta_y)/\beta_y$	14	9	17
Statistics			
Econometric methodology	FE	FE	FE
Standard errors	robust-cluster	robust-cluster	robust-cluster
Controls	Yes	Yes	Yes
Observations	512	242	270
Provinces/cities	13	13	13
Period	1963-2006	1963-2006	1963-2006
Av. number of obs. per province/city	39.4	18.6	20.8
R^2	0.549	0.619	0.364

Notes: y and f stand for GSP per capita and fiscal transfers per capita, respectively. Constant as well as control variables coefficients (population density and governor/mayor pre-electoral period) are not reported. FE stands for panel data fixed effect. R^2 corresponds to within R^2. The value 0 is reported when the first three decimal digits are equal to zero. T-statistics in parenthesis. *, ** and *** denote significance at 10%, 5% and 1% levels, respectively.

Table 7. Degree of congestion or "publicness" of publicly provided goods. Argentinean provinces.

Dependent variable (natural logarithm of)	*Total exp.*	*Police*	*Housing and urban renewal*	*Public welfare*	*Education*	*Water and sewer systems*	*Science and technology*	*Economic services*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln(Y)	0.925***	0.806***	0.989***	0.526***	0.906***	1.158**	0.559	1.525***
	[10.691]	[8.056]	[4.743]	[2.826]	[9.378]	[2.660]	[1.536]	[7.980]
ln(pop) (coef. ω_2)	0.469**	-0.039	-0.606	3.329***	0.672**	-4.334	-0.502	0.328
	[2.128]	[-0.097]	[-0.820]	[3.179]	[2.434]	[-1.625]	[-0.301]	[0.327]
ln(tax share) (coef. ω_3)	-0.061	-0.148	0.051	0.178	-0.235	-0.031	1.028	0.414
	[-0.316]	[-0.828]	[0.112]	[0.682]	[-1.420]	[-0.036]	[0.924]	[0.899]
pop. density	0.011***	0.014**	-0.017**	0.000	0.010	0.048	0.012	-0.003
	[3.002]	[2.322]	[-2.090]	[0.005]	[1.348]	[1.308]	[0.577]	[-0.167]
Congestion parameter γ								
$\gamma = \omega_2/(1+\omega_3)$	0.499	-0.046	-0.577	2.826	0.878	-4.473	-0.248	0.232
test: $\gamma = 0$ (p-value)	0.026	0.924	0.495	0.011	0.063	0.307	0.789	0.724
test: $\gamma = 1$ (p-value)	0.026	0.040	0.071	0.086	0.790	0.214	0.188	0.248
"publicness"	impure public	pure public	pure public	private	private	undetermined	undetermined	undetermined
Statistics								
Econometric methodology	FE	FE	FE	FE	FE	FE	FE	FE
Standard errors	robust-cluster	robust-cluster	robust-cluster	robust-cluster	robust-cluster	robust-cluster	robust-cluster	robust-cluster
Observations	322	322	322	322	322	317	202	322
Provinces	23	23	23	23	23	23	20	23
Period	1991-2004	1991-2004	1991-2004	1991-2004	1991-2004	1991-2004	1991-2004	1991-2004
Av. number of obs. per province	14	14	14	14	14	13.8	10.1	14
R^2	0.528	0.410	0.207	0.309	0.420	0.073	0.014	0.296

Notes: Y, pop, tax share and pop. density stand for GSP, population, tax share, and population density, respectively. Constant coefficient is not reported. FE stands for panel data fixed effect. R^2 corresponds to within R^2. T-statistics in parenthesis.
*, ** and *** denote significance at 10%, 5% and 1% levels, respectively.

Table 8. Degree of congestion or "publicness" of publicly provided goods. Brazilian states.

Dependent variable (natural logarithm of)	*Total exp.*	*Economic services*	*Police protection*	*Public welfare*	*Education*	*Housing and urban renewal*	*Health and hospitals*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ln(Y)	0.454***	0.518	0.769***	0.539	0.256	0.306	1.003***
	[3.846]	[1.583]	[3.915]	[1.369]	[1.562]	[0.601]	[4.333]
ln(pop) (coef. ω_2)	0.475	-1.178***	0.945	1.901	0.730	0.748	0.345
	[1.330]	[-2.810]	[1.481]	[1.677]	[1.556]	[0.509]	[0.481]
ln(tax share) (coef. ω_3)	-0.093	-0.292	-0.386	0.322	-0.497*	0.748	0.005
	[-0.614]	[-1.237]	[-1.366]	[1.329]	[-1.825]	[1.066]	[0.016]
pop. density	0.004**	0.004***	0.003**	0.003	0.001	-0.003	0.005**
	[2.745]	[3.264]	[2.075]	[0.665]	[0.858]	[-0.748]	[2.611]
Congestion parameter γ							
$\gamma = \omega_2/(1+\omega_3)$	0.524	-1.664	1.539	1.438	1.451	0.428	0.343
test: $\gamma = 0$ (p-value)	0.174	0.114	0.0308	0.0519	0.0634	0.559	0.594
test: $\gamma = 1$ (p-value)	0.216	0.0147	0.431	0.540	0.551	0.436	0.311
"publicness"	undetermined	pure public	private	private	private	undetermined	undetermined
Statistics							
Econometric methodology	FE	FE	FE	FE	FE	FE	FE
Standard errors	robust-cluster	robust-cluster	robust-cluster	robust-cluster	robust-cluster	robust-cluster	robust-cluster
Observations	533	451	533	532	533	513	533
States	26	26	26	26	26	26	26
Period	1985-2005	1985-2005	1985-2005	1985-2005	1985-2005	1985-2005	1985-2005
Av. number of obs. per state	20.5	17.3	20.5	20.5	20.5	19.7	20.5
R^2	0.548	0.040	0.374	0.215	0.470	0.005	0.318

Notes: Y, pop, tax share and pop. density stand for GSP, population, tax share, and population density, respectively. Constant coefficient is not reported. FE stands for panel data fixed effect. R^2 corresponds to within R^2. T-statistics in parenthesis.
*, ** and *** denote significance at 10%, 5% and 1% levels, respectively.

Table 9. Flypaper regressions by category of government spending. Argentinean provinces.

Dependent variable	Total exp. per capita	Police per capita	Housing and urban renewal per capita	Public welfare per capita	Education per capita	Water and sewer systems per capita	Science and technology per capita	Economic services per capita
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
y	0.082***	0.004**	0.001	0.001	0.023***	-0.001	0.000***	0.017
	[4.021]	[2.111]	[0.194]	[0.631]	[5.770]	[-0.495]	[3.264]	[1.067]
f	0.806***	0.095***	0.138***	0.008	0.105*	0.056***	-0.003	0.111
	[5.729]	[6.474]	[4.416]	[0.655]	[1.834]	[4.435]	[-1.630]	[0.963]
"Publicness"	impure public	pure public	pure public	private	private	undetermined	undetermined	undetermined
Flypaper effect								
test: $\beta_f = \beta_y$ (p-value)	0	0	0	0.604	0.161	0	0.103	0.469
absolute size = $\beta_f - \beta_y$	0.724	0.091	0.137	0.007	0.082	0.057	-0.003	0.094
relative size = $(\beta_f - \beta_y)/\beta_y$	9	23	137	7	4	57	-12	6
Statistics								
Econometric methodology	FE	FE	FE	FE	FE	FE	FE	FE
Standard errors	robust-cluster	robust-cluster	robust-cluster	robust-cluster	robust-cluster	robust-cluster	robust-cluster	robust-cluster
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	322	322	322	322	322	317	202	322
Provinces	23	23	23	23	23	23	20	23
Period	1991-2004	1991-2004	1991-2004	1991-2004	1991-2004	1991-2004	1991-2004	1991-2004
Av. number of obs. per province	14	14	14	14	14	13.8	10.1	14
R^2	0.254	0.259	0.113	0.014	0.194	0.063	0.059	0.069

Notes: y and f stand for GSP per capita and fiscal transfers per capita, respectively. Constant as well as control variables coefficients (population density and governor pre-electoral period) are not reported. FE stands for panel data fixed effect. R^2 corresponds to within R^2. The value 0 is reported when the first three decimal digits are equal to zero. The denominator of relative size equals to $-\beta_y$ if $\beta_y<0$. T-statistics in parenthesis.
*, ** and *** denote significance at 10%, 5% and 1% levels, respectively.

Table 10. Flypaper regressions by category of government spending. Brazilian states.

Dependent variable	Total exp. per capita	Economic services per capita	Police per capita	Public welfare per capita	Education per capita	Housing and urban renewal per capita	Health and hospitals per capita
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
y	0.002	-0.001	0.010***	0.004	0.008**	-0.010*	0.011***
	[0.094]	[-0.300]	[3.402]	[0.748]	[2.144]	[-1.805]	[3.487]
f	1.018***	0.042***	0.018	0.018	-0.033	0.088***	0.076***
	[32.947]	[5.738]	[1.238]	[0.873]	[-0.812]	[4.573]	[5.842]
"Publicness"	undetermined	pure public	private	private	private	undetermined	undetermined
Flypaper effect							
test: $\beta_f = \beta_y$ (p-value)	0	0	0.602	0.533	0.321	0	0
absolute size = $\beta_f - \beta_y$	1.016	0.043	0.008	0.014	-0.041	0.098	0.065
relative size = $(\beta_f - \beta_y)/\beta_y$	508	43	1	4	-5	10	6
Statistics							
Econometric methodology	FE	FE	FE	FE	FE	FE	FE
Standard errors	robust-cluster	robust-cluster	robust-cluster	robust-cluster	robust-cluster	robust-cluster	robust-cluster
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	541	455	541	540	541	521	541
States	26	26	26	26	26	26	26
Period	1985-2005	1985-2005	1985-2005	1985-2005	1985-2005	1985-2005	1985-2005
Av. number of obs. per state	20.8	17.5	20.8	20.8	20.8	20.0	20.8
R^2	0.597	0.018	0.321	0.068	0.052	0.086	0.232

Notes: y and f stand for GSP per capita and fiscal transfers per capita, respectively. Constant as well as control variables coefficients (population density and governor pre-electoral period) are not reported. FE stands for panel data fixed effect. R^2 corresponds to within R^2. The value 0 is reported when the first three decimal digits are equal to zero. The denominator of relative size equals to $-\beta_y$ if $\beta_y<0$. T-statistics in parenthesis.
*, ** and *** denote significance at 10%, 5% and 1% levels, respectively.