SIMON FRASER UNIVERSITY

Department of Economics

Working Papers

12-09

**"Local Spending,
Transfers and
Costly Tax Collection"**

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February, 2012

SFU Economics

Local Spending, Transfers and Costly Tax Collection*

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Abstract

This paper studies the effect of costly taxation on the fiscal response of local governments to intergovernmental transfers. Using a panel dataset of Peruvian municipalities, I find robust evidence that central government's grants have a greater stimulatory effect in municipalities facing higher tax collection costs. The results are consistent with costly taxation partially explaining the flypaper effect.

Keywords: flypaper effect, intergovernmental transfers, fiscal decentralization.

JEL: H71, H77

1 Introduction

One of the most documented empirical regularities in the fiscal federalism literature is the so-called flypaper effect (Hines and Thaler, 1995; Gamkhar and Shah, 2007). This effect refers to the non-equivalence of different sources of local revenue. In particular, local public spending is more responsive to increments in grants from the central government

than to increments in the local tax base.[1] In the traditional grants-in-aid theoretical framework, however, these findings are puzzling (Oates, 1999). If money is fungible and the local government represents the interests of the citizens, then both sources of revenue should be equivalent (Bradford and Oates, 1971).

The most accepted explanations of this phenomenon focus on failure of local politicians to reflect voters' interests, or on empirical flaws in the estimation of the effect of grants on spending.[2] A complementary argument, first proposed by Hamilton (1986), suggests instead that the flypaper effect may be due to costly taxation.[3] There is, however, scant empirical evidence evaluating this hypothesis.

In this paper, I explore empirically whether costly local taxation affects the responsiveness of local spending to grants. In order to motivate the empirical exercise, I first develop a simple model of local public spending with costly tax collection, similar in spirit to Hamilton's (1986) model. The model predicts that the responsiveness of local spending to grants *increases* with tax collection costs. I then test this prediction using a panel dataset of Peruvian district municipalities over the period 1999 to 2001. Municipalities are the lowest tier of autonomous sub-national government. They finance their budget mostly from two sources: local revenue (such as property taxes, fees, fines and contributions) and transfers from the central government

I focus on the Municipal Compensation Fund or Foncomun, a large nationwide equalization grant managed by the central government. This grant is funded with a share of the national value added tax and allocated to municipalities using a pre-defined formula. The empirical strategy exploits within-municipality variation in the Foncomun grant. As

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[1]A similar phenomenon is reported in the aid literature, see for example Van de Walle and Mu (2007).

[2]The discrepancy between voters and local politicians may be due to imperfect information (Courant et al., 1979; Oates, 1979), uncertainty (Turnbull, 1998) or the action of agenda setting budget-maximizing bureaucrats (Filimon et al., 1982). More recently, Singhal (2008) finds evidence linking the flypaper effect to the influence of interest groups. Some of the empirical flaws mentioned in the literature are functional miss-specification (Becker, 1996), omitted variables (Hamilton, 1983), reverse causality (Knight, 2002) and measurement error (Moffitt, 1984). For a detailed survey of the literature see Hines and Thaler (1995), or Gamkhar and Shah (2007).

[3]In Hamilton's model, local governments treat local income and grants differently, because local taxes create distortionary costs. The argument, however, applies broadly to any difference in the cost of public funds. For example, Dahlby (2011) develops a model where differences in the marginal cost of public funds between the central and local governments generate the flypaper effect.

a proxy for tax collection costs, I use an indicator of tenure of administrative tools such as an automated tax system or an updated cadaster.

I find evidence that municipalities facing higher tax collection costs are more responsive to additional grants. The most conservative estimates suggest that the propensity to spend out of grants for a low cost municipality ranges between 0.515 to 0.785, depending on the model specification. In contrast, the propensity to spend for high cost municipalities ranges between 0.736 to 0.956. Under the assumption that the propensity to spend out of local income is 0.10, these results can be interpreted as evidence that costly taxation explains around 20% of the flypaper effect.

The results are robust to relevant identification concerns such as time-invariant omitted variables and confounding factors associated to the measure of tax collection costs. This evidence is consistent with the argument that grants and local tax base are non-equivalent, at least in part, because of costly taxation.

The rest of the paper proceeds as follows. Section 2 develops the analytical framework. Section 3 describes the institutional background about Peruvian local governments. Section4 discusses the data and identification strategy. Section 5 presents the main results and robustness checks. Section 6 concludes.

2 A model of local spending

In this section I develop a simple model of local public spending with costly tax collection. The model is based on the standard political economy model of public finance used by Persson and Tabellini (2000) in their analysis of redistributive politics. I extend this basic framework by including costly tax collection and lump-sum grants.

The model emphasizes the role of costly taxation as a mechanism to generate non-equivalence of revenue sources. This mechanism is similar to the one proposed by Hamilton (1986).[4] There are, however, two differences that make the model more suitable for

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[4]In Hamilton's model, the local public good is financed by a combination of local income taxes and grants from the central government. Local taxation is distortionary and creates a deadweight loss that reduces citizens net income. This feature makes the propensity to spend out of grants greater than out of local income, because grants allow the local government to reduce distortionary taxation and increase

empirical testing.

First, the model motivates costly taxation by introducing tax collection costs, such as compliance or administrative costs. This is a natural extension of Hamilton's model that facilitates the empirical analysis, since collection costs are easier to measure than distortionary costs. Moreover, in the context of local public finances, tax collections costs might be as relevant as the distortionary costs of taxation (Slemrod, 1990, p.169).[5] Second, the model provides a simple expression linking the grant elasticity of spending to tax collection costs, tax rates and the ratio of grant to non-grant revenue. These features motivate the use of alternative variables to evaluate the role of costly taxation in the fiscal responsiveness to grants.

There are two tiers of government: central and local. Both provide public goods, collect taxes and have their representatives elected in general elections. In addition, the central government provides financial support to local governments in the form of lump-sum grants. I focus on the policy decisions of the local government and take the central government's policies as given.[6] This assumption implies that the local politician does not take into account the costs incurred by the central government to fund the grant scheme.

The local government rules over a community populated by a continuum of citizens of mass one. Citizens have similar income $e_i = 1$, but heterogeneous type. Their type is denoted by y_i. The individual type defines the tax she will pay and can be interpret as the value of her property.[7] In order to abstract from the effect of individual inequality, I restrict attention to symmetric distributions such that both the average and median y_i are equal to y[8]

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citizens' consumption.

[5]For example, estimates of the compliance and administrative costs of the U.S. federal and state income tax are between 5-10 percent of total tax revenue (Slemrod and Sorum, 1984; Blumenthal and Slemrod, 1992; Slemrod and Yitzhaki, 2002). In the case of local governments, Wicks and Killwort (1967) estimate collection costs for real property taxes of around 9.5 percent of the tax revenue. For an empirical survey of compliance and administrative costs see Sandford (1995).

[6]This is a plausible assumption if local governments are unable to, individually, affect central government's policies.

[7]In the Peruvian case the most important local tax is the property tax.

[8]The results are similar with asymmetric distributions. This extension is available from the author upon request.

Citizens derive utility from private consumption c_i and a homogeneous public good g provided by the local government. Preferences are defined by a quasi-linear utility function

$$U_i = c_i + H(g), \tag{1}$$

where the utility from the public good $H(g)$ is an increasing and concave function.

The assumption of a quasi-linear utility is used in several models of political economy and public finance (see for example Grossman and Helpman (1994) and Persson and Tabellini (2000).) This functional form simplifies the model significantly and allows us to obtain a more tractable expression linking tax collection costs to public spending and grants. This assumption, however, is quite restrictive. It imposes a constant marginal utility of income, as well as the same marginal utility of the public good for all citizens, regardless of income. These restrictions limit the ability of the model to study distributional issues, which may be relevant in some applications (Dixit et al., 1997).[9]

The local government funds the provision of the public good from two revenue sources: a local tax on y_i and a grant from the central government. Tax policy is not targeted and hence the local tax rate $\tau \in (0, 1)$ is the same for all citizens. The local government sets the tax rate and collects the tax revenue. In contrast, the decisions on grant funding and allocation are made by the central government.

Collecting local taxes is costly. In particular, the local government faces an administrative cost of operating the tax system equal to $\Gamma C(\tau) y$ where Γ is a cost shifter and $C(\cdot)$ is an increasing and convex function. $\Gamma C(\tau) \in (0, \tau)$ to avoid a corner solution with zero taxation. The administrative cost can represent, among others, the cost of processing tax returns, monitoring tax evasion and the required legal proceeds, or the effort by the public officer to enforce the tax system.

The assumption of increasing marginal costs $C'' > 0$ guarantees that there is an optimal level of government spending and taxation. This assumption can be justified if

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[9]This limitation is less of a concern in this paper since I only focus on the relation between collection costs, grants and public spending. Hamilton (1986) uses a general utility function and, similarly to this model, also finds that government spending is more responsive to grants in the presence of costly taxation.

the technology to collect taxes exhibits decreasing marginal returns.[10]

An alternative way to motivate costly tax collection is to include compliance costs. In the rest of the model I will focus on administrative costs because they are more relevant for the empirical case.[11]

From (1) and the previous definitions, we can write the indirect utility of citizen i as:

$$V_i = 1 - \tau y_i + H(g),\qquad(2)$$

while the local government's budget constraint is

$$g = y\left[\tau - \Gamma C(\tau)\right] + a,\qquad(3)$$

where y is the local tax base and a is the lump-sum grant per capita. Note that the expression $R \equiv y\left[\tau - \Gamma C(\tau)\right]$ represents the net tax revenue.

Assumption 1 $\Gamma C' < 1$.

This assumption guarantees that the net tax revenue is an increasing function of the tax rate.

Equilibrium policy Note that the citizen's indirect utility (2) satisfies the single-crossing property which allows us to use the median voter theorem. Thus, with credible commitment and majority rule, the equilibrium policy g^* would be the one that maximizes the median citizen's utility.

$$g^* = \arg\max\ 1 - \tau y + H(g).\qquad(4)$$

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[10]Consider, for example, a tax authority that uses a Cobb-Douglas technology with both administrative tools (A) and auditors' labor (L) to collect a tax revenue of τ (note that this is equal to the tax rate since total income is 1). Hence $\tau = T^\alpha L^{(1-\alpha)}$, with $\alpha < 1$. The price of inputs A and L are 1 and w, respectively. It is straightforward to show that, in the short run when A is fixed, the tax collection cost is $C(\tau) = w\tau^{\frac{1}{1-\alpha}}A^{-\frac{\alpha}{1-\alpha}} + A^\alpha$. Note that the marginal cost of collecting taxes is increasing in τ.

[11]I also extend the model to allow for compliance costs. This extension is available from the author upon request.

Rearranging the budget constraint (3), we can express τ as a function of g:

$$F(\tau) \equiv \tau - \Gamma C(\tau) = \frac{g - a}{y}, \tag{5}$$

where $F' > 0$, $F'' < 0$ by assumption 1 and convexity of $C(\tau)$. Since F is a monotonic function, we can write the tax rate as

$$\tau = f\left(\frac{g - a}{y}\right), \tag{6}$$

where $f(\cdot) = F^{-1}(\cdot)$ and hence $f' > 0$, $f'' > 0$.

Solving (4) and using (6), we obtain the equilibrium policy:

$$g^* = h(f'\left(\frac{g^* - a}{y}\right)), \tag{7}$$

where $h(\cdot)$ is the inverse function of $H'(\cdot)$. Note that $h' < 0$ because H is concave.

2.1 Costless tax collection

Let us first study, as a benchmark, the case of costless tax collection. In this scenario, expression (7) simplifies to $g^* = h(1)$ and it is easy to see that the effect of lump-sum grants and local tax base on g^* are both identical and equal to zero.[12]

When tax collection is costless, the model predicts that grants from the central government do not affect spending but instead are fully translated to citizens as tax rebates. Moreover, the mechanism to transfer resources becomes irrelevant because both grants and the local tax base are equivalent in terms of their effect on local government spending and taxation.

This result replicates the veil hypothesis which has provided the theoretical basis for the flypaper paradox (Oates, 1999, p. 1129). According to this hypothesis, when the local authority is representative of the citizens, both lump-sum grants and the local tax base have similar effects on local spending. Thus, the local government acts only as a

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[12]This result is extreme due to the quasi-linearity assumption which eliminates the income effect.

veil and does not distort the final allocation of resources.

2.2   Costly tax collection

Let us now relax the assumption of costless taxation. Taking total derivatives from expression (7) we can calculate the propensities to spend out of the local tax base (y) and grants:

$$\frac{dg^*}{dy} = -\frac{h'f''}{y - h'f''}\frac{g^* - a}{y}, \tag{8}$$

$$\frac{dg^*}{da} = -\frac{h'f''}{y - h'f''}. \tag{9}$$

Since $h' < 0$, and $f'' > 0$, these propensities to spend are positive. Thus, in contrast to the benchmark case, local spending increases both with the local tax base and grants from the central government. The reason is that grants reduce the tax rate required to fund a given level of spending. In turn, this lowers tax collection costs, reduces the marginal cost of the public good and promotes additional spending.

Expressions (8) and (9) allow us to compare both marginal propensities to spend and evaluate the magnitude of the flypaper effect. Using both results and definition (5), we obtain:

$$\frac{dg^*}{da} = \frac{dg^*}{dy}\frac{1}{\tau^* - \Gamma C(\tau^*)}, \tag{10}$$

where τ^* is the equilibrium tax rate and $\Gamma C(\tau^*)$ is the administrative cost as a proportion of the tax base.

Since $\Gamma C(\tau^*) \in (0, \tau^*)$ and $\tau^* < 1$, the marginal propensity to spend out of grants is *greater* than the marginal propensity to spend out of the local tax base.[13] Hence, the model predicts that grants and the local tax base are not fungible. This prediction is consistent with the observed flypaper effect and, contrary to the veil hypothesis, suggests

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[13]Moreover, finding similar marginal propensities would be rare since it requires very high tax rates and negligible collection costs.

that these two sources of local revenue are not equivalent.

Similar to Hamilton (1986), the non-equivalence result is driven by the differences in the cost of funds faced by the local government. In particular, a local government finds it more costly to collect local taxes than to use grants from the central government. In the model, this cost difference arises from the inability of the local government to internalize the cost of funding the intergovernmental transfers. This result points out a potential source of inefficiency: local governments may overspend if they do not take into account the tax collection costs incurred by the central government.

2.3   Testable Predictions

In the empirical section, I follow Becker (1996) and use a double logarithmic specification. This specification provides estimates of elasticities instead of propensities to spend. In order to link the model to the empirical exercise, we can rewrite equation (10) in terms of elasticities:

$$\varepsilon_a = \varepsilon_y \frac{a}{y} \frac{1}{\tau^* - \Gamma C(\tau^*)}, \tag{11}$$

$$\varepsilon_a = \varepsilon_y \frac{a}{g - a}, \tag{12}$$

where $\varepsilon_a \equiv \frac{dg}{da} \frac{a}{g}$ and $\varepsilon_y \equiv \frac{dg}{dy} \frac{y}{g}$ are the elasticities to spend out of grants and out of the local tax base, respectively, and $\frac{a}{g-a}$ is the ratio of grant to non-grant revenue.

From (11) and (12) it is straightforward to obtain the following testable predictions:

Prediction 1: the elasticity to spend out of grants increases with tax collection costs, $\frac{d\varepsilon_a}{d\Gamma} > 0$.

Prediction 2: the elasticity to spend out of grants decreases with the tax rate, $\frac{d\varepsilon_a}{d\tau} < 0$.

Prediction 3: the elasticity to spend out of grants increases with the ratio of grant to non-grant revenue, $\frac{d\varepsilon_a}{d(a/(g-a))} = \varepsilon_y \geq 0$.

Note that predictions 2 and 3 provide alternative ways to explore the importance of costly taxation using tax rates and the ratio of grant to non-grant revenue instead

of measures of tax collection costs. This is possible because with costly taxation, tax rates are inversely related to tax collection costs. In Section 5, I test empirically these predictions in the context of Peruvian district municipalities.

3   Institutional Background

Peru is divided into three tiers of sub-national administrative units: departments, provinces and districts. In the period of analysis, there were 24 departments, 194 provinces and around 1650 districts. District municipalities are the lowest tier of autonomous sub-national government. Their main responsibilities are the provision of local services -such as waste collection, local police and civil registry- and development and maintenance of local infrastructure. They, however, do not participate in the provision of education or health services, and cannot redistribute cash directly to citizens.

Municipalities finance their budget mostly from two sources: local revenue (such as local taxes, fees, fines and contributions) and transfers from the central government (see Table 1). In the period 1999 to 2001, these two sources represented around 83 percent of the total budget. The remaining budget corresponds mostly to debt, sales of assets and the budget balance from previous years.[14]

3.1   Local revenue, and tax collection costs

The most important source of local revenue is the property tax (or *impuesto predial*). In 2001, this tax amounted to 80 percent of total local tax revenue.[15]

The property tax is levied on the estimated value of the real estate property. Local governments, however, have little control over the tax rate and tax base. The tax rate is defined by national law while the property value is calculated using criteria defined by a national surveyor agency such as property size, quality and economic use. The amount

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[14]Municipalities can roll forward any amount of local revenues or transfers not spent in a fiscal year.

[15]Other sources of local revenue include taxes to property sales, gambling and entertainment, fees for waste management, parking, registry services or business licenses, as well as contributions to public works and fines.

Table 1: Aggregate Municipal Budget 1999-2001,
in millions of Nuevos Soles

Source	Annual Budget	% total budget
A. Transfers	1065.8	44.6
Foncomun grant	718.9	30.1
Glass of Milk	228.4	9.5
Other transfers[a]	118.5	5.0
B. Local Revenue	924.8	38.7
Taxes	361.2	15.1
Service fees	496.2	20.7
Fines and contributions	67.4	2.8
C. Other Revenue[b]	328.2	13.7
D. Previous year balance	73.1	3.1
Total revenue	2391.9	

Source: Municipalities' budget reports.
[a] Includes tax-sharing of income tax of extractive industries and custom duties.
[b] Includes credit and capital income.

actually collected, however, depends on the municipality's monitoring and enforcement effort.

A common form of tax evasion is the failure of owners to report improvements to existing properties (which could increase the taxable base). To address this problem, local tax authorities usually maintain a register of properties or cadaster, with details about location, size and ownership of properties.

In the empirical analysis, I use the tenure of an updated cadaster as one of the proxies of tax collection costs (see section 4.1 for further details on variables and data sources). The rationale for using this proxy is twofold. First, the cadaster is recognized as a tool to implement and operate property tax systems (United Nations, 2005; International Federation of Surveyors, 2005). In this view, an updated cadaster may reduce the collection costs of the property tax. Second, it seems to capture an important dimension of tax collection costs. For example, the local revenue per capita among municipalities with an updated cadaster is 34 Nuevos Soles. In contrast, this figure among municipalities without it is less than half, 15 Nuevos Soles.[16]

In addition, I also use, as a measure of tax collection costs, an indicator of tenure of automated tax systems. In practice, this means having tax information -such as the registry of tax payers and payment records- in electronic format, or access to tax management software. In the sample, 23% of municipalities report having an updated cadaster, while 7% report having an automated tax system.

These two measures are not without their problems.[17] A first concern is that they may fail to capture differences in actual tax collection costs. This measurement error would create an attenuation bias. Second, they may just reflect other municipality characteristics that also affect spending decisions. In that case, they would confound the empirical analysis and lead to inconsistent estimates. I discuss these concerns in more detail in Section 5.1.

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[16] In the period of analysis, the average exchange rate was 3.46 Nuevos Soles = 1 US$.

[17] Ideally, I would like to use better estimates of tax collection costs such as spending in tax administration or revenue offices. This information, however, is not available.

3.2 The Foncomun grant

In addition to their own local revenue, district municipalities receive several transfers from the central government (see Table 1). The most important is the Foncomun, an equalization grant that represents around 30 percent of municipalities' revenue.[18] Other transfers include the Glass of Milk (*Vaso de Leche*), a conditional grant earmarked to a food support program, and sharing schemes of national taxes such as the income tax of extractive industries and custom duties.[19] I focus on the Foncomun because it is the largest and most widespread transfer.

The Foncomun is an equalization grant allocated to all district municipalities. It is the most important source of revenue for local governments. In the period 1999-2001, it represented around 30 percent of total municipal budgets.

The Foncomun is funded with a fixed proportion of the national value added tax. This tax is managed and collected by the central government without any intervention by local governments. The central government defines the size of the total Foncomun budget, based on tax revenue estimates.

Use   During the period of analysis, the use of the Foncomun was partially conditional. In particular, municipalities were required to spend at least 80 percent of the Foncomun on capital expenditures. Capital expenditures are broadly defined and include expenditure on durable assets, investment projects and related expenses such as feasibility studies and consultancies. The Foncomun, however, is not earmarked to a particular project.

In practice, the compliance with this conditionality was limited. In aggregate, the proportion of the Foncomun actually spent on capital expenditures decreased from 67 percent in 1998 to 54 percent in 2001. This evidence suggests that the Foncomun may have been de facto treated as an unconditional grant. In 2003, the spending conditionality was removed.

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[18]Foncomun stands for *Fondo de Compensación Municipal* or Municipal Compensation Fund.

[19]These transfers are assigned only municipalities in areas with natural resources or custom offices.

Allocation formula The amount of Foncomun received on a given year does not depend on the previous years' spending performance. Similarly, there are no features that would have made the Foncomun a matching-grant.[20] Instead, the Foncomun is allocated to all district municipalities using an allocation formula defined in national legislation.

In the period of analysis, the Foncomun allocation formula was proportional to population size and indicators of needs. The allocation was done in two steps. First, the Foncomun was distributed among provinces based on population weighted by an index of children mortality collected in 1981.[21] Second, the amount assigned to each province was shared among district municipalities based on a weighted measure of population size, with double weight for rural population. This last step used data on urbanization rates from the 1993 Population Census.[22]

This allocation procedure generates variation between municipalities and spatial correlation within a province. In particular, the Foncomun per capita a municipality receives depends of the province's child mortality rate, and of the municipality's urbanization rate relative to the rest of municipalities in the same province.

The allocation formula reflects both the rationale of the Foncomun grant and the data limitations in 1993, the year it was created. According to law, the Foncomun's should be distributed considering equalization and compensation criteria such as poverty, demographics, and territory characteristics.[23] In practice, however, at the moment of creation of the transfer, there were no estimates of local poverty in Peru.[24] This data limitation may explain the use of child mortality and urbanization in the allocation formula, instead of straight measures of poverty.

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[20] With matching grants, the flypaper effect would just reflect the differences in prices of the public good.

[21] A province is the administrative unit immediately above a district.

[22] There has been several changes to the allocation formula in 2002 and 2010. The current allocation formula uses a richer, and updated, set of indicators of needs, poverty, and population. It also includes indicators of local government's performance such as relative size of capital expenditure and the ratio of local taxes to total revenue.

[23] Ley de Tributaciòn Municipal (Municipal Tax Act) Art. 87.

[24] There were some estimates of poverty done in 1999 by Foncodes, a central government's office, using measures of infrastructure needs at district level. Only since 2003 there are annually-updated estimates of poverty at the regional level. This data became available with the sample expansion of the Households Living Standards Survey (ENAHO).

There are two additional observations. First, changes in the allocation formula require amendments to the national legislation. Hence, municipalities cannot, individually, affect the allocation formula or weights. Second, in the period of analysis, the allocation weights do not update the information on child mortality, only the estimates of population size. These features reduce concerns of possible bargaining between municipalities and the central government, or changes in Foncomun due to manipulation of reported data, both possible sources of endogenous transfers.

The additional transfer In 2000 and 2001, the central government created a transitory fund, called *asignación adicional* or additional transfer, to increase the Foncomun size.[25]

The fund was financed with the national budget and redistributed to municipalities receiving a monthly Foncomun smaller than 25,000 Nuevos Soles (around US$7,300). The extra amount transferred to a municipality was defined by law and was inversely proportional to the calculated Foncomun grant (see Table 2). Note that the additional transfer was a lump-sum not a grant per capita. For accounting and budgetary purposes, the additional transfer was considered as part of the Foncomun grant.

Table 2: Allocation of additional transfer, in Nuevos Soles

Calculated monthly Foncomun	Monthly additional transfer
11,000 to 17,000	4,000
17,001 to 20,000	3,000
20,001 to 23,000	2,000
23,001 to 25,000	Variable[a]

[a] Difference between 25,000 and calculated monthly Foncomun.

The additional transfer was in place from August 2000 to December 2001 and was assigned to around 60 percent of district municipalities. In practice, the additional transfer benefited municipalities with small populations. These municipalities were supposed to

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[25]This policy was a response to the decline in value added tax revenues, the main source of Foncomun's funding.

receive a smaller total Foncomun but ended up receiving a larger amount. This implies that their Foncomun per capita was greater than a comparable municipality with larger population.

Table 3 compares socio-demographic characteristics of municipalities that received the additional transfer to municipalities that did not. The variables are measured in 1999, a year before the implementation of the additional transfer.[26] Note that the main difference between the two groups are population size, urbanization, density, and access to piped water, but there are not significant differences in poverty rates.

Table 3: Socio-demographic characteristics in 1999

Variable	Received additional transfer		Mean comparison
	No	Yes	p-value
	(1)	(2)	(3)
Population	23909.3	2446.3	0.000
	(55460.6)	(1728.2)	
Population density	836.3	43.1	0.000
	(3290.2)	(328.9)	
% urban population	38.3	43.3	0.003
	(33.6)	(27.3)	
Poverty headcount	46.2	46.6	0.576
	(15.7)	(13.1)	
% access piped water	58.8	65.8	0.000
	(31)	(33.8)	
Nr. Municipalities	651	910	

Note: Table reports unconditional means. Standard deviations in parenthesis. Column (3) reports the p-value of the test that the means of municipalities that received the additional transfer and did not received are equal.

The additional transfer created within-municipality variation in the Foncomun, in addition to the variation between municipalities due to the allocation formula. In particular, municipalities that received the additional transfer experienced a faster growth of the Foncomun. For example, in the period 1999 to 2001, the Foncomun per capita of municipalities that received the additional transfer grew, on average, by 17.7 percent per

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[26]I describe in more detail the data sources in Section 4.

year. In contrast, the Foncomun of municipalities not entitled to the additional transfer grew, on average, by 5 percent per year.

In the empirical section, I exploit this source of variation to estimate the elasticity of spending out of grants and explore how it changes with measures of tax collection costs.

4 Empirical Strategy

4.1 Data

I use a panel data set of 1,558 Peruvian district municipalities with information on annual budgets, administrative resources and socio-demographic characteristics.[27] The budgetary information covers three years (1999 to 2001) and comes from annual reports prepared by the local governments. These reports have official status and are used for national accounting and auditing by different government agencies [28]. They include detailed information on municipalities' revenues and expenditures, including the amount received from different transfers.[29] I express the revenue and expenditure variables in per capita values using population estimates for 1999.

I also collect data on the municipality's administrative resources such as having an updated cadaster -a register with details about location, size and ownership of properties- or automated administrative systems. The data comes from surveys conducted in 1999 by the National Statistics Institute to assess the resources and capabilities of district municipalities.[30] The results of the survey were not intended to affect the transfers' allocation or the implementation of other governmental programs. Participation in the survey was compulsory for all district municipalities and the questionnaire was completed by the local authority or a representative.

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[27]The sample size is smaller than the universe of 1,650 municipalities due to lack of budgetary information for some small municipalities.

[28]The budget reports I use correspond to the copy sent to the Ministry of Economy.

[29]I compared the amount of transfers registered in the budget reports with the records from the Ministry of Economy -the office in charge of distributing the transfers- and I found similar values.

[30]The survey is called *Registro Nacional de Municipalidades* or the National Municipality Register. The survey collects information about human resources, equipment, municipality services, local infrastructure and current investment projects.

I complement the dataset with socio-demographic variables from several sources. I obtain measures of population density and percentage of urban population from the 1993 Population Census, as well as population estimates for 1999 from the National Statistics Office. Poverty headcount and access to utilities are estimates for 1999 from Foncodes -a central government's office in charge of several anti poverty programs- and used for the prioritization of public works and development projects.

Main variables I use the value of expenditure and Foncomun per capita as measures of local spending (g) and grants (a), respectively. I also calculate the additional transfer per capita. As I describe below, I use this variable as an instrument for Foncomun per capita.

As proxies for tax collection costs, I use the tenure of tax administration tools. I focus on two tools identified in the National Municipality Register: an updated cadaster and automated tax systems.[31]

As discussed in Section 3, the choice of these proxies responds to the importance of the cadaster to manage property tax systems, and the data limitations. I aggregate the information of both measures of tax collection costs by constructing a dummy called *high cost* equal to 1 if a municipality does not have an updated cadaster and an automated tax system, and 0 otherwise.[32] In terms of the model, high cost=1 represents a higher value of Γ, the shifter of the tax collection cost. In the sample, around 75 percent of municipalities are classified as high cost.

The model also predicts the differences in the grant elasticity of spending by the tax rate (τ) and by the grant to non-grant ratio ($\frac{a}{g-a}$) (predictions 2 and 3). These predictions allow us to indirectly assess the importance of costly taxation, without directly observing tax collection costs. As empirical counterparts of τ I use the average local revenue per capita in 1998. This source of revenue includes local taxes, fees, contributions and fines

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[31]Note that the category of municipalities without an updated cadaster include municipalities with an outdated cadaster and without any cadaster.

[32]As a robustness check, I also report the results using the components of the dummy (having an automated tax system or an updated cadaster) separately (see Table 8).

collected directly by the municipality.[33] As a proxy of $\frac{a}{g-a}$, I use the ratio of Foncomun to non-Foncomun revenue in 1998.

Table 4 presents summary statistics of the main variables, and the p-values of a mean comparison between low cost and high cost municipalities. There are three important observations. First, municipalities classified as low cost have a higher value of own revenue per capita, and a lower ratio of Foncomun to non-Foncomun revenue. This is consistent with these municipalities actually facing lower tax collection costs, and hence being able to collect more local taxes.

Second, while having similar levels of expenditure per capita, high cost municipalities receive a higher Foncomun per capita, and hence have a larger ratio of Foncomun to expenditure (proxy of $\frac{a}{g}$). This raises concerns that differences in grant elasticities may be driven mechanically by differences in the relative contribution of Foncomun to total expenditure.[34] In the empirical section, I address this concern by using the different ratios for high and low cost municipalities to transform the grant elasticities into propensities to spend, and by estimating these propensities directly using a linear model.

Finally, there are systematic differences between both types of municipalities. High cost municipalities have smaller populations, they are less urban, less dense and poorer. These systematic differences between low and high cost municipalities raise relevant concerns that I discuss in Section 5.1.

4.2 Econometric Specification

The purpose of the empirical exercise is to estimate the grant elasticity of spending (ε_a) and evaluate how it varies with tax collection costs. To do so, I estimate the following baseline regression:

$$\ln g_{it} = \beta_0 \ln a_{it} + \beta_1 (\ln a_{it} \times \text{high cost}_i) + \eta_i + \epsilon_{it}, \tag{13}$$

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[33]I also use alternative proxies such as the local tax per capita in 1998 and the property tax per capita in year 2001, the only year available. The results, not reported, are similar.

[34]Note that $\varepsilon_a = \frac{dg}{da}\frac{a}{g}$.

Table 4: Summary Statistics and Mean Comparison

Variable	Total	Tax collection cost		Mean comparison p-value
		Low cost	High cost	
Model counterparts				
Expenditure per capita (g)	165.3	171.6	163.2	0.062
	(124.9)	(128.3)	(123.7)	
Foncomun per capita (a)	100.2	87.0	104.5	0.000
	(86.5)	(78.9)	(88.4)	
Foncomun/Expenditure ($\frac{a}{g}$)	0.623	0.545	0.649	0.000
	(0.206)	(0.239)	(0.187)	
Own revenue per capita in 1998 (τ)	23.3	44.9	15.5	0.000
	(79.9)	(132.8)	(46.1)	
Foncomun/Non Foncomun revenue in 1998 ($\frac{a}{g-a}$)	2.1	1.5	2.3	0.000
	(2.2)	(1.5)	(2.4)	
Tax collection costs				
No updated cadaster	76.5	16.9	100.0	0.000
	(42.4)	(37.5)	(0)	
No automated tax system	92.5	69.9	100.0	0.000
	(26.4)	(45.9)	(0)	
District characteristics				
% received additional transfer	57.0	44.7	61.1	0.000
	(49.5)	(49.8)	(48.8)	
Population	11711.4	23874.3	7641.1	0.000
	(37967.7)	(63512.5)	(22605.8)	
Population density	383.9	1125.1	134.2	0.000
	(2205.1)	(3914.2)	(1049.8)	
% urban population	41.2	50.5	38.0	0.000
	(30.3)	(34)	(28.2)	
Poverty headcount	46.4	41.6	48.1	0.000
	(14.3)	(15.9)	(13.3)	
% access piped water	62.8	60.8	63.5	0.190
	(32.8)	(32.4)	(32.9)	
Nr observations	4144	1021	3123	
Nr. Municipalities	1558	376	1182	

Notes: Table reports unconditional means. Standard deviation are in parentheses. The last column reports the p-value of the test that the means of high and low cost municipalities are equal.

where g_{it} is the expenditure per capita of municipality i in year t, a_{it} is the amount of Foncomun per capita and high $cost_i$ is the indicator of having high collection costs.

Following Becker (1996), I use a double logarithmic specification. This functional form reduces concern of flypaper due to mis-specification and produces estimates of elasticities instead of propensities to spend. I also check the robustness of the main results using a linear specification. In addition, I cluster the standard errors by year and province. This clustering accounts for the possible correlation within provinces due to the Foncomun allocation procedure.

The interaction term ($\ln a_{it} \times$ high $cost_i$) captures differences in the grant elasticity of spending by tax collection costs. Note that in this specification $\widehat{\beta_0}$ and $\widehat{\beta_0} + \widehat{\beta_1}$ are the estimated grant elasticity of spending for municipalities with low and high collection costs, respectively. The model predicts that ε_a is increasing in tax collection costs, which implies $\widehat{\beta_1} > 0$.

A main concern when estimating equation (13) is the presence of omitted variables correlated both with Foncomun and expenditure per capita. This may arise, for example, if municipalities with unobservable greater propensities to spend also receive a larger Foncomun per capita.

The identification strategy addresses this concern in two ways. First, the baseline regression includes municipality fixed effects η_i. This procedure exploits within municipality variation driven by the growth over time of the Foncomun budget, and the additional transfer distributed in late 2000 and 2001. Moreover, it allow us to control for time-invariant heterogeneity that may bias the regression estimates such as the observed demographic differences in Table 4, or unobserved differences such as the long-run level of income, or size of tax base.

Second, I use the additional transfer per capita (add transfer$_{it}$) as an instrument for the Foncomun per capita. As an instrument for the interaction term $\ln a_{it} \times$ high $cost_i$ I use $\ln(\text{add transfer}_{it}) \times$ high $cost_i$. I estimate this regression using panel data with fixed effects and instrumental variables. In this specification, the identification assumption is that the changes in the additional transfer are related to changes in expenditure only

through changes in the Foncomun.

5 Main results

Table 5 presents the main results. Column 1 estimates the baseline regression (13) including municipality fixed effects. Column 2 estimates the 2SLS model using add transfer as an instrument for Foncomun per capita.[35] Using both methods, the parameter associated with the interaction term ($\widehat{\beta_1}$) is positive and significant. This result suggests that the grant elasticity of spending (ε_a) is significantly larger for municipalities with high tax collection costs.

I obtain similar results using a linear model (columns 3 and 4). This specification might lead to overestimation of the flypaper effect (Becker, 1996), but produces direct estimates of the propensity to spend out of grants ($\frac{dg}{da}$). Note that in both cases, the estimated $\frac{dg}{da}$ is significantly larger for high cost municipalities. For example, in column 3 the estimated $\frac{dg}{da}$ for a low cost municipality is 0.736 while for a high cost is 0.956, a value almost 30 percent larger. These results are consistent with the model predictions that grants have a greater stimulatory effect in localities with costlier taxation (prediction 1).

As a reference, the middle rows of Table 5 display the implied $\frac{dg}{da}$ and their 95% confidence interval. For columns 3 and 4, these figures are obtained directly from the linear model. In contrast, for columns 1 and 2, I need to transform the estimated elasticities into propensities. I do so by dividing them by the average ratio of Foncomun to total expenditure. Note that the implied propensities to spend are large, with values ranging from 0.52 to 1.16. These estimates, however, are within the ranges reported in the literature (Hines and Thaler, 1995).

The previous results only suggest that, consistent with Hamilton's (1986) model, costly taxation increase the responsiveness of local spending to grants. In general, how-

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[35]There are two instruments: one the for variable in level and the other for the interaction term. The system is just identified, which reduces concern of weak instrument bias. The first stage, not reported, confirms that the excluded instruments are significantly, and positively, correlated to the endogenous variables. The multivariate F statistics of excluded instruments, suggested by Angrist and Pischke (2009) in the case of multiple instruments, are 23.9 and 93.7, respectively.

ever, I cannot say anything about the magnitude of the flypaper effect or the contribution of costly taxation to explain this phenomenon. To do so, I would need an estimate of the propensity to spend out of income, $\frac{dg}{dy}$. In the case I study, I cannot estimate this propensity due to the lack of information on income, or tax base, at municipal level.

We can make some progress, however, by assuming a similar value of $\frac{dg}{dy}$ for high and low cost municipalities. Under that assumption, the previous results can be interpreted as evidence that costly taxation partially explains the flypaper effect. A back of the envelope calculation, taking the most conservative estimate of $\frac{dg}{da}$ and assuming $\frac{dg}{dy} = 0.10$, suggests that the observed differences in tax collection costs account for around 20% of the flypaper effect.[36]

Exploring additional model predictions A concern with the previous results is that the measure of tax collection costs may fail to capture actual cost differences. To address this issue, I exploit the model's additional predictions.

Recall that, in the presence of costly taxation, the model predicts that: (i) elasticity of spending out of grants (ε_a) decreases with the tax rate, and (ii) ε_a increases with the ratio of grant to non-grant revenue ($\frac{a}{g-a}$).[37] These predictions suggest alternative ways to explore the role of costly taxation without directly measuring tax collection costs.

To do so, I estimate the baseline regression replacing *high* by measures of the tax rate and $\frac{a}{g-a}$. Table 6 shows the results. Column 1 and 2 replace *high cost* by the log of the own revenue per capita in 1998, a proxy for the tax rate and estimate the model using OLS and 2SLS. The estimated parameter associated to the interaction term is negative and significant. Columns 3 and 4 instead use the ratio of Foncomun to non-Foncomun revenue in 1998, a proxy for $\frac{a}{g-a}$. In this case, the estimated β_1 is positive. These findings are consistent with the model (predictions 2 and 3). Moreover, they provide additional support to the claim that tax collection costs are relevant to explain differences in the

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[36]0.10 corresponds to the upper bound of estimated $\frac{dg}{dy}$ in the literature (Hines and Thaler, 1995). I use the ratio $\frac{dg/ga}{dg/dy}$, proposed by Becker (1996), as a measure of the magnitude of the flypaper effect.

[37]Intuitively, we can use tax rates and $\frac{a}{g-a}$ because, in equilibrium, high cost municipalities would have lower tax rates, and higher dependence on grants.

Table 5: Main results

	Ln(expenditure per capita)		Expenditure per capita	
	(1)	(2)	(3)	(4)
Ln(Foncomun per capita)	0.321*** (0.053)	0.591*** (0.072)		
Ln(Foncomun per capita)× high cost	0.168*** (0.058)	0.136** (0.056)		
Foncomun per capita			0.736*** (0.094)	0.921*** (0.120)
Foncomun per capita × high cost			0.220** (0.104)	0.212* (0.114)
Implied dg/da				
dg/da low cost	0.515 [0.347-0.684]	0.948 [0.722-1.174]	0.736 [0.55-0.921]	0.921 [0.684-1.157]
dg/da high cost	0.785 [0.665-0.904]	1.166 [0.986-1.346]	0.956 [0.798-1.114]	1.133 [0.955-1.31]
Estimation method	OLS	2SLS	OLS	2SLS
Observations	4,035	4,035	4,035	4,035
Nr municipalities	1,449	1,449	1,449	1,449
R-squared	0.276	0.257	0.305	0.299

Notes: Robust errors in parentheses. Standard errors are clustered by province and year. * significant at 5%; ** significant at 1%. All columns include municipality fixed effects and a time trend. High cost is a dummy equal to 1 if municipality does not have an updated cadaster or an automated tax system. Column 2 uses ln(add transfer) and ln(add transfer)×high as excluded instruments. Column 3 uses the same variables but in levels. Implied dg/da calculated using the average ratio Foncomun/Expenditure. 95% confidence interval is in brackets below the calculated propensities.

response of local spending to grants.

Table 6: Testing additional model predictions

	Ln(expenditure per capita)			
	(1)	(2)	(3)	(4)
Ln(Foncomun per capita)	0.520***	0.723***	0.369***	0.596***
	(0.034)	(0.062)	(0.046)	(0.084)
Ln(Foncomun per capita) × Ln(own revenue per capita 1998)	-0.046***	-0.042**		
	(0.016)	(0.018)		
Ln(Foncomun per capita) × Foncomun/Non-Foncomun 1998			0.033***	0.025*
			(0.010)	(0.014)
Estimation method	OLS	2SLS	OLS	2SLS
Observations	3,308	3,308	3,378	3,378
Nr municipalities	1,176	1,176	1,201	1,201
R-squared	0.256	0.242	0.256	0.242

Notes: Robust errors in parentheses. Standard errors are clustered by province and year. * significant at 5%; ** significant at 1%. All columns include municipality fixed effects and a time trend. Columns 2 and 4 use ln(add transfer) as an instrument for ln(Foncomun per capita).

5.1 Additional checks

As previously mentioned, there are systematic differences between municipalities with low and high tax collection cost. High cost municipalities tend to have smaller, less dense and more rural populations. To the extent that these variables only affect the level of spending, their effect is controlled by including the municipality fixed effect.

A main concern, however, is that the measure of tax collection costs may just reflect these systematic differences. In that case, the estimated $\widehat{\beta}_1$ might capture differences in grant elasticities attributed to these other factors, not to tax collection costs.

I address this concern twofold. First, I include full interactions of ln(Foncomun per capita) with observables such as population size, density, poverty headcount and access to piped water. This procedure effectively accounts for differences in grant elasticities related to these observable factors. If the variable high cost is just picking up these

municipality features, the estimates of β_1 should become insignificant when including these interaction terms.

Columns 1 and 2 in Table 7 display the results using the panel data with fixed effects and the instrumental variable approach. In both cases, findings are similar to the baseline regressions: the grant elasticity of spending is increasing in tax collection costs. Interestingly, the estimates also suggest that municipalities with smaller populations are more responsive to grants. This may reflect a larger marginal benefit of public spending.

Second, I perform a falsification test using the Glass of Milk transfer. In contrast to the Foncomun, the Glass of Milk transfer is fully earmarked to a food assistance program This food program is supported by the central government but managed locally. Since local governments cannot use this revenue to fund other expenditures, we should not expect any differential spending response by tax collection costs. A significant difference would be indicative that the measure of collection costs is picking up another municipality's characteristic which affects public spending.[38]

Columns 3 and 4 in Table 7 show the results of this falsification test. In both cases, I add ln(Glass of Milk per capita) and its interaction with the measure of tax collection costs. Note that the grant elasticity of spending of the Foncomun is still increasing in tax collection costs. In contrast, the elasticity of spending of the Glass of Milk is not different between low and high cost municipalities.

Finally, I check the robustness of the results to alternative ways to construct the measure of tax collection costs. Recall that, in the baseline regression, I classify a municipality as high cost if it lacks both an updated cadaster and an automated tax system.

First, I estimate the baseline regression (13) using both measures of administrative tools separately. Columns 1 to 4 in Table 8 display the results. Columns 1 and 2 replace the dummy high cost by *no cadaster*. This variable indicates lack of an updated cadaster only. Columns 3 and 4 use an indicator of lack of an automated tax system (*no automated*). Note that the results using *no cadaster* are similar to the baseline results. In contrast, the results become insignificant when using *no automated*. This suggests that

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[38]For example, unobserved technical capability or citizen's preference for public spending.

Table 7: Additional checks

	Ln(expenditure per capita)			
	(1)	(2)	(3)	(4)
Ln(Foncomun per capita)	1.303***	1.275***	0.288***	0.554***
	(0.435)	(0.396)	(0.058)	(0.082)
Ln(Foncomun per capita) × high cost	0.126**	0.117**	0.169***	0.137**
	(0.059)	(0.057)	(0.064)	(0.067)
Ln(Glass of Milk per capita)			0.129***	0.099***
			(0.033)	(0.029)
Ln(Glass of Milk per capita) × high cost			0.012	0.016
			(0.033)	(0.040)
Ln(Foncomun per capita) × ln(population)	-0.129***	-0.121***		
	(0.040)	(0.033)		
Ln(Foncomun per capita) × poverty headcount	0.079	0.245		
	(0.278)	(0.349)		
Ln(Foncomun per capita) × population density	0.033***	-0.065		
	(0.010)	(0.045)		
Ln(Foncomun per capita) × % urban population	-0.041	-0.074		
	(0.090)	(0.102)		
Ln(Foncomun per capita) × % piped water	0.054	0.045		
	(0.046)	(0.049)		
Estimation method	OLS	2SLS	OLS	2SLS
Observations	3,973	3,973	4,035	4,035
Nr. municipalities	1,425	1,425	1,449	1,449
R-squared	0.288	0.278	0.288	0.270

Notes: Robust errors in parentheses. Standard errors are clustered by province and year. * significant at 5%; ** significant at 1%. All columns include municipality fixed effects and a time trend. Columns 2 and 4 use ln(add transfer) as an instrument for ln(Foncomun per capita).

combining both measures, as in the baseline regression, may produce more conservative results.

The insignificant result in columns 3 and 4 may be due to the lack of variation in the variable *no automated*. In the sample, 92.5% of municipalities lack an automated tax system. This lack of variation may make the estimates less stable and noisier. To evaluate this, I replicate Table 8 using a more parsimonious specification. In particular, I replace municipality fixed effects by department fixed effects. The results, displayed in Table 9 in the Appendix, are similar to the ones obtained using the baseline specification.

Second, I move towards a more continuous measure of tax collection costs. To do so, I use the number of tax administration tools the municipality lacks (*high number*). This is a discrete variable that ranges from 0 to 2. Columns 5 and 6 in Table 8 show the results using this variable instead of the dummy high cost. Note that the results are similar to the baseline regression.

Table 8: Alternative measures of tax collection costs

	(1)	(2)	(3)	(4)	(5)	(6)
			Ln(expenditure per capita)			
Ln(Foncomun per capita)	0.280***	0.580***	0.456***	0.625***	0.201*	0.485***
	(0.058)	(0.067)	(0.069)	(0.104)	(0.118)	(0.107)
Ln(Foncomun per capita) × no cadaster	0.216***	0.163***				
	(0.064)	(0.059)				
Ln(Foncomun per capita) × no automated			-0.001	0.081		
			(0.070)	(0.089)		
Ln(Foncomun per capita) × high number					0.143**	0.120**
					(0.060)	(0.050)
Estimation method	OLS	2SLS	OLS	2SLS	OLS	2SLS
Municipality fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,516	3,516	4,026	4,026	4,035	4,035
Number of ubigeo	1,262	1,262	1,446	1,446	1,449	1,449
R-squared	0.273	0.252	0.275	0.255	0.276	0.257

Notes: Robust errors in parentheses. Standard errors are clustered by province and year. * significant at 5%; ** significant at 1%. All regressions include municipality fixed effects and a time trend. Column 2, 4 and 6 uses ln(add transfer) as instrument for ln(Foncomun per capita). See main text for definition of *no cadaster*, *no automated* and *high number*.

6 Conclusion

This paper explores empirically the effect of costly local taxation on the responsiveness of local governments to grants from the central government. Using the case of Peruvian district municipalities, I find robust evidence that grants have a greater stimulatory effect on the spending of local governments with higher tax collection costs -measured by the lack of administrative tools.

These findings provide empirical support to the argument that costly taxation partially explains the flypaper effect. In this view, grant recipients may be more responsive to increases in transfers because they are perceived as marginally cheaper than other revenue sources. This argument may also be relevant to explain the lack of fungibility of grants and local revenue in other contexts, such as development aid.

The model also points out to a potential source of inefficiency associated to fiscal decentralization. In particular, local governments may consider grants as cheaper sources of revenue, because they may fail to internalize the cost of funding the transfer scheme. In this case, local spending would be higher than optimal and the flypaper effect would be a symptom of overspending at local level.

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A   Model extensions

A.1   Asymmetric income distribution

In the baseline model I assume a symmetric distribution of the type y_i. Let us relax this assumption and consider a more general case. Denote the median and average y_i are y_m and y, respectively. Also let us define the ratio $k \equiv \frac{y_m}{y}$. I assume that k can be affected by changes on average y_i and that $0 < k < 1$. In this setup k captures the degree of inequality between the average taxpayer and the median voter. The rest of the setup is the same.

With this modification, the government's budget constraint remains the same, $g = y\,[\tau - \Gamma C(\tau)] + a$, and the tax rate can still be written as $\tau = f(\frac{g-a}{y})$. However the equilibrium policy becomes

$$g^* = \arg\max\ 1 - \tau y_m + H(g)$$

because the politician maximizes the median voter's indirect utility.

Solving the maximization problem we can rewrite the equilibrium policy as:

$$g^* = h(kf'(\frac{g-a}{y})) \tag{14}$$

Recall that $h' < 0$ and thus the level of public spending decreases with income inequality k.

Taking total derivatives to (14) we obtain the propensities to spend out of local income and grants:

$$\frac{dg^*}{dy} = \frac{yk'h'f'}{y - kh'f''} - \frac{kh'f''}{y - kh'f''}\frac{g^* - a}{y}$$

$$\frac{dg^*}{da} = -\frac{kh'f''}{y - kh'f''}$$

From these two expressions and definition (5) we can relate both propensities to spend to obtain the magnitude of the flypaper effect:

$$\frac{dg^*}{da} = \frac{dg^*}{dy}(-\frac{k'}{k}\frac{f'}{f''}y + \tau - \Gamma C(\tau))^{-1} \tag{15}$$

Note that, similar to the case of symmetric income distribution, the magnitude of the flypaper effect is increasing on the administrative costs shifter Γ. Moreover, in the particular case when the income distribution is unaffected by changes on average income, $k' = 0$, expression (15) becomes identical to (10).

A.2 Compliance and administrative costs

Consider a more general case with both compliance and administrative costs. In particular, for citizen i the compliance cost is $\Gamma_c C_c(\tau)y_i$ while for the tax authority the administrative cost represents a proportion $\Gamma_a C_a(\tau)$ of the tax base. Both $\Gamma_c C_c(\tau)$ and $\Gamma_a C_a(\tau)$ are increasing and convex functions and adopt values strictly between 0 and τ.

Given the previous assumptions, we can re-write equations (2) and (3) as

$$V_i = 1 - y_i[\tau + \Gamma_c C_c(\tau)] + H(g)$$

$$g = y\left[\tau - \Gamma_a C_a(\tau)\right] + a$$

Rearranging the budget constraint, we can express τ as a function of g:

$$F(\tau) \equiv \tau - \Gamma_a C_a(\tau) = \frac{g-a}{y} \tag{16}$$

where $F' > 0$, $F'' < 0$ by assumption 1 and convexity of $C_a(\tau)$. Since F is a monotonic function, we can write the tax rate as

$$\tau = f\left(\frac{g-a}{y}\right)$$

where $f(\cdot) = F^{-1}(\cdot)$.

It follows that the median citizen's indirect utility can be written as

$$1 - y\left[f + \Gamma_c C_c(f)\right] + H(g) \tag{17}$$

The maximization of equation 17 with respect to g provides the level of public spending in equilibrium;

$$g^* = h((1 + \Gamma_c C_c')f') \tag{18}$$

where $h(\cdot)$ is the inverse function of $H'(\cdot)$.

Calculating comparative statics from (18), we obtain:

$$\frac{dg^*}{dy} = -\frac{h'A}{y - h'A}\frac{g^* - a}{y} \tag{19}$$

$$\frac{dg^*}{da} = -\frac{h'A}{y - h'A} \tag{20}$$

where $A = (1 + \Gamma_c C_c')f'' + f'f'\Gamma_c C_c''$

From visual inspection of (19) and (20), and using definition (16), we obtain the following relation between both propensities to spend:

$$\frac{dg^*}{da} = \frac{dg^*}{dy}\frac{1}{\tau - \Gamma_a C_a(\tau)} \tag{21}$$

Note that the magnitude of the flypaper effect is similar to the obtain in the case without compliance costs. However, the propensities to spend are different.

Note that in the special case of no administrative costs, $\Gamma_c = 0$, expression (21) becomes:

$$\frac{dg^*}{da} = \frac{dg^*}{dy}\frac{1}{\tau^*}$$

Similar to the model only with administrative costs, this extension predicts a propensity to spend out of grants larger than the propensity to spend out of local income.

B   Additional empirical results

Table 9: Alternative measures of tax collection costs - without municipality fixed effect

	Ln(expenditure per capita)					
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(Foncomun per capita)	0.407***	0.560***	0.270**	0.486***	0.229*	0.469***
	(0.099)	(0.081)	(0.133)	(0.102)	(0.134)	(0.107)
Ln(Foncomun per capita) × no cadaster	0.212***	0.110**				
	(0.052)	(0.049)				
Ln(Foncomun per capita) × no automated			0.368***	0.194***		
			(0.098)	(0.075)		
Ln(Foncomun per capita) × high number					0.226***	0.118***
					(0.055)	(0.044)
Estimation method	OLS	2SLS	OLS	2SLS	OLS	2SLS
Municipality fixed effect	No	No	No	No	No	No
Department fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,611	3,611	4,135	4,135	4,144	4,144
R-squared	0.664	0.653	0.687	0.677	0.698	0.687

Notes: Robust errors in parentheses. Standard errors are clustered by province and year. * significant at 5%; ** significant at 1%. All regressions include department fixed effects and a time trend. Column 2, 4 and 6 uses ln(add transfer) as instrument for ln(Foncomun per capita). See main text for definition of *no cadaster*, *no automated* and *high number*.