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FEDERAL TRANSFER MULTIPLIERS. QUASI-EXPERIMENTAL EVIDENCE FROM BRAZIL

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Federal Transfer Multipliers. Quasi-Experimental Evidence from Brazil
Raphael Corbi, Elias Papaioannou, and Paolo Surico
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ABSTRACT

According to Brazilian law, federal transfers to municipal governments change discontinuously at numerous predetermined population thresholds. We employ a 'fuzzy' regression discontinuity design to identify the causal effect of federal transfers on local economic activity. The analysis points to local fiscal multipliers between 1.4 and 1.8 across a range of specifications that control for fixed municipal characteristics, national business cycle and monetary policy. In line with the predictions of a currency union model, transfers from the federal government tend to be more effective for municipalities in states less open to trade and in areas where financial constraints are likely to be tighter.

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1 Introduction

The unprecedented scale and breadth of the policy response to the Great Recession of 2007-09 have reignited the public debate on the ability of government interventions to stimulate the economy. While major international policy institutions, most recently the International Monetary Fund, have revised upward their estimates of the size of the fiscal 'multiplier' (see Blanchard and Leigh (2013)), the debate on the effects of fiscal policy seems far from settled.

A reason behind the lack of consensus among economists and policy makers lies in the fact that the debate has mostly evolved around the notion of a seemingly 'average' multiplier. But as emphasized by recent theoretical work, the effects of government interventions may vary significantly with prevailing macroeconomic conditions, including the zero lower bound of nominal interest rates (Woodford (2011), Christiano, Eichenbaum, and Rebelo (2011)), slack in the labour market (Michaillat (2013)), the exchange rate regime (Corsetti, Kuester and Muller (2013)), trade openness (Nakamura and Steinsson (2014)), and the presence of liquidity constraints (Gali, Lopez-Salido, and Valles (2007)).

The on-going crisis in the Euro-area has also partly shifted the spotlight from quantifying 'average' multipliers to the role of fiscal policy, cross-border transfers in particular, in a currency union. Synthesizing various theoretical insights on the heterogeneous role of fiscal policy, Farhi and Werning (2012) develop a framework, which provides an analytical mapping between the effects of public spending when financed by outside transfers and when financed by local revenues. Their work shows that 'local' multipliers can be quite large when financed by external means. Furthermore, these effects are larger when the local economy is closed and agents face tight liquidity constraints.

Identification. In spite of recent theoretical advances, there is not much empirical research that: (i) quantifies the effects of fiscal transfers in a monetary union and (ii) evaluates the theoretical predictions on the heterogeneous effects of government spending. Furthermore, most empirical studies exploiting regional variation to identify local public spending multipliers draw inference from advanced economies (Shoag (2012), Serrato and Wingender (2014), Nakamura and Steinsson (2013), Acconcia, Corsetti, and Simonelli (2014)) and evidence on emerging markets is scant. This paper tries to fill these gaps in the literature using quasi-experimental policy variation in Brazil, where transfers from the federal government to municipalities change discontinuously at numerous pre-determined population thresholds.

While municipalities belonging to the same population bracket (in a given year and state) receive the same amount of transfers, municipalities with a handful of inhabitants above the upper bound of each bracket receive a significantly larger amount of transfers (on average 20% more) than municipalities with a few inhabitants that fall just below the threshold. Hence, population fluctuations around the pre-determined legislated cut-offs represent an ideal source of (locally) exogenous variation to identify the causal effects of fiscal policy on economic activity employing a ('fuzzy') Regression Discontinuity (RD) design.

Results Preview. Our analysis uncovers three main regularities. First, the average effect on local economic activity of an exogenous increase in government spending of 1% of municipal GDP varies between 1.4% and 1.8% across a range of specifications which, over and above municipality fixed factors, also control for variation in the national business cycle, monetary policy and federal fiscal policy. These results apply both when we use municipal output data (provided by the national statistical agency) and when we use satellite image data on light density at night to account for potential measurement error in the official output estimates.

Second, the average federal transfer multiplier masks considerable heterogeneity. Fiscal policy has pronounced effects in less-developed and more isolated municipalities (mostly in the North of Brazil), whereas government spending multipliers in more-open and economically/financially developed states (mostly in the Center and the South) tend to be around (or just below) one.

Third, we show that both the average fiscal multiplier and the estimated heterogeneity accord well with a calibrated version of the currency union model with federal transfers of Farhi and Werning (2012) that nests neoclassical and Keynesian effects. We also use their framework to approximate fiscal multipliers if municipal spending was financed by local taxes rather than via outside transfers. The counterfactual simulations suggest that the effects of public spending financed by local revenues is between 20% and 50% smaller than the effects when financed by federal transfers.

Related Literature. Our work is related to the voluminous literature that assesses the role of government spending on macroeconomic performance. One strand of works uses time series at the national level, exploiting for identification either aggregate sources of exogenous variation, mostly wars, or imposing zero and sign restrictions in structural vector auto-regressions. Given the identification challenges of these approaches, it should not come as a surprise that this body of research has produced a wide range of estimates (e.g., Ramey (2011), Hall (2009), and Auerbach and Gorodnichenko (2011)).

Thus, a newer and growing strand of the empirical literature has turned to disaggregated analyses, creatively exploiting "quasi-random" variation in public spending across regions. Our paper fits into this line of research. Nakamura and Steinsson (2014) interact state-level military procurement and spending with country-level changes in military build-ups to identify the impact of fiscal shocks on state output. Shoag (2010) uses variation in the idiosyncratic component of US states' portfolio of defined-benefit pension plan asset returns as an "instrument" for local spending. Serrato and Wingender (2014) exploit fund reallocations driven by unanticipated revisions to local population estimates. Overall, these studies report local multipliers over the post-WWII period around two (range 1.4 to 2.6).[1] However, Fishback and Kachanovskaya (2010) and Fishback and Price (2013) find much lower multipliers for the post-Great Depression spending across U.S. states and with WWII military purchases across U.S. counties, respectively.

It is hard extrapolating these findings to other international contexts, as countries vary significantly from the U.S. in terms of trade openness, exchange rate regime, monetary policy stance and liquidity constraints. And theory suggests that these features may affect significantly the fiscal policy-output nexus. There are few works estimating (local) fiscal multipliers outside the U.S. and even fewer papers studying heterogeneity. Acconcia, Corsetti and Simonelli (2014) exploit cuts in public spending triggered by the dismissal of Italian province governments suspected of mafia infiltration and estimate local multipliers just below 2. Porcelli and Trezzi (2014) use variation on public reconstruction activity across Italian municipalities after an earthquake to identify the average effects of public spending and they find much smaller spending multipliers (around 1). Brückner and Tuladhar (2014) exploit geographical variation within Japanese prefectures and report multipliers that are not statistically different from one. Hence, studies outside the United States also yield a wide range of estimates, hinting that there may be considerable heterogeneity. In line with this interpre-

[1] As for recent government interventions, Feyrer and Sacerdote (2012) use state variation in the seniority of the U.S. Congressmen as an "instrument" for local government expenditure; their analysis yields average multipliers below one and some heterogeneity across spending categories. Chodorow-Reich, Feiveson, Liscow and Woolston (2012) exploit pre-crisis variation on medicare/medicaid allocations and find larger effects of the 2009 American Recovery and Reinvestment Act (ARRA) on employment.

tation, Becker, Egger and von Ehrlich (2010, 2013) find significant variation in the response of the local economy to European Union transfers towards disadvantaged regions of member states.[2]

Contribution. While related to these studies, our work departs on some key dimensions. From a methodological standpoint, we build on empirical research in labor and political economy (e.g., Angrist and Lavy (2001), van der Klaauw (2002), Hahn, Todd and Van der Klaauw (2001), Ferrez and Finan (2010)) to develop a 'fuzzy' RD design that identifies local fiscal multipliers. Moreover, building on insights from the growth and development economics literature (and in particular Henderson, Storeygard and Weil (2012)), we combine municipal GDP estimates – which are likely to have non-negligible error-in-variables – with satellite images on light density at night to minimize measurement error and improve upon inference. As luminosity data are available at a very fine resolution level for all countries going back to the early 1990s, this approach can potentially be applied in many other settings where the relevant level of geographical disaggregation poses a challenge for the accuracy of official statistics.

Another important aspect of our analysis is the detailed investigation of the potentially heterogeneous effects of municipal spending across two key dimensions emphasized by the theoretical literature: trade openness and the presence of liquidity constraints. In line with theory, we find that the effects of government spending are particularly pronounced in isolated states and in financially underdeveloped municipalities. Furthermore, we use a calibrated new-Keynesian currency union model to spell out, by means of counterfactual simulations, the mapping between our federal transfer multiplier estimates and spending multipliers financed by local taxes.

Finally, the focus on Brazil seems of independent interest, as the literature appears dominated by studies on advanced economies and estimates for emerging markets are scant. (Notable exceptions are the cross-country studies by Kraay (2010, 2014)).

[2]Our identification design –which is new in the fiscal policy literature– builds on recent research in political economy that has exploited the non-linear allocation mechanism of federal transfers in Brazil to assess their role on poverty and education (Litschig and Morrison (2013) and Gadenne (2014)), test scores (Corbi (2013), and corruption (Brollo, Nannicini, Perotti and Tabellini (2013)). Using a similar 'fuzzy' RD design, though based on the different population thresholds that determine local politicians' pay, Ferraz and Finan (2011a) study the role of monetary incentives on politicians' quality (see also Ferraz and Finan (2008, 2011b)).

Paper Organization. The paper is organized as follows. The next section presents the institutional framework that govern the allocation of federal transfers to Brazilian municipalities. In Section 3 we discuss identification. We first present the 'fuzzy'-RD estimation framework and then discuss the key identifying assumptions. Section 4 reports the baseline results which link output with locally (at the various population cutoffs) exogenous variation in federal transfers. In Section 5 we account for possible measurement error in local GDP using satellite images on light density at night. In Section 6 we first explore the heterogeneous effects of federal transfers across the main Brazilian regions and then investigate heterogeneity with respect to trade openness and financial constraints. In Section 7 we interpret our empirical findings via the lens of the currency union model of Farhi and Werning (2012). We also use the theoretical framework to approximate 'aggregate' multipliers under the counterfactual scenario of locally-financed spending changes. In Section 8 we summarize and discuss areas of future research.

2 Institutional Framework and Data

2.1 Institutional Framework. Federal Transfers Scheme

The Federative Republic of Brazil is organized at three different levels of government: the Union (federal level), 26 states and 1 federal district (the regional level), and $5,565$ municipalities (the local level). The executive and legislative powers are organized independently at all three levels, while the judiciary system is organized only at the federal and state level. Municipal governments are managed by an elected mayor (*Prefeito*) and an elected council (*Camara dos Vereadores*), which are in charge of a significant portion of public goods provision, related to education, health, and (small-scale) infrastructure.[3] Brazilian municipalities have limited ability to raise taxes, which on average (median) correspond to only 6% (4.5%) of total local revenues in our sample of municipalities with less than $51,000$ inhabitants (this represents less than 1% of local GDP; see Table 1). This makes their funding highly dependent on transfers from the states and the federal government. A major role is played by an automatic federal fiscal transfer scheme, the *Fundo de Participação dos Municípios* (FPM). FPM is the largest program of transfers to local municipalities in Brazil, accounting for almost 80% of all types of federal transfers and 32% of total municipal revenues. The

[3]For size and administrative organization, Brazilian municipalities are akin to U.S. counties.

FPM program transferred $R\$29.5$ billion ($US\$14$ billion) from the national government to municipalities in 2006, the middle year of our sample. In comparison, *Bolsa Familia,* which is currently the largest conditional cash transfer program in the world targeting low-income households distributed $R\$8.2$ billion ($US\$3.9$ billion) to 11 million families in the same year. At the national level, the pool of resources for the FPM fund amounts to 22.5% of total revenues raised through the federal income tax and the industrial products tax.

The FPM was introduced in 1965 as a constitutional amendment by the military government in an attempt to distribute resources in an orderly and transparent fashion (and weaken local political elites). The allocation mechanism was shaped by subsequent legislation in 1981 (decree 1881) and was rectified by the Federal Constitution of 1988 (Art. 159 Ib). Since then, there have being no further changes.[4]

In each year, FPM funds are allocated to each municipality according to a predetermined mechanism that relies on local population estimates and the state which the municipality belongs to. First, a fixed share of total funds is assigned to each of the 26 states. Second, each municipality (in a given state and year) is assigned a coefficient that depends on pre-specified population brackets. Specifically, let $FPM_{i,t}^{k}$ be the federal transfers received by municipality i in state k and year t. The allocation mechanism is:

$$FPM_{i,t}^{k} = FPM_{t}^{k} \frac{\lambda^{i,t}}{\sum_{i \epsilon k} \lambda^{i,t}} \tag{1}$$

where FPM_{t}^{k} is the amount allocated to state k in year t and $\lambda^{i,t}$ is the FPM coefficient of municipality i in year t.[5] The fraction $\frac{\lambda^{i,t}}{\sum_{i \epsilon k} \lambda^{i,t}}$ is simply the share of FPM_{t}^{k} transfers in year t for municipality i in state k.

Figure 1 gives the FPM coefficients for each population bracket. The intervals between the various thresholds are equidistant: the population brackets in-between the three first cut-offs ($10,188$, $13,584$, and $16,980$) are $3,396$, while the brackets double to $6,792$ for cities larger than $16,981$ people. In order to have symmetric bands – following Brollo, Nannicini, Tabellini, and Perotti (2013)– our sample consists of municipalities that, in a given year, range from $3,396$ residents below the first threshold to $6,792$ inhabitants above the seventh threshold. Yet we mostly focus in the neighborhood of the cut-offs using various "bandwidths" (1000,

[4]The *Tesouro Nacional* (National Treasury) website provides a detailed description of the FPM program (see http://www3.tesouro.fazenda.gov.br/estados_municipios/download/CartilhaFPM.pdf).

[5]The state shares were determined based on state's population and output according to the 1991 census. Since then the state shares have not been altered. Appendix Table 1 reports the state shares.

500, and 250). Since we have numerous discontinuities, each municipality-year observation is assigned to the nearest cutoff. We construct seven population-intervals centered on each discontinuity. Intervals are bounded by the midpoints between adjacent thresholds. The intervals are [6,793-11,887], [11,887-15,283], [15,283-20,377], [20,377-27,169], [27,169-33,961], [33,961-40,753] and [40,753-50,939]. Appendix Table 2 reports the number of observations (municipality-years) grouped by whether they are above or below each threshold.

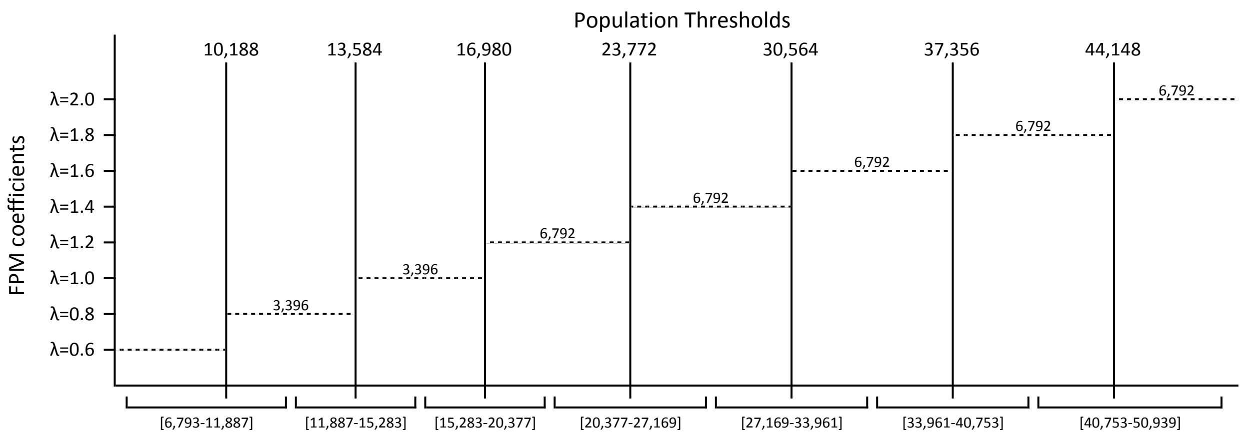


Figure 1: FPM Coefficients and Population Intervals

There are two interesting features of the FPM allocation mechanism. First, municipalities in the same bracket (in a given year and state) should get the exact same amount of federal transfers, independently of the exact number of inhabitants. For example, a city with a population of 5,000 should receive the same amount as a city of 10,000 inhabitants. Thus in per capita terms there are non-negligible differences even for municipalities in the same population interval. Second –and most importantly for our identification– federal transfers change discontinuously at the cutoffs. For instance, the population of Anita Garibaldi, a municipality in the southern state of Santa Catarina, fluctuated between 9,991 and 10,193 over the period 2001-2007. The population count increased by only 13 inhabitants between 2002 and 2003 (from 10,180 to 10,193), but, since the first threshold is at 10,188, transfers increased considerably (by R\$78,087) in 2003. Yet, in 2004, when the population fell by just 38 to 10,155, FPM transfers dropped by R\$243,624.[6]

The FPM coefficients are based on yearly population estimates produced by the federal statistical agency, the IBGE –*Instituto Brasileiro de Geografia e Estatistica* (Brazilian In-

[6]In the Supplementary Appendix we exemplify the non-linear allocation mechanism of federal transfers discussing in detail four additional examples.

stitute of Geography and Statistics)– and supervised by a federal court. IBGE calculates municipal population taking into consideration past censuses, regional birth and death rates, migration trends, and other features.[7] Figure 2 describes the timeline of the allocation process. The population estimates for year t (e.g. 2001) are made publicly by October 31^{st} of year t-1 (2000). On the basis of these estimates, the Federal Budget Court (*Tribunal de Contas da Uniao*) publishes the FPM coefficient for each municipality. Given this information, local authorities form the budget for the (fiscal) year t (e.g. 2001). The budget is typically approved by the municipal councils by the end of year t-1 (December 2000) and FPM funds are transferred during year t (2001).

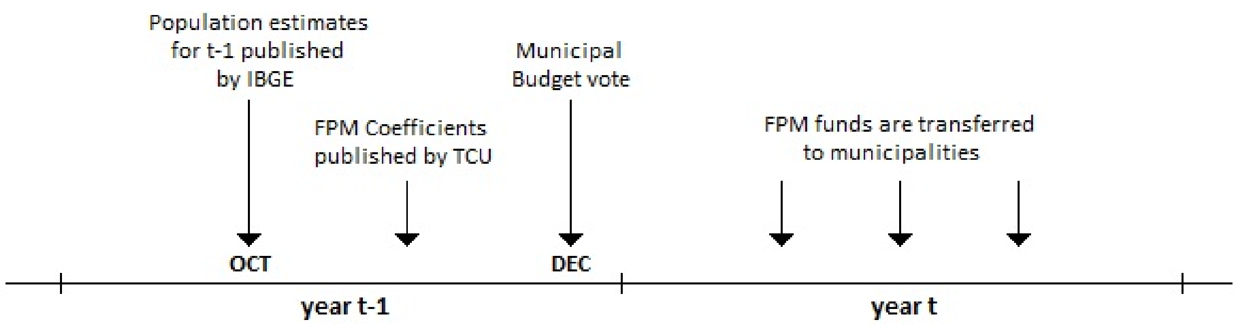


Figure 2: FPM Allocation Timeline

2.2 Sample and Descriptive Evidence

As the number of municipalities falls with population (Appendix Table 2) and because reliance on federal transfers is smaller for larger cities (which have other means to finance their budgets), we follow Brollo, Nannicini, Perotti and Tabellini (2013) and focus on the seven lower thresholds, thereby examining the role of federal transfers to municipalities with a population between $6,793$ and $50,939$ inhabitants. To account for some (unrealistically) high or low values of population and GDP growth (exceeding 50%), we drop the top and bottom 1% of observations for the main variables in each year.[8] This results into an unbalanced panel of $27,987$ observations, covering $3,139$ distinct municipalities over the period $2000-2011$.

[7] The IBGE methodology tries to make local population estimates consistent with state-level and federal-level estimates (http://www.ibge.gov.br/home/estatistica/populacao/estimativa_pop.shtm).

[8] Our results are robust to this particular treatment of outliers. Since our sample still includes some unrealistically high/low values we estimate (and report) empirical models with least-absolute-deviation (median) and Huber's "robust" regression method.

Overall, our sample covers 60% of Brazilian municipalities. These account for about 25% of Brazilian population, which was close to 175 (197) million in 2000 (2011).

Table 1 illustrates the richness of the experiment. Panel A shows that our sample is almost equally split between municipalities that during the period 2000-2011 stay in the same population bracket (which serve as the 'control' group) and municipalities that move to either a higher or lower population bracket (which constitute the 'treatment' group). In particular, $1,256$ of the $3,139$ municipalities (40%) do not change population bracket in any given year. $1,050$ municipalities experience only positive jumps (33.3%), 74 cities experience only negative jumps, while 759 municipalities (26.5%) experience at least one positive and one negative jump. Since in most specifications we focus on the neighborhood of the seven cutoffs, in Appendix Table 3 we tabulate similar statistics narrowing to the seven population cutoffs using a $1,000$ and a 500 "bandwidth". The pattern is similar. Our "local" sample is almost evenly split between municipalities whose population fluctuates around the cutoffs but without crossing them and municipalities that move to a higher or lower FPM population interval.

Panels B and C report the number of municipalities that remain in the same population bracket or move to move across brackets by year and by cut-off. Almost all movements are either to the immediately higher (+1) or lower (-1) population brackets, $1,513$ and 519 episodes respectively. The larger number of positive jumps should not come as a surprise, as during this period Brazil experienced considerable population growth. Most of the upward or downward jumps regard cities falling within the first four thresholds (i.e. with population up to $27,169$). There are fewer jumps around thresholds 5, 6, and 7. This is mainly driven by the fact that around two-thirds of the municipalities in our sample are small; the number of jumps in any population bracket relative to the number of observations is roughly constant.

2.3 Data and Summary Statistics

Municipal output data, fiscal policy variables, and population estimates are provided by the IBGE and retrieved from IPEA's (*Instituto Pesquisas Economica Aplicada*) web-site. IBGE employs a top-down approach that first calculates federal and state output across 15 sectors (public administration, fishing, agriculture, mineral extraction, construction, food, transportation, etc.) and then constructs municipal output using state-level GDP estimates. To approximate municipal output, IBGE combines value added measures at the state level with the structure of production at the local level (i.e. municipal sectoral share of employees, production, income, social contributions, etc.) using a variety of sectoral censi and surveys[9]. Data on FPM transfers are retrieved from the National Treasury (*Tesouro Nacional*).

Table 2 - Panel *A* reports summary statistics for population and output growth. Average (median) population growth in our sample is 1.1% (0.9%), reflecting the overall increase over this period in Brazilian population. Average municipal GDP per capita growth in our sample is strong, around 5.0%. For the same period, the average GDP growth at the national level has been approximately 3.6%. The stronger performance in our sample comes from the fact that growth has been smaller in bigger cities: for example, output growth in the two largest cities, *Sao Paulo* and *Rio de Janeiro*, which account for almost 20% of the country's population, has been around 2%.

Table 2 - Panel *B* gives summary statistics on the fiscal condition of Brazilian municipalities. FPM transfers constitute a significant portion of municipality revenue and expenditure. FPM transfers account on average for 3.5% of local GDP and approximately 25% of the local budget, while municipal spending accounts for 12% of municipal output. Reliance on FPM transfers is larger for smaller cities. FPM transfers account for 4% of local GDP for cities with a population less than $16,980$, while it is 2.2% for cities with a population from $30,000$ to $50,000$. The other main sources of municipalities' revenue are transfers from the state governments and in some cases royalties, which on average constitute 7.5% of local GDP. Since there are institutional constraints which prevent municipalities for borrowing and overspending, localities run balanced budgets (on average there is a tiny fiscal surplus of 0.2% of local GDP).[10] In our sample we observe expenditure exceeding revenue only in 5% of our sample (and even in these cases the deficits seem negligible).[11]

IBGE also provides information on the composition of spending. According to the Brazilian Constitution (Art. 24), municipalities are responsible for providing an array of basic services, such as building and running elementary schools ('education') and primary health clinics ('health'). Local governments also spend on infrastructure, such as building local roads and running local water supply, sanitation and waste management systems ('housing

[9]For a complete description of the methodology, go to http://www.ibge.gov.br/home/estatistica/economia /pibmunicipios/srmpibmunicipios.pdf

[10]The key piece of legislation imposing restrictions on over-borrowing and running fiscal deficits at all three layers of the administration is the Fiscal Responsibility Law of 2000 (see Melo, Pereira, and Souza (2010)).

[11]Appendix Table 4 gives summary statistics in the "local" (to the FPM cut-offs) sample using a $1,000$ inhabitants bandwidth. There are no major differences.

and urbanism'). The largest component of municipal spending is education (around 32% of total expenditure) followed by Health and Sanitation (20%), Administration (16%) and Housing & Urbanism (10%).[12]

3 Identification

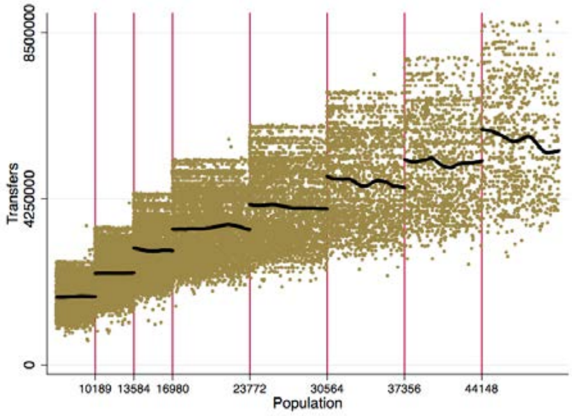
In this section, we first describe the "fuzzy" regression discontinuity (RD) design that allows us to isolate the causal effect of municipality spending – stemming from locally exogenous changes in federal transfers around the FPM cutoffs – on economic activity. We then discuss and present supportive evidence on the validity of the key identifying assumptions.

3.1 Empirical Framework. "Fuzzy" RD Design

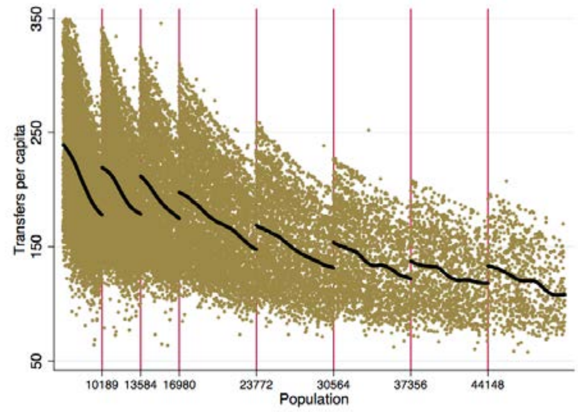
Source of Exogenous Variation. The allocation of FPM transfers to municipal governments is a non-linear function of population. While both the level and changes in population are likely to depend on local economic conditions and other hard-to-observe factors, federal transfers change abruptly at several pre-determined population thresholds. Hence, population movements around the cutoffs can be used as a source of quasi-exogenous variation to estimate the causal effects of fiscal policy on municipal economic activity in the neighborhood of the discontinuity generated by each threshold (Angrist and Pischke (2008)). This identification design relies on the fact that federal transfers change discontinuously following a smooth change in municipal population (and other relevant factors) across the cut-offs.

To illustrate the discontinuities in the allocation mechanism, in Figure 3*a* we plot actual FPM transfers (on the vertical axis) against population (on the horizontal axis). The solid red vertical lines indicate the population cutoffs at which the transfer allocation coefficients (λ) change (Figure 1). Small light-colored dots represent municipality-year observations. Large dark dots denote averages over population bins of 200 inhabitants. Jumps are visible whenever population crosses the FPM cutoffs. The discontinuities become even more apparent in Figure 3*b*, which displays the relationship between transfers per capita and population. Since the increase in the allocation coefficients (λ) at each cutoff is the same (0.2), in per capita terms the largest increase/decrease applies to the smallest cutoffs.

[12]The other categories of public spending (e.g., Agriculture, Communications, Labour, Social Assistance,



(a) Actual FPM Transfers



(b) Actual FPM Transfers per capita

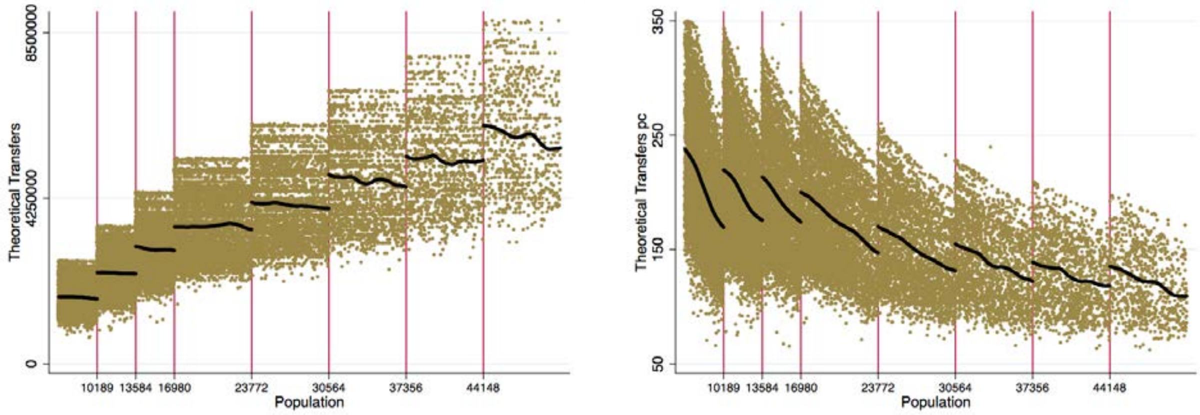
Figure 3: Actual FPM Transfers vs Population Estimates

As federal transfers are not shaped exclusively by the FPM population brackets, we apply a 'fuzzy' regression discontinuity approach, which allows for imprecise assignment to a particular treatment.[13] This approach isolates the component of federal transfers that would have occurred close to the discontinuity if enforcement was perfect. In this regard, applying the FPM formula (equation (1)) we estimate for every municipality in each year the law-implied ('theoretical') FPM transfers ($\tilde{T}_{i,t}$), which is solely based on: (i) the total pot of FPM in the country in every year; (ii) the fixed state shares; and (iii) the FPM coefficients of each municipality (in a given state in year). Figures 4a-4b plot law-implied (theoretical) FPM transfers (in levels and in per capita) against municipal population. In these plots the discontinuities at the seven cutoffs are sharp by construction.

Empirical Specification. If actual FPM transfers ($T_{i,t}$) was the only relevant factor that changes discontinuously at the cutoffs, then we could estimate the effects of locally exogenous (law-implied) movements of municipalities across population thresholds on economic activity, running variants of the following empirical specifications in the "neighborhood" (h)

etc.) are quite small (consisting individually of less than 5% of total spending).

[13]This mis-assignment of funds has many causes, including the fact that throughout the 1990s some municipalities split into two, but (temporarily) managed to keep their former FPM coefficient through court disputes. In an effort to correct such distortions, the federal government established that by 2008 all municipalities should be framed in the correct population brackets with their relevant coefficients. To avoid immediate disruption to the public finances of the involved municipalities, however, the law established a transition period to the new regime, so that in the period 2001-07 some municipalities still received FPM transfers that were not consistent with their population.



(a) Law-implied FPM Transfers (b) Law-implied FPM Transfers per capita

Figure 4: Law-implied FPM Transfers vs Population Estimates

of the seven population cutoffs (c)

$$\begin{aligned} FS &: \quad T_{i,t} = f(P^c_{i,t-1}) + \gamma_{FS}\tilde{T}_{i,t} + \lambda_i + \delta_t + \varepsilon_{i,t} \qquad (2) \\ RF &: \quad Y_{i,t} = f(P^c_{i,t-1}) + \gamma_{RF}\tilde{T}_{i,t} + \lambda_i + \delta_t + \varepsilon_{i,t} \qquad (3) \\ \forall P_{i,t-1} &\in \quad (c-h, c+h) \end{aligned}$$

The first (stage) specification associates actual federal transfers ($T_{i,t}$) with theoretical FPM transfers ($\tilde{T}_{i,t}$). Under perfect assignment, the coefficient on theoretical transfers (γ_{FS}) should equal one and the model fit should be perfect ($R^2 = 1$). The second specification links (in a "reduced form") municipal output ($Y_{i,t}$) to theoretical (law-implied) transfers ($\tilde{T}_{i,t}$) that (conditional on time fixed effects and state-municipality fixed factors) are based solely on the FPM coefficients.

δ_t is a vector of year constants capturing aggregate developments, such as federal tax proceeds (which affect the size of the FPM program) and national business cycles. λ_i represents municipal fixed effects, which capture all time-invariant factors determining local output (and possibly spending) that may be related to geography, ecology, culture, local institutional quality, corruption, etc.[14]

$f(P^c_{i,t-1})$ is a RD-polynomial on population (the 'running-forcing' variable) that accounts

[14] Naritomi, Soares, and Assuncao (2012), for instance, show that there are sizable differences across Brazilian municipalities on institutional quality that are related to the type of colonization and local geographic features.

for how far/close municipalities are from the closest cutoff (^{c}) in the previous year ($_{t-1}$). Following Angrist and Lavy (1999), Hahn, Todd and Van der Klaauw (2001), van der Klaauw (2002), and subsequent works (e.g., Brollo, Nannicini, Tabellini, and Perotti (2013), Ferrez and Finan (2011)), we combine the estimation of the "first-stage" regression and the "reduced-form" specification in an Instrumental Variable (IV) set-up, which isolates the effects on municipal output of locally (close to the discontinuities) exogenous changes in federal transfers ('fuzzy' RD).[15] The IV ("fuzzy") model reads:

$$\begin{aligned} IV \quad &: \quad Y_{i,t} = f(P^c_{i,t-1}) + \gamma_{IV}\hat{T}_{i,t} + \lambda_i + \delta_t + \varepsilon_{i,t} \\ \forall P_{i,t-1} \quad &\in \quad (c-h, c+h) \end{aligned} \tag{4}$$

where $\hat{T}_{i,t}$ denotes the component or actual federal transfers predicted by the law solely on the basis of the population discontinuities generated by the non-linear allocation mechanism.

Local Regression Approach. Following Imbens and Lemieux (2008), Lee and Lemieux (2010, 2014), Angrist and Pischke (2009), and Gelmand and Imbens (2014), we estimate two-variants of 'local regression specifications', which restrict estimation in the neighborhood of the seven cutoffs using four bandwidths (h = 1000, 750, 500 and 250 inhabitants). First, we estimate simple OLS and IV models without including any RD polynomials. This approach is transparent, simple and straightforward to implement (Angrist and Lavy (1999)). However, it may yield imprecise estimates, especially when the bandwidth is small. Moreover this method may still not account well for differences in population (especially when the bandwidth is wide). Second, we estimate local regressions with a "rectangular kernel". These models include cutoff-specific linear RD polynomials on municipality population, allowing for different slopes of standardized population for municipalities below and above the discontinuity. Moreover these models also include cutoff-specific constants.[16]

[15]See Angrist, Battistin, Vuri (2014), Hinnerich and Pettersson-Lidbom (2014), Pettersson-Lidbom (2012)

[16]Imbens and Lemieux (2008) write "*from a practical point of view, one may just focus on the simple rectangular kernel, but verify the robustness of the results to different choices of bandwidth.*" Lee and Lemieux (2010) argue that it is "*more transparent to just estimate standard linear regressions (rectangular kernel) with a variety of bandwidths, instead of trying out different kernels corresponding to particular weighted regressions that are more difficult to interpret.*" For completeness, we also report in the appendix specifications using all observations (both far and close to discontinuities) and conditioning on high-order cutoff-specific RD polynomials (as Brollo, Nannicini, Tabellini and Perotti (2013)). While this approach would seem less attractive because it places equal weight to municipalities far and close to the discontinuities (see Gelmand and Imbens (2014)), it yields similar results.

Specifications. We estimate three variants of the 'fuzzy' RD (IV) model. First, we run log level specifications where all variables (output, actual and law-implied FPM transfers) are expressed in logarithmic per capita terms ($y_{i,t} \equiv \log(Y_{i,t}/P_{i,t}); \tilde{t} = \log(\tilde{T}_{i,t}/P_{i,t}); t = \log(T_{i,t}/P_{i,t})$). Namely:

$$\log Level \quad : \quad y_{i,t} = f(P^c_{i,t-1}) + \gamma_{IV}\hat{\tau}_{i,t} + \lambda_i + \delta_t + \varepsilon_{i,t} \tag{5}$$

$$\forall P_{i,t-1} \quad \in \quad (c-h, c+h); \;\; h\{1000, 750, 500, 250)$$

where $\hat{\tau}_{i,t}$ denotes the component of the logarithm of actual transfers per capita ($t = \log(T_{i,t}/P_{i,t})$) predicted by the log of law-implied FPM transfers per capita ($\tilde{t} = \log(\tilde{T}_{i,t}/P_{i,t})$).

Second, we first-difference the above regression equation and estimate models on log differences which, over and above year fixed effects, also include state fixed effects (λ_s), so as to further account for unobserved factors on growth rates.[17] The log difference 'fuzzy' RD (IV) model reads:

$$\log Diff \quad : \quad \Delta y_{i,t} = f(P^c_{i,t-1}, P^c_{i,t-2}) + \gamma_{IV}\Delta\hat{\tau}_{i,t} + \lambda_s + \delta_t + \varepsilon_{i,t} \tag{6}$$

$$\forall P_{i,t-1}, \forall P_{i,t-2} \quad \in \quad (c-h, c+h); \;\; h\{1000, 750, 500, 250)$$

In the log difference specification we focus on municipalities that in the previous two years stay within each of the four bandwidths.

Third, we estimate specifications in differences without taking a logarithmic transformation, as this yields a coefficient estimate that can directly be interpreted as a local federal transfer multiplier. This approach is perhaps more appropriate as the FPM allocation mechanism is expressed in levels rather than in logs.[18] However, since GDP contains some extreme observations, we estimate these specifications both with OLS and using least-absolute-deviation, which computes median treatment effects.

Notes. An attractive feature of the Brazilian allocation mechanism is the presence of many discontinuities. Thus our results are unlikely to be subject to the usual critique of most

[17] In the previous draft of the paper, we also estimated specifications in log differences (growth rates) which also included municipality fixed effects. Yet, as Lee and Lemieux (2010) argue it is unnecessary for identification in an RD design to add panel fixed effects, as this imposes stricter identifying assumptions. Moreover further "differencing" the data leads to an efficiency loss, yielding somewhat imprecise estimates.

[18] We thank Josh Angrist for making this remark.

RD estimates that, since the identified effects are local (at the discontinuity), they may not apply globally. It would seem of some interest to point it out that, unlike earlier contributions exploiting the allocation of federal resources across municipalities in Brazil to study other outcomes, our design makes the identification strategy in this paper particularly strong. This is because, by exploiting within-municipality variation, we are also able to account for unobserved features (see also Gadenne (2014)). This seems key as almost certainly in a large and heterogeneous country such as Brazil, municipalities differ considerably across many dimensions (see Pettersson-Lidbom (2012) for a similar discussion in the context of Swedish and Finnish municipalities). In all specifications, we report heteroskedasticity-robust standard errors clustered at the micro-region level, which the IBGE defines as "*groups of economically integrated municipalities sharing borders and structure of production*".[19] This approach accounts both for residual auto-correlation and for spatial spillovers across nearby (adjacent) municipalities. This adjustment yields more conservative estimates as standard errors are larger as compared to simply clustering at the municipality level.

3.2 Identifying Assumptions

The RD design relies on four identifying assumptions.

I) Federal Transfers at the Discontinuities. A *sine qua non* requirement is that FPM transfers change sharply when municipalities move (smoothly) across the FPM population cutoffs. Figures $4a - b$ provides visual support for this: in spite of noise in the allocation of federal funds, there are evident jumps at the FPM thresholds. Figure 5 plots actual FPM transfers per capita averaged across all seven cutoffs over 50 inhabitants bins. There is clear evidence that the law shaping FPM transfers is broadly enforced, although some mis-assignment is evident even with averaged-data.

In Table 3, we formally assess the link between actual FPM transfers and law-implied (theoretical) transfers. All specifications include state fixed effects and year constants to account for the fixed state shares and time variation in the size of the overall FPM program, which changes as the Brazilian economy (and thus federal proceeds) grows (equation (1)). The estimates in row (1) show that -in line with the allocation mechanism- there is an almost

[19] See IBGE (1990, page 10). Our sample comprises 547 micro-regions with an average of 21 micro-regions per state and 5 municipalities per micro-region.

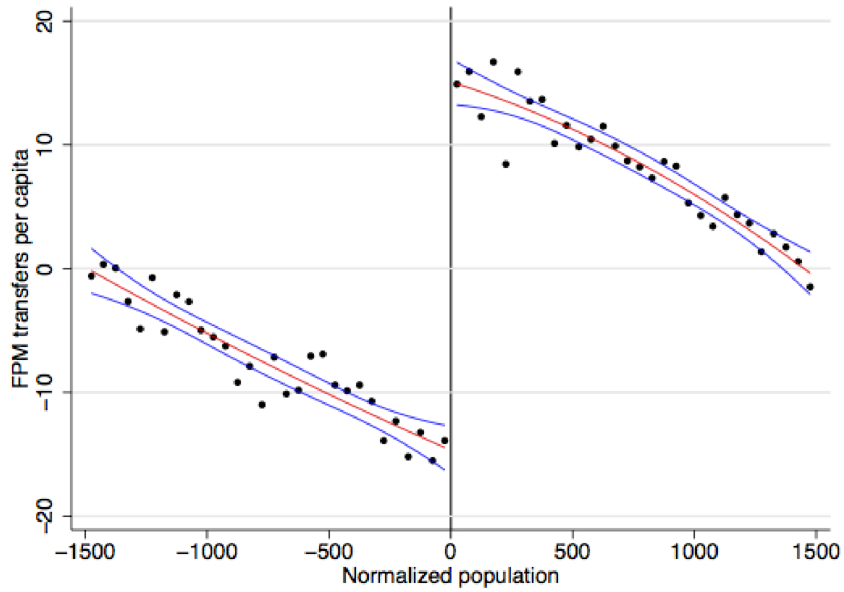


Figure 5: Actual FPM Transfers per capita

one-to-one relationship between law-predicted and actual transfers. The same applies when we divide actual and law-predicted by population (row (2)). While the coefficient on law-predicted transfers is close to 1, the model-fit is far from perfect, indicating that the rules are not fully enforced. The within (marginal) R^2 (once we also net out both state fixed effects and year fixed effects) is high, but well-below one (around $0.5 - 0.65$). In rows (3) and (4) we report least absolute deviation (median) and Huber (robust regression) estimates to account for outliers. The estimate is 0.99 implying a one-to-one relationship.[20]

II) Local Government Spending. A related condition for identification is that municipal spending also changes abruptly at the cutoffs in response to FPM shocks. Figure 6 plots average (across all seven cutoffs) municipal spending below and above the discontinuities. While relatively more noisy than FPM transfers, municipal spending also visibly changes discontinuously at the cutoffs. This result is not surprising since municipalities are required by law to (and actually do) run balanced budgets (Table 2-Panel *B*). In Appendix Table 8 we

[20] Appendix Table 5 reports analogous specifications in logs. The message is similar. There is a significant link between the logarithm of federal transfers (per capita) and the log of law-implied (theoretical) FPM transfers. In Appendix Table 6 we show that similar results are obtained using FPM transfers in first differences. While the OLS coefficients in the first-difference specifications are somewhat attenuated, least absolute deviation (median) and Huber estimates are very close to one. Appendix Table 7 shows that the link between actual (realized) and law-implied FPM transfers applies across all seven cutoffs.

further examine the responsiveness of local government expenditure to FPM transfers. The OLS and LAD local regression estimates are close to (and not statistically different from) one. The model fit is relatively good, though lower than the one linking law-implied FPM transfers to actual transfers (Table 3). The association between law-implied FPM transfers and municipal spending holds for municipalities near to all cutoffs (Appendix Table 9). We also estimated two-stage-least-squares (2SLS) models linking municipal spending with the component of FPM transfers predicted by the law. The 2SLS estimates (reported in Appendix Table 10) are close to one, suggesting that local government spending responds almost one to one to federal transfer shocks.

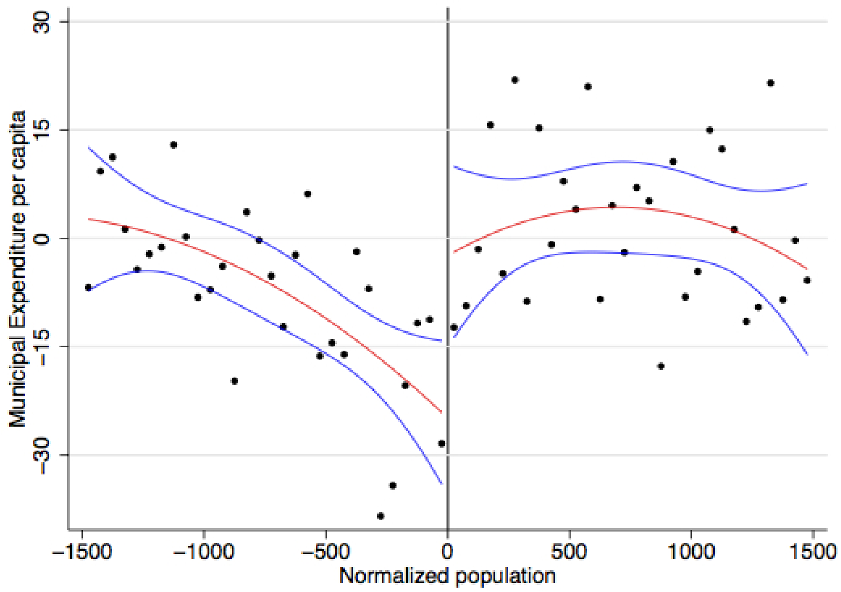


Figure 6: Local Expenditure per capita

III) Other Fiscal Instruments. Another necessary condition for identification is that no factor other than FPM transfers (and local expenditure) moves abruptly at the thresholds. This is a standard assumption in RD setups and it requires that any other relevant covariates vary smoothly in the cutoffs (Imbens and Lemieux (2008), Lee and Imbens (2010, 2014)). This assumption is similar to the 'exclusion restriction' in an IV setting requiring that the 'instrument' (law-implied FPM transfers around the cutoffs in our application) should affect the outcome variable (GDP) only via determining the endogenous variable (actual FPM transfers). While this assumption cannot be directly tested, there are many pieces of supportive evidence.

First, since our identification strategy compares federal transfers and output for the same municipality (at different points in time), concerns related to 'selection' or that cities may differ systematically across geographic, institutional, or other features (which apply to cross-sectional approaches) are not particularly severe. Furthermore, Gadenne (2014) shows that municipalities moving to an adjacent FPM population bracket are similar to those that do not cross the cutoffs, across many political economy features, such as the political alignment of the mayor and councillors to the federal government, political competition, and mayoral terms.

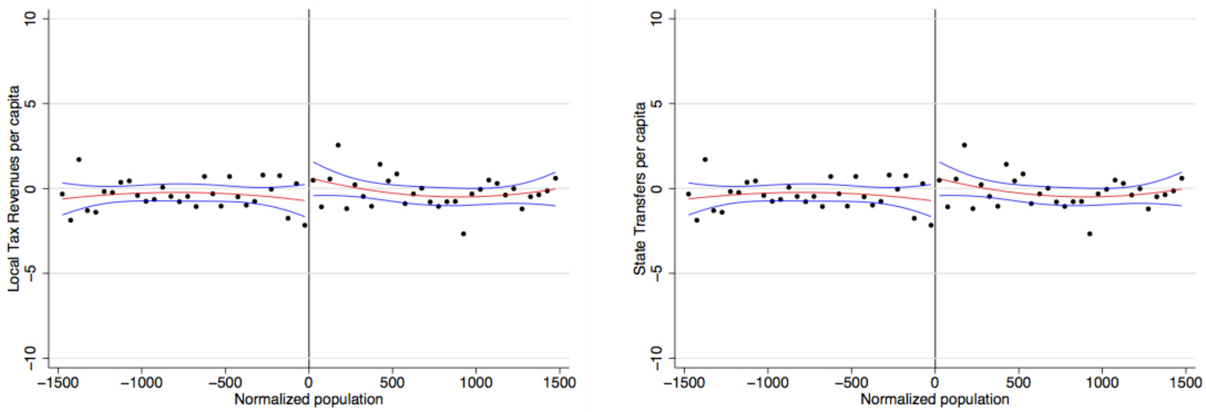
Second, previous cross-sectional studies show that municipal characteristics are quite similar at both sides of the cut-offs (e.g., Brollo, Nannicini, Tabellini and Perotti (2013), Litschig and Morrison (2012)). While there is some weak evidence that the national government in the late 1980s and early 1990s tried to favor municipalities with politically aligned local politicians, this effect has decayed over time, and in any case such an effect would be absorbed by the municipality constants.[21]

Third, to the best of our knowledge there is no other federal or state grant scheme following such a discontinuous allocation mechanism.[22] Yet, one may worry that those local governments gaining extra FPM funds may decide not to spend them. Likewise, municipalities that receive a lower amount of FPM funds (because their population falls into a lower bracket) may obtain additional funding from the state, other federal transfer programs or by raising local taxes. Both the legal-institutional setting and the summary statistics (Table 2-Panel B) suggest that these issues are unlikely to be present in our setting: municipalities appear to run balanced budgets and their expenditure seems to adjust to changes in revenues.

In Table 4 we formally examine whether FPM transfers correlate with local tax revenues and state transfers close to the seven population cut-offs using increasingly narrower bandwidths. In some sense, this is a 'placebo' test as there should be no abrupt change on local tax and state revenues for municipalities just above the FPM cut-offs. Starting with the

[21]Litschig (2013) shows that there was some sorting in the early 1990s as the central government favored cities aligned with it. Yet, Brollo, Naniccini, Perotti, and Tabellini (2013), who focus on the 2000s, show that there is little evidence of manipulation.

[22]After 2004 local councillors pay increases abruptly (by 50%) for municipalities with more than $10,000$ inhabitants, a value close to the first threshold of $10,188$. Ferrez and Finan (2011) show that the characteristics of councillors differ at this cutoff. In the Supplementary Appendix, we verify that our findings are not sensitive to excluding observations centered on the initial cutoff of $10,188$.



(a) Local Tax Revenue

(b) Transfers from State-level government

Figure 7: Other sources of revenue around population cutoffs

evolution of local tax revenues in Panel A, the local regression estimates in columns (2)-(5) are small and statistically indistinguishable from zero The within-R^2 is less than 1%. These patterns, which apply both in the (log) level and the (log) difference specifications show that local taxes do not vary systematically at the population cut-offs where FPM transfers change sharply. Figure 7a provides a visualization of this pattern.

The picture is similar when we study the evolution of transfers per capita from state-level government around the FPM discontinuities in Panel B. The local regression estimates in columns (2)-(5) are statistically indistinguishable from zero and the within R^2 is zero. Figure 7b provides an illustration by plotting transfers per capita from state-level government around the cut-off points. There is virtually no change at the FPM discontinuities.

IV) Precise Systematic Manipulation. The final identification assumption is that authorities should not systematically and precisely manipulate population estimates so as to receive more transfers. Several pieces of evidence suggest that manipulation is not a serious concern.[23] First, since we exploit within-municipality variation, we assuage concerns that federal authorities may systematically favor some municipalities or some regions. Second, as previous works have shown, there seems to be little manipulative sorting even when one

[23] One should stress here that the validity of the RD design in challenged only if municipalities can precisely manipulate population (the 'assignment' variable). Lee and Lemieux (2014) write: "*If individuals – even while having some influence – are unable to precisely manipulate the assignment variable, a consequence of this is that the variation in treatment near the threshold is randomized as though from a randomized experiment.*" See also Lee (2008).

examines cross-sectional variation. The lack of systematic manipulation is not particularly surprising because the local population estimates are produced by an independent federal agency rather than by local (or state) administrators. Moreover, population estimates and IBGE work is supervised by the Federal Court of Auditors. Actually if there is manipulation, this seems to be the case for the census years.[24] Third, our sample includes many cities that move to lower population brackets and it seems implausible to think that the multiplier associated with a negative jump be the outcome of manipulation. Fourth, in the spirit of McCrary (2008), we examined whether there is sorting of municipalities on the right of the population cut-offs. In line with previous studies, the distribution plots (reported in the Appendix) show no much bunching on the right of the seven discontinuities. An exception is 2008 and 2011, which reflect the special population census of 2007 and the regular census of 2010. We have thus verified that our findings are not sensitive to excluding the year 2008 (or the period 2008-2011), whose population changes, while still unrelated to the local business cycle, may have been anticipated or manipulated.

4 Baseline Empirical Results

This section presents our baseline estimates on the average effect of locally exogenous changes of public spending on municipal economic activity. We begin by reporting the 'reduced-form' specifications which associate municipal output (growth) with law-implied ('theoretical') federal transfers in the neighborhood of the FPM cut-offs. We then estimate the average effect of municipal government spending on local economic activity combining the 'reduced-form' and the 'first-stage' estimates into an instrumental variable setting ('fuzzy' RD).

4.1 Reduced-Form Estimates

Table 5 presents estimates of the 'reduced-form' specification that associates real per-capita municipal GDP with law-implied (theoretical) FPM transfers per capita. Panel A reports (log) level specifications (with year and municipality fixed effects), while Panel B gives (log) difference specifications (with year and state fixed effects). To account for output growth dynamics, we augment the (log) difference specification with two lags of the dependent variable.

[24] Furthermore, most local authorities attempt to extract larger shares of federal funds were pursued by splitting from or merging with other municipalities as well as by appealing to the federal budget court, a supreme institution which seems unlikely to be influenced systematically by small municipalities.

Accordingly, in all tables, we report the cumulated response of output (given by $\gamma/(1\text{-}\rho_1\text{-}\rho_2)$ where γ is the coefficient on FPM transfers and ρ_s are the autoregressive coefficients).[25]

Columns (2)-(5) and (6)-(9) report local linear regression estimates that restrict estimation in the 'neighborhood' of the seven discontinuities using progressively smaller bandwidths. We move from a bandwidth of 1000 inhabitants in each side of the cut-offs (in (2) and (6)), to 750 inhabitants (in (3) and (7)), to 500 (in (4) and (8)) and 250 (in (5) and (9)). Narrowing the bandwidth minimizes concerns that the estimates capture the effect of some unobserved feature or reverse causation. Yet, this comes at an efficiency cost since the number of observations falls (considerably in the case of the 250 bandwidth). In columns (2)-(5) we report simple local linear regressions, while columns (6)-(9) report models with cut-off-specific linear polynomials on population distance from the discontinuity, allowing for different slopes above and below each cut-off and also cut-off-specific constants ("rectangular kernel"). For comparability to the local regression estimates, in column (1) we report simple OLS estimates in the full sample (i.e. both close and far from the discontinuities).

Four main regularities emerge from the (log) level specifications in Panel *A*. First, across all permutations the elasticity of output with law-implied (theoretical) FPM transfers is positive and statistically significant at standard confidence levels. This applies even in the restrictive specifications (in (5) and (9)) where we use a bandwidth of 250 inhabitants. Second, consistent with our identification strategy, the point estimates tend to decline when we narrow estimation close to the cut-offs. The coefficient stabilizes when we use the 500 inhabitants bandwidth (0.065 and 0.055). These elasticities imply that a one percent increase in federal transfers is associated with a rise in local GDP of approximately 0.06%. Third, the local regression estimates that include the RD rectangular kernel yield somewhat more conservative estimates, suggesting that conditioning further on population improves the identification of the impact of law-implied FPM transfers on local output.[26] Fourth, the elasticity of federal transfers to GDP over the full sample is significantly larger than the elasticities in the neighborhood of the discontinuities, illustrating the usefulness of the RD approach.[27]

[25] In Appendix Table 11 we assess robustness to various lag length selection. Given the presence of municipality fixed effects, we refrain to augment the level specifications with any lag of the dependent variable as this would be subject to the "Nickell-bias".

[26] Adding higher-order RD polynomials on population distance to the cutoffs yields similar estimates.

[27] To the extent that in the full-sample higher local population drives both higher municipal economic activity and higher local government spending/federal transfers, one would expect the estimates in column (1) to be larger than the estimates of the restricted "local" samples in any other column.

Panel B reports log difference specifications. The results are similar. The RD estimates of our preferred specification in (column (8)) which zooms on a 500 bandwidth near the discontinuities and includes cut-off-specific RD polynomials is 0.061. The estimate is only slightly larger, when we do not include the rectangular kernel, 0.068 (in (4)). Thus the log difference specifications also imply that a federal transfer increase of 1% boosts on average local economic activity by 0.065%.

Panel C reports the median treatment effect (using least absolute deviations) based on the difference specification without taking logs. The RD estimates are once more strongly significant across all specifications, with a coefficient that tends to stabilize around 1.4 reais (per any one reais increase in theoretical transfers) in our favorite model using a 500 inhabitant's bandwidth. As we will show in the next section, the estimates in Panels A and B of Table 5 produce similar fiscal multipliers.

Sensitivity Analysis. We have performed various checks examining the association between municipal output (growth) and law-implied (changes on) FPM transfers close to the seven discontinuities that shape federal transfers. For brevity, we report (and comment on) these checks in the Appendix. Specifically, we show that the results are robust to:

- estimating log difference specifications without controlling for lagged output dynamics or when we include one, two or even three lags of the dependent variable;
- estimating least absolute deviations and Huber's "robust" regression methods, which are less sensitive than OLS to outliers;
- allowing the 'reduced-form' association to vary across each cut-off. The elasticity is strong across all cut-offs;
- using observations both close and relatively further away from the discontinuities, controlling for high-order cut-off-specific polynomials (as in Brollo, Nannicini, Tabellini, and Perotti (2013));
- excluding municipalities around the initial cut-off $(10, 188)$, which is close to a discontinuity determining local councilor's pay after 2004 (Feraz and Finan (2010));
- excluding either only 2008, the year that followed the special census when some manipulation seems to have occurred, and even all post-2007 observations;

- augmenting the specifications with a variable that sums real per-capita transfers in all municipalities within the same micro-region to examine whether there are spillover effects of federal transfers to nearby municipalities. The analysis reveals that spillovers are small (and in many permutations statistically insignificant);

- augmenting the baseline specifications with population growth in the micro region to (partially) account for migration across adjacent municipalities.

4.2 The Federal Transfer Multiplier

The academic and policy discussion about the effectiveness of fiscal interventions has been framed in terms of average 'fiscal multipliers', estimates reflecting the percentage change in output driven by a change in a given fiscal instrument (transfers in our application) as large as 1% of GDP.

To compute the federal transfer multiplier, we first estimate the IV ("fuzzy" RD) model (equations (5) and (6)), computing effectively the ratio of the "reduced-form" elasticities (Table 5) to the first-stage coefficients that link actual-realized to law-implied FPM transfers. We do so with both the log level specifications (that besides year fixed effects also includes municipality constants and state-specific time trends) and the log difference specifications (that includes state fixed effects and year fixed effects).[28] The IV estimates capture the impact on municipal output of the component of actual FPM transfers predicted by the law shaping federal transfers in the neighborhood of the FPM population cut-offs. As the model is expressed in logs, we apply the elasticity formula to back out the federal transfer multiplier. The latter step amounts multiplying the IV elasticities by 21, which is the sample median of the ratio of local GDP to FPM transfers (see also Serrato and Wingender (2014)).[29]

Table 6 reports the federal transfer multipliers in our preferred local linear regression bandwidth ("< 500" inhabitants). These are the "multiplier" counterparts of the "reduced-

[28] Table 3 (and Appendix Tables $5-7$) report estimates projecting realized FPM transfers to law-implied ("theoretical") FPM transfers. Yet, the first-stage estimates are somewhat different as the model includes municipality (rather than) state fixed-effects. This has, however, a small impact on the estimates. The only difference is the slight drop in the coefficient on theoretical FPM transfers (from approximately $0.95-1$ in the models with state fixed-effects to $0.85-0.9$ when we add municipality fixed effects).

[29] The choice of the median (as opposed to the mean value of 28) reflects the distribution of local GDP over federal transfers, which is skewed because of a long right tail of larger municipalities (see Table 2). The elasticity formula is $\hat{\beta}_{IV} = \frac{\partial Y}{\partial TR}\frac{TR}{Y}$ where $(\partial Y/\partial TR)$ refers to the federal transfer multiplier and (TR/Y) stands for the inverse of the local GDP to federal transfers ratio.

form" estimates reported in columns (4) and (8) of Table 5. The first row provides simple local RD estimates, while the second row also include the RD-polynomial on normalized population. Columns (1) and (2) report the 2SLS estimates in log-level and log-differences specifications. They yield local federal transfer multipliers around $1.4 - 1.75$. Column (3) evaluates the sensitivity of our results to using an estimator based on least absolute deviations, which is robust to the presence of outliers (which seems particular relevant in our application on municipal GDP growth). In particular, column (3) reports the median treatment effect using the IV Quantile Regression (IVQR) method of Chernozhukov and Hansen (2006).[30] The IVQR estimates are $1.5 - 1.6$. Columns (4) and (5) report 2SLS and IVQR estimates when changes in GDP, actual and law-implied FPM transfers are expressed in simple differences. So these models represent the non-log difference counterparts of columns (2) and (3). The advantage of taking first differences (as opposed to log-difference) is that the IV estimates can be interpreted directly as multipliers without any transformation (i.e., one does not need to take a stand on the 'appropriate' ratio of federal transfers to local GDP to be used in the elasticity formula for the log-difference specification). The disadvantage is that in the presence of non-linearity and fat tails, which can only be made more severe by not taking logs, the least square estimates become tilted towards outliers and produce less precise inference. Indeed, the 2sls estimate in column (4) is larger, ranging from 2 to 2.3. Yet, the IVQR results in column (5) yield multipliers around $1.5 - 1.6$, which are in line with the log level and log difference specifications. The standard errors of the least-absolute-deviation specifications tend to be smaller, thereby leading to more accurate inference.

In summary, our preferred specification yields "federal transfer multipliers" around $1.5 - 1.6$. And reasonable perturbations make the estimates range from 1.4 to 1.8. Even when we do not account for outliers in GDP, the multiplier estimates increase slightly to around 2, a value not dissimilar from other local multiplier studies (Shoag (2012), Nakamura and Steinsson (2014), Serrato and Wingender (2014)). We have conducted various sensitivity checks (which we report for brevity in the Appendix). The multiplier estimates are similar when we exclude municipalities around the initial cut-off that is close to the discontinuity shaping local politicians pay after 2004 (range from 1.2 to 1.7) or when we drop 2008, the post-special special Census year (range from 1.6 to 1.8). The multipliers slightly increase

[30]Similar results are obtained for the (log) level specification using the method described in Canay (2011) to solve the incidental parameter problem involved with estimating an (IV)QR model in the presence of panel fixed effects.

when we drop all post 2007 observations (around 2.1) or when we focus on the wider (750 and 1000 inhabitants) bandwidths (range between 1.65 to 2).

5 Improving Local GDP Measurement

GDP at the municipal level is likely to be a noisy measure of local economic activity. Error-in-variables seems unavoidable for any study employing subnational (or even aggregate) data for developing and under-developed countries. While our analysis benefits from having access to local GDP estimates of Brazilian municipalities at annual frequency from the national statistical agency, the methodology unavoidably employs a certain level of extrapolation which might introduce non-negligible measurement error. Moreover, as the size of the shadow economy in Brazil is not small (especially in agriculture-based communities), official statistics may miss a sizeable part of local activity. While classical measurement error in the dependent variable does not lead to biased estimates (asymptotically), it may lower considerably the model fit yielding imprecise estimates (Wooldridge (2002)).[31]

To account for error in the local GDP series, we also estimate models using satellite images on light density at night to proxy local economic activity. This approach follows Henderson, Storeygard, and Weil (2012), who show that luminosity can be a very useful proxy for GDP in developing countries. Luminosity data are available from the National Oceanic and Atmospheric Administration (NOAA) at yearly frequency (since 1992) and over very fine level of resolution, which implies they can be easily aggregated at the municipality level using the Brazilian administrative map.[32]

We repeated the estimation of the "reduced-form" specification using the log of per capita luminosity as the dependent variable. Table 7 reports the results of the log level and the log difference specifications (Panel A and Panel B, respectively). The coefficient on law-implied FPM transfers is positive and highly significant. The elasticity in our preferred specification in column (8), which focuses on a 500 inhabitants bandwidth and include cut-off-specific linear RD polynomials, implies that a ten percent increase on FPM transfers is associated with an

[31]As in our empirical specifications, we also use first-differences of local log GDP, this may further lower the signal-to-noise ratio (Griliches and Hausman (1986)).

[32]Luminosity data have been recently used in various applications by the growth-development literature (e.g., Michalopoulos and Papaioannou (2013, 2014), Pinkovskiy (2014), Hodler and Raschky (2014), Alesina *et al.* (2014), Sala-i-Martin and Pinkovskiy (2014)). Yet to the best of our knowledge, luminosity data have not been used by the macro literature focusing on business-cycles and stabilization (fiscal and monetary) policy. The Appendix reports the correlation between luminosity and local GDP across Brazilian municipalities.

increase in luminosity of approximately 1.3-1.5 percent. These results add confidence that the baseline reduced-form estimates (in Table 5) and the associated federal transfer multipliers (in Table 6) are not driven by some peculiar form of measurement error in municipal output data. Furthermore, the standard errors are considerably lower than in the analogous specifications with municipal value added (in Table 5), corroborating the notion that luminosity data are less noisy.

In the Appendix, we first apply the aggregation procedure of Henderson, Storeygard, and Weil (2012), which aims to produce lesser noisy GDP measures by combining local output estimates with luminosity, and then we re-estimate the reduced-form estimation using the 'improved' lights-GDP combined output measures.[33] The local regression estimates at the 500 bandwidth imply that a one percent increase in law-implied FPM transfers close to the seven cut-offs is associated with a rise in municipal output of approximately 0.085-0.1 percentage points. Moreover, compared to the analogous estimates in Table 5, the standard errors fall, yielding much stronger inference. These estimates imply federal transfer multipliers around (or slightly exceeding) 2, though it is important to recognize that producing the combined lights-GDP measure necessarily involves some judgmental choices.

6 Heterogeneity

Brazilian municipalities vary markedly across many dimensions, including financial and economic development, geographical remoteness and trade openness. In this section we exploit this sizable variation to examine heterogeneity. We first assess the impact of federal transfers across the main macro regions. Then we examine the potentially heterogeneous effects of federal transfers with respect to trade openness and the presence of financial-liquidity constraints, two aspects that theory has emphasized as key determinants of the size of fiscal multipliers.

[33] The key idea is that since luminosity and the GDP series are noisy proxies of the same signal (i.e. local economic activity) but with orthogonal errors, one can combine the two proxies to produce a less noisy measure of municipal output.

6.1 Brazilian Macro Regions

Brazilian states are typically grouped into five macro regions: North, North-East, Centre-West, South-East and South.[34] Economic activities (inhabitants) in the North represent about 5% (8%) of national GDP (population). Although the North is the largest in terms of land area region, there is a small number of municipalities (260 in our sample), as population density is low in the Amazon Rainforest. The North-East region accounts for 28% of Brazilian population, but only 13% of GDP. It is the poorest region and hosts the largest number of municipalities (1241 in our sample). The Centre-West contributes 6% to national population and 9% of aggregate economic activity. This region is not particularly industrialized and it is the most reliant on imports from other regions. In our sample, we have 234 municipalities. More than half of Brazilian GDP is produced in the South-East, the richest and most densely populated region (869 municipalities in our sample). The map is completed by the South where about 12% of Brazilians live, producing 17% of national GDP. In our sample, there are 535 municipalities.

Table 8 reports "reduced-form" local linear regression estimates (with and without RD polynomials) allowing the elasticity of law-implied FPM transfers to per capita GDP to vary across the five regions.[35] Due to the small number of municipalities in each region, we report results with a somewhat wide bandwidth (1000), though we have verified that the estimates are similar (though noisier) with the smaller bandwidths. Columns (1)-(2) report log-level specification estimates, whereas columns (3)-(4) report results from the log-differences specifications. A number of regularities stand up. First, the two northern regions exhibit the largest and mostly significant effect of federal transfers on municipal GDP per-capita. The point estimates are more than twice as large as the country-wide estimates (in Table 5). Second, municipalities in either the Centre-West or the South, the two regions featuring the most developed financial and economic systems and trading the most with the rest of the country, are associated with the lowest (and typically insignificant) estimates. Third, the impact of federal transfers on local economic activity for municipalities in the South-East is somewhere in-between.

[34] In Appendix Table 1, we report all Brazilian states by macro region. The Table also gives average GDP per-capita, population, trade openness and a proxy of banking sector development for each state.

[35] The link between actual FPM and law-implied FPM transfers is strong across all five regions. The (first-stage) estimate is similar across all regions (around 0.85).

6.2 Trade Openness

Theory highlights the importance of openness in determining the impact of fiscal policy on economic activity. If local consumption is tilted towards "imported goods" from other regions or from abroad, then the stimulative impact of transfers will be attenuated. In contrast, with sizable home bias (and sticky prices), government spending can have sizable stimulative effects (e.g., Farhi and Werning (2012)).[36] Ilzetzki, Mendoza, and Vegh (2013) provide some empirical support to this idea using a panel of 44 countries over the past four decades. Our results (in the previous sub-section and table) that the stimulative effect of fiscal policy are more pronounced in the Northern states, which are geographically isolated and do not engage much in intra-Brazilian trade, are in line with these predictions and available cross-country evidence. Yet, since Brazilian macro regions differ across many dimensions, these results are only suggestive.

In an effort to shed more light on the interactive effect of fiscal policy with trade openness, we estimated models that link municipal output (growth) with law-implied federal transfers in the neighborhood of the seven discontinuities, allowing the elasticity to differ for municipalities in relatively more open and relatively more closed states.[37] In particular, using the median value of the inter-state trade flows from Romeo de Vasconcelos (2001), which refer to the late 1990s, we construct indicators for "more open" and "more closed" states (defined as states in the top and bottom 50% of the trade openness distribution, respectively) and then interacted law-implied FPM transfers with these two indicator variables (see Appendix Table 1).[38]

Table 9 gives the corresponding "local" regression estimates using various bandwidths. Across all specifications, the coefficient on law-implied federal transfers in relatively "more closed" states is positive (range 0.09 to 0.14) and always significant at standard confidence levels. The estimate on law-implied FPM transfer for cities in relatively "more open" states is also positive, but way smaller (range $0.03 - 0.11$). In all permutations, the coefficient on

[36] These trade-offs go back to the "Transfer Problem" controversy and the debate between Keynes (1929) and Ohlin (1929).

[37] Ideally we would need proxies of openness at the municipality (rather than the state) level;, which however (to the best of our knowledge) are not available.

[38] Trade openness in each state is measured as the value of import plus the value of export over GDP at the state level. The median (average) value of the trade openness proxy is 0.82 (0.88). The mean value in the Northern and North-Eastern states are 0.66 and 0.82, respectively (with considerable variance however, as the range is $0.30 - 1.58$). The mean value in the South, South-East and Centre-West is 1.05 (range $0.72 - 1.38$).

relatively more closed states is larger as compared to the analogous coefficient on relatively more open states. The estimates in our preferred specifications using the 500 bandwidth (Panel C) are $0.075 - 0.1$ and 0.035 for municipalities in relatively more closed and relatively more open states, respectively. This implies that the average federal transfer multiplier in relatively more closed states is approximately $2.0 - 2.5$ (and highly significant), while the federal transfer multiplier in relatively more open states is about one.[39]

The results are similar when we use luminosity to measure municipal output (growth). In all specifications (reported in Appendix Table 24), the output-FPM transfer elasticity is higher for municipalities in relatively closed as opposed to relatively more open states. Moreover, since the standard errors are tighter the estimates are significantly different from each other in many specifications.

6.3 Financial Constraints

While fiscal policy tends to have small -if anything- effects in a simple RBC framework (where infinitely - lived "Ricardian" agents maximize inter-temporal utility), this is reversed if (labor and product) markets are not fully competitive and (some agents) face liquidity-financial constraints (e.g. Gali, Valles, and Lopez-Salido (2007), Farhi and Werning (2012)).[40] Our results in Table 8 on regional heterogeneity are in line with these ideas, as the degree of financial constraints is likely larger in Northern states as compared to the more developed central and southern states.

We further examine potential heterogeneity on the impact of federal transfers and the associated swings of local government spending in municipalities where there are likely to be sizable financial constraints and cities with relatively fewer constraints. Using municipality-level bank penetration data from the Central Bank (which refers to 2007), we split our sample into a group of municipalities without a bank branch (21%) and a group of cities with at least one bank branch (79%) as a proxy for easiness of access to financial services.[41] We then re-estimated the baseline "reduced-form" specification, allowing the coefficient on

[39] The first-stage estimates linking actual (realized) to law-implied FPM transfers is around 0.85 for both sets of states.

[40] According to various cross-country measures (e.g., World Bank, OECD), Brazil does not seem to have very competitive product and labor markets.

[41] See Appendix Table 1 for descriptive statistics by state. The average for the 7 States in the North and the 9 states in the North-East is 0.60 (range $0.43 - 0.82$). The average for the 3 states in the Centre-West, the 4 states in the South-East and the 3 States in the South is 0.95.

(the log of) law-implied transfers to differ for the two groups of states. Table 10 reports local regression estimates that explore heterogeneity of the output elasticity to theoretical FPM transfers in relatively less and more financially developed municipalities. Three key patterns emerge. First, the estimate on law-implied FPM transfers for municipalities with no bank penetration is quite large and highly significant. The coefficient in our preferred log difference specification using a 500 inhabitants bandwidth (Panel C) is $0.125 - 0.13$ implying quite large "transfer" multipliers (in-between 2.5 and 3). Second, the estimate on law-implied FPM transfers for more financially developed municipalities (where there is at least one bank branch) is small(er) and in many specifications statistically insignificant. Third, in almost all specifications the difference in the coefficient estimates between the two groups is statistically significant, suggesting that financial constraints play an important role in shaping the effect of fiscal policy on economic activity. The results are similar (and more precisely estimated) when we use luminosity to proxy local development (Appendix Table 25).

Summary. The analysis showed that the "average" federal transfer multiplier masks non-negligible heterogeneity. First, the stimulative effects of federal-transfers are pronounced in the Northern Brazilian states that are more isolated, less connected with the rest of the country, less developed, and with smaller bank penetration. Second, municipalities in less trade-oriented states are more likely to receive a large and significant boost in economic activity from government spending (financed by federal transfers), whereas municipalities in more open states benefit less from local fiscal expansion. Third, we find that changes in federal transfers have large effects in municipalities where agents are more likely to face tight financial-liquidity constraints (as there are no bank branches).

7 Insights from a currency union model

It is useful to examine how our empirical findings (both on the average effect of federal transfers and heterogeneity) compare with the predictions of a macroeconomic model of government spending financed by federal transfers in a currency union like Brazil. To this end, we employ the theoretical setup of Farhi and Werning (2012), which provides closed-form solutions to local and aggregate multipliers under alternative financing rules.[42] This theoretical model, which builds on Gali and Monacelli (2005, 2008), Corsetti, Kuester and

[42] We are grateful to Emmanuel Farhi and Ivan Werning for kindly sharing their codes.

Muller (2013) and Nakamura and Steinsson (2014), nests neoclassical and Keynesian effects of fiscal policy in a currency union both under complete and incomplete markets (see also Farhi and Werning (2013, 2014)).

Three features of the framework in Farhi and Werning (2012) make their model particularly attractive for our application. First, they consider the response of output when federal transfers increase inside a currency union (under a fixed exchange rate). They derive local fiscal multipliers when government spending is not financed by local revenues: this is precisely the case in our application. Second, their framework allows us to analyze heterogeneity of local federal transfer multipliers with respect to trade openness (summarized by home bias in consumption) and financial-liquidity constraints (exemplified by the share of hand-to-mouth consumers).[43] Third, their framework allows (under some "standard" assumptions) getting a rough estimate on the magnitude of the fiscal multiplier, if local spending was financed internally (and not by exogenous external sources).

7.1 Parameterization

In an effort to limit our degrees of freedom, we borrow most parameter values from Farhi and Werning (2012).[44] As for steady state values, we adapt the ex-ante real interest rate (8%) and the local government spending-output ratio (10%) to Brazilian data. The persistence of municipal government spending is set to 0.5, consistent with the estimates of an AR(2) process in our sample. The fraction of price resetting firms is 0.25 per quarter, consistent with the average duration of individual price spells for CPI goods and services reported in Barros *et al.* (2011). In the baseline calculations, the home bias parameter (i.e. the fraction of non-locally produced consumption goods and services) equals 0.4 and the fraction of hand-to-mouth consumers is set to 0.25. In our quantitative analysis we vary the values of these parameters as follows:

[43] For brevity we do not sketch fully their model. For details see Farhi and Werning (2012). In a nutshell the model has the following structure. Households with constant-elasticity-of-substitution preferences over differentiated goods derive utility from private consumption, government expenditure and leisure. Firms compete monopolistically and face in each quarter some fixed probability of resetting their price. Agents can only trade a risk-free bond and their consumption is tilted toward locally-produced goods. The local government engages in public spending, which can be financed either at the local (via taxes) or at the currency union level. The nominal interest rate is fixed, consistent with our empirical specifications where the common yearly time-effects absorb, among other things, variation in monetary policy.

[44] In particular, the elasticity of inter-temporal substitution is set to 1, the elasticity of labor supply to 3, the elasticity between local and foreign goods to 1, and the elasticity of varieties to 6. These values are also in line with earlier works (e.g., Nakamura and Steinson (2013)).

- Trade Openness – the fraction of the consumption basket that is not locally produced ranges in-between $[0.2, 0.8]$.
- Liquidity Constraints – the fraction of hand-to-mouth consumers varies from 0 (corresponding to no liquidity constraints) to 0.25 (implying moderate/considerable frictions).

7.2 Results

Figure 8 reports the one-year cumulated response of local output to a government spending shock as large as 1% of steady state output. The top panel displays the magnitude of the fiscal multipliers, as we alter the parameter capturing home bias in consumption (while keeping the share of hand-to-mouth consumers to 0.25). The bottom panel shows how the local multiplier changes when we vary the share of hand-to-mouth consumers (while keeping the share of non-locally produced consumption basket to 0.4).

Each panel gives two lines. The blue-circled lines summarize the effects on local output of a government spending shock financed with external means: the federal transfer multiplier. These theoretical multipliers are the closest counterpart to our regression discontinuity estimates. The red lines plot the output effects of government spending if this was financed by raising local taxes. This is the theoretical counterfactual on what the impact on local output would have been if Brazilian municipalities had to finance their spending via local taxes -rather than by federal sources. So the difference between the blue and the red line can be interpreted as the contribution of the source of financing to the impact of fiscal policy.[45]

Several interesting results emerge. First, the federal transfer multiplier tends to be close to $1.8 - 2$ under the baseline parameterization (i.e. when the share of liquidity-constrained consumers is around 0.25 and municipalities' openness is around 0.4). These model predictions confront well with our baseline RD estimates of average transfer multipliers. These large effects arise from the fact that government spending is financed externally and therefore Ricardian effects are modest. Furthermore, home-bias in consumption implies that transfers yield large Keynesian demand effects that dominate the (negative) neoclassical wealth effect.[46]

[45] The red line may also be interpreted as the locus of national fiscal multipliers for a small open economy operating in a liquidity trap (i.e., with a fixed nominal interest rate) and under a fixed exchange rate regime. As emphasized by Farhi and Werning (2012), the national multiplier in a liquidity trap is likely to be larger under a flexible exchange rate regime as the initial devaluation associated with the fiscal expansion triggers also an expenditure-switching effect.

[46] Farhi and Werning (2012) show that the neoclassical channel becomes relevant only when the terms-of-trade appreciate considerably.

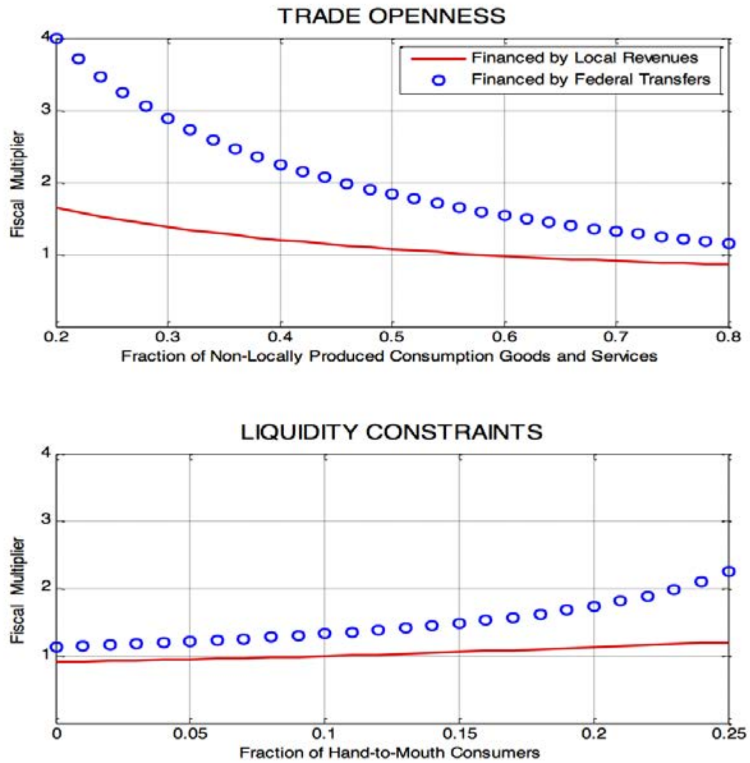


Figure 8: Local vs National Multiplier - Heterogeneity Analysis

Second, the model suggests that, given our parameterization, a federal transfer multiplier of around 2 tend to map to a fiscal multiplier of approximately 1.3-1.6 when government spending is financed by local revenues (as opposed to federal transfers). The simulations plotted in the two panels show that compared to the federal transfer calculations, locally-financed fiscal multipliers are between 10% smaller (for municipalities very open to trade and/or unconstrained in their access to financial markets) and 50% smaller (when municipalities are isolated and consumers have limited access to financial markets). Across the entire parameter space, self-financed local multipliers span the interval $[0.9, 1.8]$. While these multipliers are still 'local', the range becomes now closer to the available estimates from macro studies on national multipliers, which are very often self-financed (see Blanchard and Leigh (2013)).[47]

Third, the effect of government spending on local activity is quite strong in closed economies, but it weakens in municipalities more open to international trade (top panel). Intuitively this

[47] Self-financed fiscal multipliers in complete markets are always below one.

emerges because the Keynesian stimulative local demand effect gets attenuated when local consumption is tilted towards externally-produced goods. The simulations show that federal transfer multipliers can be as large as 4 for isolated municipalities where 80% of the consumption basket is produced locally. Yet, the transfer multiplier falls to 1 when this fraction reaches 20%. These values are in line with our estimates (in the previous Section) on the heterogeneous impact of government spending across Brazilian regions.

Fourth, fiscal multipliers are larger for localities where agents face liquidity constraints (bottom panel). This stems from the fact that in response to a positive government shock, hand-to-mouth agents increase their consumption immediately, stimulating local demand. Increasing the proportion of liquidity constrained households moves the transfer multiplier from a value just above 1 (when there are no constraints) to values of 2.2 (when 25% of the local population is hand-to-mouth agents). These model calibrations also confront well with our RD estimates, showing that federal transfer multipliers can even exceed two in areas where agents face considerable liquidity constraints.[48]

Summary. The quantitative exploration in this section shows that our RD estimates of federal transfer multipliers in Brazil are in line with the implications of a relatively standard small open economy macro model of fiscal policy, tailored to account for the fact that local spending is externally financed taking place in a currency union. The model calibration is also useful to get a sense of the effect of fiscal policy under the counterfactual scenario in which government spending is internally financed via local taxes. Perhaps more importantly, the combination of a simple calibration of Farhi and Werning's (2012) model with our empirical results show that transfer multipliers within a currency union can have large stimulative effects, especially in isolated areas and region/municipalities where agents face financial constraints.

8 Conclusion

We identify the local economy impact of swings in fiscal policy induced by the highly nonlinear allocation mechanism of federal transfers to Brazilian municipalities. Our 'fuzzy' re-

[48]A higher degree of price flexibility is associated with uniformally smaller local multipliers (e.g. between 0.7 for local taxes financing and 1.5 for federal transfers under near-fully flexible prices) but it has a modest impact on the *wedge* between the effects of externally financed (blue line) and internally financed (red line) local government spending.

gression discontinuity estimates uncover three main regularities. First, a change in public spending of 1% of municipal GDP (financed by federal transfers) is associated with an average change in local economic activity of about 1.4 to 1.8 percent. Using light density imagery from satellites to improve the measurement of municipal GDP yields similar, more accurate and -if anything- slightly larger estimates. Second, the average effect masks sizable heterogeneity. Municipalities in Northern Brazilian regions, which are more isolated and less economically and financially developed, benefit the most from federal transfers, as compared to municipalities in the Southern states, which are more open and more developed. In line with recent theoretical works, we document that the stimulative impacts of local government spending (stemming from exogenous changes in federal transfers) are stronger for municipalities in relatively more open states and in municipalities with no bank penetration. Third, we interpret our RD estimates on both the average effect of fiscal policy and the heterogeneous impact of federal transfers through the lens of a relatively standard open economy dynamic macro model that nests neoclassical and Keynesian channels allowing for variation on the financing source of fiscal expansions and regional differences on openness and financial constraints (Farhi and Werning (2012)). The RD estimates square nicely with the model predictions under typical parameterizations. We also simulate the size of the local multiplier under the counterfactual scenario that government spending is financed by local taxes rather than federal transfers. The simulations reveal that the fiscal multiplier is approximately $20\% - 50\%$ smaller when one accounts for the distortionary effects of local taxation.

While the context of our study is specific, our results provide a benchmark for other cases in which federal transfers represent a viable political option to stimulate the economy of specific areas in a monetary union. The evidence from Brazil suggests that federal transfers can generate sizable stabilization effects, especially for isolated and less financially developed regions. Building on recent theoretical advances that provide a justification for these patterns, further empirical research is needed to extend these conclusions to other settings, such as the euro area and other emerging markets.

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Table 1 - Descriptive Evidence

Panel A: Distribution of Municipalities; "Control" and "Treatment" Groups

	No Movement	Moves to Higher Bracket	Total
No Movement	1,256	1,050	2,306
Moves to Lower Bracket	74	759	833
Total	1,330	1,809	3,139

Panel B: Municipality Moves to a Higher or Lower Population Bracket by Year

	Movements to a Lower (-) and Higher (+) Population Bracket					
Years	-2	-1	no change	+1	+2	Total
2000	0	15	1,827	58	0	1,900
2001	0	19	2,298	65	0	2,382
2002	3	168	1,763	392	10	2,336
2003	0	2	2,392	58	0	2,452
2004	0	5	2,281	56	0	2,342
2005	0	10	2,080	129	0	2,219
2006	0	0	2,321	64	0	2,385
2007	0	8	2,461	68	0	2,537
2008	2	211	1,842	231	2	2,288
2009	0	0	2,222	154	0	2,376
2010	0	3	2,465	55	0	2,523
2011	0	78	1,986	183	0	2,247
Total	5	519	25,938	1,513	12	27,987

Panel C: Municipality Moves to a Higher or Lower Population Bracket by Bracket

	Movements to a Lower (-) and Higher (+) Population Bracket					
Population Brackets	-2	-1	no change	+1	+2	Total
6,793–10,188	0	0	6,119	220	2	6,341
10,189–13,584	0	70	4,856	275	4	5,205
13,585–16,980	0	119	3,601	297	0	4,017
16,981–23,772	1	119	5,015	252	0	5,387
23,773–30,564	0	95	2,799	212	4	3,110
30,565–37,356	2	52	1,738	146	2	1,940
37,357–44,148	0	36	1,131	111	0	1,278
44,149–50,939	2	28	679	0	0	709
Total	5	519	25,938	1,513	12	27,987

Panel A reports the number of municipalities that move across FPM population brackets and the number of municipalities that stay in the same FPM population bracket across the sample period 2000-2011. Panel B reports the number of municipalities that stay in the same FPM population bracket and the number of municipalities that move to a higher or lower FPM population bracket per year. Panel C reports the number of municipalities that stay in the same FPM population bracket and the number of municipalities that move to a higher or lower FPM population bracket by FPM population bracket.

Table 2 - Summary Statistics

Panel A: Municipal Output and Population

	Output			Population			Output projected on lights		
Population Bracket	Mean GDP p.c. Growth	Median GDP p.c. Growth	Std. Dev. GDP Growth	Mean Pop. Growth	Median Pop. Growth	Std. Dev. Pop. Growth	Mean GDP p.c. Growth	Median GDP p.c. Growth	Std. Dev. GDP Growth
6,793–10,188	5.2%	4.9%	11.9%	0.6%	0.6%	4.1%	4.9%	4.8%	8.2%
10,189–13,584	5.3%	4.9%	11.3%	0.9%	0.8%	4.9%	4.8%	4.5%	7.8%
13,585–16,980	5.2%	5.3%	11.2%	1.1%	0.9%	4.8%	4.7%	4.6%	7.5%
16,981–23,772	5.2%	4.9%	11.2%	1.2%	1.0%	4.6%	4.7%	4.5%	7.4%
23,773–30,564	4.9%	4.8%	11.0%	1.4%	1.1%	4.5%	4.6%	4.2%	7.0%
30,565–37,356	5.3%	5.0%	10.8%	1.5%	1.2%	4.2%	4.4%	4.3%	6.7%
37,357–44,148	4.7%	4.7%	9.6%	1.5%	1.2%	4.2%	4.2%	4.1%	6.2%
44,149–50,939	4.9%	4.9%	10.1%	2.0%	1.4%	3.6%	3.9%	3.9%	6.2%
Total	5.1%	5.0%	11.2%	1.1%	0.9%	4.5%	4.7%	4.5%	7.5%

Panel B: Municipal Fiscal Measures (Transfers, Tax Reveues, and Expenditure)

	Sources of Revenue			Fiscal Position		Categories of Expenditures (% of Total)			
Population Bracket	FPM Transfers / GDP	Other Transfers / GDP	Local Taxes / GDP	Budget Surplus / GDP	Expenditure / GDP	Public Administration	Education	Housing & Urbanism	Health & Sanitation
6,793–10,188	4.0%	7.9%	0.7%	0.2%	13.0%	16.6%	30.5%	9.4%	22.1%
10,189–13,584	4.4%	8.1%	0.8%	0.2%	13.8%	16.5%	32.0%	9.6%	22.1%
13,585–16,980	3.8%	7.5%	0.8%	0.2%	12.4%	15.6%	32.2%	9.9%	22.7%
16,981–23,772	3.4%	7.1%	0.8%	0.2%	11.7%	15.9%	32.3%	9.9%	22.5%
23,773–30,564	2.6%	6.5%	0.8%	0.2%	10.2%	15.8%	32.6%	10.4%	22.2%
30,565–37,356	2.4%	6.3%	1.0%	0.2%	10.0%	15.7%	32.6%	10.6%	22.8%
37,357–44,148	2.2%	6.6%	1.1%	0.2%	10.2%	15.2%	31.4%	10.9%	23.5%
44,149–50,939	2.2%	6.6%	1.1%	0.1%	10.3%	14.9%	33.0%	11.0%	23.8%
Total	3.5%	7.4%	0.8%	0.2%	12.1%	16.0%	31.9%	9.9%	22.4%

The table gives summary statistics for the main variables employed in the empirical analysis. The sample includes 27,987 yearly observations covering 3,139 Brazilian municipalities over the period 2000-2011. Panel A reports the mean, median, and standard deviation of municipal GDP, population, and an alternative measure of municipal GDP that combines GDP with satellite image data on light density at night (see the appendix for details on the construction of this measure that aims accounting for error-in-variables in the GDP series). Panel B reports summary statistics on fiscal revenue and expenditure for the municipalities. Section 2 gives details on the FPM allocation mechanism.

Table 3 - Actual and Law Implied (Theoretical) FPM Transfers

			Local Linear Regressions			
	Bandwidth	All	<1000	<750	<500	<250
		(1)	(2)	(3)	(4)	(5)
(1)	Levels	0.978***	0.973***	0.97***	0.97***	0.967***
		(0.001)	(0.002)	(0.003)	(0.003)	(0.003)
	within (marginal) R^2	0.654	0.600	0.590	0.577	0.547
(2)	Levels per capita	1.013***	0.985***	0.979***	0.974***	0.967***
		(0.003)	(0.004)	(0.004)	(0.005)	(0.006)
	within (marginal) R^2	0.380	0.291	0.293	0.299	0.284
(3)	Level per capita - Median	0.996***	0.996***	0.995***	0.995***	0.995***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
	within (marginal) R^2	0.379	0.286	0.288	0.300	0.289
(4)	Level per capita - Robust (Huber)	0.992***	0.992***	0.992***	0.991***	0.992***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
	within (marginal) R^2	0.434	0.343	0.351	0.364	0.349
	Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
	State Fixed Effects	Yes	Yes	Yes	Yes	Yes
	Observations	27976	10503	7840	5092	2538

The table reports regression estimates associating actual (realized) municipal FPM transfers to law-implied (theoretical) FPM Transfers. The table reports estimates from four specifications. Row (1) reports OLS coefficient estimates when both the dependent and the independent variable are expressed in levels (no transformation). Row (2) reports OLS coefficient estimates when both actual FPM transfers (the dependent variable) and law-implied (theoretical) transfers (the independent variable) are expressed in per capita terms. Row (3) reports least-absolute-deviation (median) estimates associating actual FPM transfers per capita with law-implied FPM transfers per capita. Row (4) reports Huber ("robust regression") estimates associating actual FPM transfers per capita with law-implied FPM transfers per capita. We construct municipal law-implied (theoretical) transfers applying the FPM allocation mechanism formula (see Section 2).

Column (1) reports estimates in the full sample that includes municipalities both close and far from the seven FPM cutoffs. Columns (2)-(5) report local regression (RD) estimates that restrict estimation in the neighborhood of the FPM cutoffs using four bandwidths, 1000 inhabitants (column (2)), 750 inhabitants (column (3)), 500 inhabitants (column (4)), and 250 inhabitants (column (5)). All specifications include state fixed effects and year fixed-effects (constants not reported). The table also reports the within (marginal) R2. Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table 4 - Other Sources of Municipal Revenue around the FPM Cutoffs

Panel A: Municipal Taxes per capita

		Local Linear Regressions			
Bandwidth	All	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)
Log Level	0.372***	0.115	0.117	0.109	0.109
	(0.088)	(0.109)	(0.119)	(0.141)	(0.218)
within (marginal) R^2	0.001	0.000	0.000	0.000	0.000
Observations	24510	9161	6761	4380	2144
Log Difference	-0.088	-0.105	-0.109	-0.088	0.314
	(0.105)	(0.132)	(0.150)	(0.178)	(0.330)
within (marginal) R^2	0.002	0.000	0.000	0.000	0.000
Observations	24456	7235	4975	2847	1014
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes

Panel B: State-Level Transfers per capita

		Local Linear Regressions			
Bandwidth	All	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)
Log Level	1.400***	0.521	0.490	0.421	0.386
	(0.272)	(0.336)	(0.367)	(0.431)	(0.666)
within (marginal) R^2	0.000	0.000	0.000	0.000	0.001
Observations	24109	9046	6675	4332	2116
Log Difference	0.008	-0.001	-0.001	-0.024	0.005
	(0.021)	(0.028)	(0.031)	(0.037)	(0.074)
within (marginal) R^2	0.000	0.000	0.000	0.000	0.000
Observations	25677	7637	5270	3010	1065
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes

Panel A reports regression estimates associating the natural logarithm of municipal taxes per capita to the natural logarithm of law-implied (theoretical) FPM transfers per capita. Panel B reports regression estimates associating the natural logarithm of municipal revenues from state-level transfers per capita with the natural logarithm of law-implied (theoretical) FPM transfers per capita. Panel A and Panel B report two specifications. Row (1) reports log level OLS specification estimates where both the dependent and the independent variable are expressed in logs. Row (2) reports log difference OLS specifications where both variables are expressed in first-differences.

Column (1) reports estimates in the full sample that includes municipalities both close and far from the seven FPM discontinuities. Columns (2)-(5) report local regression (RD) estimates that restrict estimation in the neighborhood of the FPM cutoffs using four bandwidths, 1000 inhabitants (column (2)), 750 inhabitants (column (3)), 500 inhabitants (column (4)), and 250 inhabitants (column (5)).The table also reports the within (marginal) R2. All specifications include state fixed effects and year fixed-effects (constants not reported). Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table 5 - Reduced-form Estimates.
Law-Implied Federal Transfers and Municipal Output in the Neighborhood of FPM Cutoffs

Panel A: Log Level Specifications - *Log (GDP p.c.)*

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
log(LAW-FPM p.c.)	0.243***	0.119***	0.085***	0.065***	0.092***	0.085***	0.072***	0.054**	0.065*
	(0.020)	(0.022)	(0.024)	(0.026)	(0.031)	(0.023)	(0.023)	(0.025)	(0.039)
Observations	27976	10503	7840	5092	2538	10503	7840	5092	2538
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-time Time Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

Panel B: Log Difference Specifications - *Δ Log (GDP p.c.)*

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δlog(LAW-FPM p.c.)	0.17***	0.116***	0.104***	0.068***	0.091***	0.113***	0.101***	0.061***	0.073**
	(0.011)	(0.014)	(0.016)	(0.021)	(0.034)	(0.014)	(0.017)	(0.021)	(0.033)
Observations	23696	6758	4622	2561	889	6758	4622	2561	889
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

Table 5 - Reduced-form Estimates. (cont.)
Law-Implied Federal Transfers and Municipal Output in the Neighborhood of FPM Cutoffs

Panel C: Difference Specifications - Least-Absolute-Deviation (Median) Regression Estimates - *Δ (GDP p.c.)*

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δ(LAW-FPM p.c.)	2.448***	1.652***	2.034***	1.378***	1.459***	1.666***	1.679***	1.368***	1.335***
	(0.129)	(0.18)	(0.222)	(0.267)	(0.306)	(0.202)	(0.222)	(0.247)	(0.247)
Observations	23696	6758	4622	2561	889	6758	4622	2561	889
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

The table reports “reduced-form” estimates associating the natural logarithm of municipal GDP per capita to the natural logarithm of law-implied (theoretical) FPM transfers per capita in the neighborhood of the seven FPM cut-offs. Panel A reports log level OLS specifications. These models include municipality fixed-effects, year fixed-effects, and state-specific linear time trends (constants not reported). Panel B reports log differnce OLS specifications, where both the dependent and the independent variables are expressed in log differences. These models include state fixed-effects and year fixed-effects. These models also include two lags of the dependent variable (logarithmic growth of municipal GDP p.c.). The reported coefficients represent the cumulated effect (taking into consideration the lags). Panel C reports least-absolute-deviation (median) regression estimates where both the dependent and the independent variables are expressed in first-differences (without applying a logarithmic transformation). These models include state fixed-effects and year fixed-effects (constants not reported). In these models the standard errors are calculated using the Delta method.

Column (1) reports estimates in the full sample that includes municipalities both close and far from the seven FPM discontinuities. Columns (2)-(9) report local regression (RD) estimates that restrict estimation in the neighborhood of the FPM cutoffs using four bandwidths, 1000 inhabitants (columns (2) and (6)), 750 inhabitants (columns (3) and (7)), 500 inhabitants (columns (4) and (8)), and 250 inhabitants (columns (5) and (9)). The specifications in columns (6)-(9) include cutoff-specific 1st-order regression-discontinuity polynomials on absolute distance to the closest threshold (the “running-forcing” variable). The RD polynomial allows coefficients to differ at each side (below/above) of each cutoff and also include cutoff-specific constants (“rectangular kernel”).

The table also reports the within (marginal) R2. Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99 % (***), 95% (**) and 90% (*) confidence level.

Table 6 - Federal Transfer Multiplier (500 Bandwidth)

	Log Level Specifications	Log Difference Specifications		Difference Specifications	
	2SLS	2SLS	IVQR-q50	2SLS	IVQR-q50
	(1)	(2)	(3)	(4)	(5)
	Panel A: Local Regression Estimates				
Federal Transfer Multiplier	1.708***	1.764***	1.528***	2.334***	1.574***
	(0.662)	(0.536)	(0.263)	(1.000)	(0.232)
	Panel B: Local Regression Estimates with a Rectangular Kernel				
Federal Transfer Multiplier	1.378**	1.6***	1.621***	2.026**	1.477***
	(0.64)	(0.564)	(0.297)	(1.008)	(0.262)
Observations	4561	2560	2560	2560	2560
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Municipality Fixed Effects	Yes	No	No	No	No
State Fixed Effects	No	Yes	Yes	Yes	Yes
State-time Time Trends	Yes	No	No	No	No

The table reports estimates of the federal transfer multiplier based on "fuzzy" regression-discontinuity (instrumental variable) estimates that restrict estimation in the neighborhood of the seven FPM population cut-offs using a 500 inhabitant's bandwidth. The "fuzzy" RD estimates associate municipal GDP per capita to the component of actual (realized) FPM transfers per capita explained by law-implied (theoretical) FPM transfers per capita that is constructed applying the FPM allocation mechanism formula (see the discussion in Section 2).

Column (1) reports multipliers based on 2sls estimation of the log-level specifications. The multiplier is recovered by multiplying the 2sls ("fuzzy" RD) coefficient estimates (and standard errors) with the median value of the local output / federal transfers ratio (which is 21; see Table 2-Panel B). Column (2) reports multipliers based on 2sls estimation of the log-difference specifications. The multiplier is recovered by multiplying the 2sls ("fuzzy" RD) coefficient estimates (and standard errors) with the median value of the local output / federal transfers ratio (which is 21; Table 2-Panel B). Column (3) reports multipliers recovered from an instrumental variable (two-step) quantile (median) estimation of the log-difference specifications. The multiplier is recovered by multiplying the 2sls ("fuzzy" RD) coefficient estimates (and standard errors) with the median value of the local output / federal transfers ratio. For the estimation of these models we apply the procedure of quantile treatment effects of Chernozhukov and Hansen (2007). Column (4) report multipliers based on 2sls estimation of the simple (non-log) difference specifications. Since no transformation is employed, this method directly gives multipliers. Column (5) reports multipliers based on an instrumental variable (two-step) quantile (median) estimation of simple (non-log) difference specifications. Since no transformation is employed, this method directly gives the multiplier for the municipality at the median of the distribution. For the estimation of these models we apply the procedure of quantile treatment effects of Chernozhukov and Hansen (2007). Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99 % (***), 95 % (**) and 90 % (*) confidence level.

Table 7 - Reduced-form Estimates Using Satellite Image Data on Light Density at Night

Panel A: Log Level Specifications - *Log (Luminosity p.c.)*

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
log(LAW-FPM p.c.)	0.387***	0.207***	0.191***	0.21***	0.249***	0.148***	0.155***	0.169***	0.224***
	(0.031)	(0.038)	(0.039)	(0.047)	(0.056)	(0.04)	(0.041)	(0.047)	(0.059)
Observations	27976	10503	7840	5092	2538	10503	7840	5092	2538
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-time Time Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

Table 7 - Reduced-form Estimates Using Satellite Image Data on Light Density at Night (cont.)

Panel B: Log Difference Specifications - Lights-Predicted *Δ Log (Luminosity p.c.)*

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δlog(LAW-FPM p.c.)	0.248***	0.174***	0.149***	0.166***	0.157***	0.164***	0.14***	0.135***	0.093
	(0.021)	(0.028)	(0.03)	(0.036)	(0.056)	(0.03)	(0.032)	(0.038)	(0.063)
Observations	23693	6753	4617	2560	889	6753	4617	2560	889
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

The table reports “reduced-form” estimates linking municipal output per capita to law-implied (theoretical) FPM transfers per capita in the neighborhood of the FPM cut-offs using satellite image data on light density at night to proxy local economic activity. Panel A reports log level OLS specifications associating log lights per capita to law-implied (theoretical) FPM transfers per capita. These models include municipality fixed-effects, year fixed-effects, and state-specific linear time trends (constants not reported). Panel B reports log difference OLS specifications associating the logarithmic growth of lights per capita to the logarithmic growth of law-implied FPM transfers per capita. These models include state fixed-effects and year fixed-effects (constants not reported). The log difference specifications also include two lags of the dependent variable (logarithmic growth of luminosity per capita). The reported coefficients represent the cumulated effect (taking into consideration the lag structure). Standard errors are calculated using the Delta method.

The specifications in columns (6)-(9) include cutoff-specific 1st-order regression-discontinuity polynomials on absolute distance to the closest threshold (the “running-forcing” variable). The RD polynomial allows coefficients to differ at each side (below/above) of each cutoff and also include cutoff-specific constants (“rectangular kernel”). Column (1) reports estimates in the full sample that includes municipalities both close and far from the seven FPM discontinuities. Columns (2)-(9) report local regression estimates that restrict estimation in the neighborhood of the FPM cutoffs using four bandwidths, 1000 inhabitants (columns (2) and (6)), 750 inhabitants (columns (3) and (7)), 500 inhabitants (columns (4) and (8)), and 250 inhabitants (columns (5) and (9)).The table also reports the within (marginal) R2. Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table 8 - Heterogeneity across Main Brazilian Macro Regions

Local Regression Estimates (Bandwidth 1000 Inhabitants)

	Log Level Specifications		Log Difference Specifications		Region Characteristics			
	(1)	(2)	(3)	(4)	Trade Openness	Financial Development	Income p.c.	Number of Municipalities
NORTH	0.224***	0.223***	0.224***	0.213***	0.792	62.3%	3649	260
	(0.096)	(0.091)	(0.041)	(0.041)				
NORTHEAST	0.227***	0.192***	0.164***	0.16***	0.790	60.8%	2487	1241
	(0.024)	(0.025)	(0.021)	(0.021)				
SOUTHEAST	0.073***	0.037	0.152***	0.151***	0.970	93.0%	6630	869
	(0.028)	(0.029)	(0.018)	(0.018)				
SOUTH	-0.028	-0.066**	-0.031	-0.035	1.139	96.5%	7900	535
	(0.029)	(0.030)	(0.021)	(0.021)				
CENTRE-WEST	0.086**	0.052	0.031	0.026	1.234	93.9%	7552	234
	(0.040)	(0.041)	(0.032)	(0.032)				
Year Fixed Effects	Yes	Yes	Yes	Yes				
Municipality Fixed Effects	Yes	Yes	No	No				
State-time Time Trends	Yes	Yes	No	No				
Linear Cutoff-Specific RD Polynomial	No	Yes	No	Yes				
State Fixed Effects	No	No	Yes	Yes				

The table reports "reduced-form" estimates associating the natural logarithm of municipal GDP per capita to the natural logarithm of law-implied (theoretical) FPM transfers per capita in the neighborhood of the FPM cut-offs using a 1000 inhabitants bandwidth allowing the coefficient (elasticity) to differ across each of the five main Brazilian macro regions. Columns (1) and (2) report log level OLS specifications. These models include municipality fixed-effects, year fixed-effects, and state-specific linear time trends (constants not reported). Columns (3) and (4) report log difference LS specifications where both variables are expressed in first-differences. These models include state fixed-effects and year fixed-effects (constants not reported). The log difference specifications also include two lags of the dependent variable (logarithmic growth of municipal GDP p.c.). The reported coefficients represent the cumulated effect (taking into consideration the lags). Standard errors are calculated using the Delta method. The specifications in columns (2) and (4) include cutoff-specific 1st-order regression-discontinuity polynomials on absolute distance to the closest threshold (the "running-forcing" variable). The RD polynomial allows coefficients to differ at each side (below/above) of each cutoff and also include cutoff-specific constants ("rectangular kernel"). The last four columns give summary statistics for the main Brazilian macro regions. Column (5) reports the average of trade openness (based on state-level exports and imports to all other Brazilian states) in the beginning of the sample period (1999). Column (6) reports the average of a proxy of financial development, based on the number of municipalities with a bank branch in 2007. Column (7) reports the average of municipal GDP p.c. Column (8) reports the total number of municipalities in our sample. Appendix Table 1 gives summary statistics at the state-level and also lists states by macro region. Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table 9 - Heterogeneity w.r.t. Trade Openness
Local Regression Estimates (Various Bandwidths)

	Log Level Specifications		Log Difference Specifications		
	(1)	(2)	(3)	(4)	Obs.
			Panel A: 1000 Bandwidth		
CLOSED	0.126***	0.093***	0.141***	0.137***	10503 / 6730
	(0.027)	(0.027)	(0.019)	(0.019)	
OPEN	0.113***	0.077***	0.121***	0.117***	
	(0.024)	(0.025)	(0.016)	(0.016)	
			Panel B: 750 Bandwidth		
CLOSED	0.097***	0.087***	0.127***	0.125***	7840 / 4605
	(0.028)	(0.028)	(0.022)	(0.022)	
OPEN	0.074***	0.059***	0.109***	0.104***	
	(0.027)	(0.026)	(0.018)	(0.019)	
			Panel C: 500 Bandwidth		
CLOSED	0.082***	0.073***	0.109***	0.1***	5092 / 2554
	(0.031)	(0.031)	(0.028)	(0.029)	
OPEN	0.052*	0.039	0.04	0.032	
	(0.030)	(0.029)	(0.025)	(0.026)	
Year Fixed Effects	Yes	Yes	Yes	Yes	
Municipality Fixed Effects	Yes	Yes	No	No	
State-time Time Trends	Yes	Yes	No	No	
Cutoff-Specific RD Polynomial	No	Yes	No	Yes	
State Fixed Effects	No	No	Yes	Yes	

The table reports "reduced-form" estimates associating the natural logarithm of municipal GDP per capita to the natural logarithm of law-implied (theoretical) FPM transfers per capita in the neighborhood of the FPM cut-offs allowing the coefficient (elasticity) to differ across municipalities in relatively more open to trade Brazilian states and in relatively more closed to trade states. To distinguish between relatively open and relatively closed states, we use the median of the share of imports and exports to other Brazilian states as a share of state-level GDP. Appendix Table 1 reports the values of the trade openness proxy for each of the 26 Brazilian states. Panel A reports local regression estimates that restrict estimation in the neighborhood of the FPM cutoffs using a 1000 inhabitant's bandwidth (on each side of the cutoff). Panel B reports local regression estimates that restrict estimation in the neighborhood of the FPM cutoffs using a 750 inhabitant's bandwidth. Panel C reports local regression estimates that restrict estimation in the neighborhood of the FPM cutoffs using a 500 inhabitant's bandwidth.

Columns (1) and (2) report log level LS specifications. These models include municipality fixed-effects, year fixed-effects, and state-specific linear time trends (constants not reported). Columns (3) and (4) report log difference LS specifications where both variables are expressed in first-differences. These models include state fixed-effects and year fixed-effects (constants not reported). The log difference specifications also include two lags of the dependent variable (logarithmic growth of municipal GDP p.c.). The reported coefficients represent the cumulated effect (taking into consideration the lags). Standard errors are calculated using the Delta method. The last column gives the number of observations for the log level and the log difference specifications. The specifications in columns (2) and (4) include cutoff-specific 1st-order regression-discontinuity polynomials on absolute distance to the closest threshold (the "running-forcing" variable). The RD polynomial allows coefficients to differ at each side (below/above) of each cutoff and also include cutoff-specific constants ("rectangular kernel"). Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table 10 - Heterogeneity w.r.t. Financial Constraints
Local Regression Estimates (Various Bandwidths)

	Log Level Specifications		Log Difference Specifications		
	(1)	(2)	(3)	(4)	Obs.
			Panel A: 1000 Bandwidth		
Low Level Financial Constr.	0.081***	0.049**	0.097***	0.093***	10503/6758
	(0.023)	(0.024)	(0.015)	(0.015)	
High Level Financial Constr.	0.211***	0.181***	0.165***	0.16***	
	(0.027)	(0.028)	(0.020)	(0.020)	
			Panel B: 750 Bandwidth		
Low Level Financial Constr.	0.049**	0.037	0.083***	0.08***	7840/ 4622
	(0.025)	(0.024)	(0.017)	(0.018)	
High Level Financial Constr.	0.173***	0.167***	0.158***	0.153***	
	(0.030)	(0.029)	(0.023)	(0.023)	
			Panel C: 500 Bandwidth		
Low Level Financial Constr.	0.028	0.017	0.049**	0.038	5092/ 2554
	(0.028)	(0.027)	(0.023)	(0.024)	
High Level Financial Constr.	0.16***	0.163***	0.131***	0.126***	
	(0.031)	(0.032)	(0.031)	(0.031)	
Year Fixed Effects	Yes	Yes	Yes	Yes	
Municipality Fixed Effects	Yes	Yes	No	No	
State-time Time Trends	Yes	Yes	No	No	
Cutoff-Specific RD Polynomial	No	Yes	No	Yes	
State Fixed Effects	No	No	Yes	Yes	

The table reports “reduced-form” estimates associating the natural logarithm of municipal GDP per capita to the natural logarithm of law-implied (theoretical) FPM transfers per capita in the neighborhood of the FPM cut-offs allowing the coefficient (elasticity) to differ across municipalities which are relatively more/less financially constrained. Municipalities without any bank branch are considered with high level of financial constraints, while municipalities with at least one branch are considered to have a low level of financial constraint. Panel A reports local regression estimates that restrict estimation in the neighborhood of the FPM cutoffs using a 1000 inhabitant’s bandwidth (on each side of the cutoff). Panel B reports local regression estimates that restrict estimation in the neighborhood of the FPM cutoffs using a 750 inhabitant’s bandwidth. Panel C reports local regression estimates that restrict estimation in the neighborhood of the FPM cutoffs using a 500 inhabitant’s bandwidth.

Columns (1) and (2) report log level LS specifications. These models include municipality fixed-effects, year fixed-effects, and state-specific linear time trends (constants not reported). Columns (3) and (4) report log difference LS specifications where both variables are expressed in first-differences. These models include state fixed-effects and year fixed-effects (constants not reported). The log difference specifications also include two lags of the dependent variable (logarithmic growth of municipal GDP p.c.). The reported coefficients represent the cumulated effect (taking into consideration the lags). Standard errors are calculated using the Delta method. The last column gives the number of observations for the log level and the log difference specifications. The specifications in columns (2) and (4) include cutoff-specific 1st-order regression-discontinuity polynomials on absolute distance to the closest threshold (the “running-forcing” variable). The RD polynomial allows coefficients to differ at each side (below/above) of each cutoff and also include cutoff-specific constants (“rectangular kernel”). Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Federal Transfer Multipliers: Quasi-Experimental Evidence from Brazil*
Supplementary Online Appendix

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Abstract

The Supplementary Appendix is organized into five parts. Section 1 illustrates the discontinuous nature of the FPM allocation mechanism with two examples. Section 2 reports descriptive and summary statistics. Section 3 presents further results on the link between local spending, actual federal transfers and law-implied (theoretical) FPM transfers. Section 4 reports an extensive set of sensitivity checks which supports the robustness of the "reduced-form" relationship between municipal output and theoretical FPM transfers in the neighborhood of the discontinuities. Section 5 reports local multiplier estimates using a combined GDP-luminosity proxy of local economic activity aimed to reduce measurement errors in municipal output.

*All errors are our own responsibility.

1 Examples of the Allocation Mechanism

In order to illustrate the discontinuous nature of the allocation mechanism, we discuss two sets of examples where federal transfers change from one year to the next. Before proceeding, it is useful to emphasize that differences in FPM transfers for a given municipality over two consecutive years are driven by two (possibly opposing) forces: (*i*) the move, if any, to a higher or lower population threshold, (*ii*) the growth of the national economy, which when positive (as in the case of Brazil over our sample period) typically translates into higher fiscal revenues and thus a larger pot of money available for the FPM program which is independent of municipal population estimates.

Consider two pairs of municipalities in the same state (*Minas Gerais*) and in the same period (2010-2011). The first pair consists of *Berilo* and *Mirabela*, two municipalities that experienced a slight drop in population from 2009 to 2010. This is depicted in Appendix Figure 1. The inhabitants of *Berilo* went from 13,717 to 12,300. The decline, though small, was nevertheless enough to cross the population cutoff of 13,584 residents and to have its FPM coefficient reduced from λ=1.0 to λ=0.8. Accordingly, FPM transfers in 2011 slightly fell from R\$3,577,842 to R\$3,304,312 (the fall was small because during this period the total pot increased considerably as Brazil's growth was strong, close to 4%). On the other hand, the population decline in *Mirabela* from 13,252 to 13,042 inhabitants was such that the municipality stayed in the same population bracket. Although the FPM coefficient remained unchanged (λ=0.8), *Mirabela* witnessed an increase in federal transfers from R\$2,862,273 to R\$3,304,312 as strong national growth between 2010 and 2011 significantly increased the overall size of total federal transfers.

The second pair of cities –*Caetanopolis* and *Pedralva*– experienced a slight increase in population. On the one hand, the population of *Pedralva* went up by just 116 inhabitants, from 11,351 to 11,467. This population change, however, was not sufficient to move the city to the higher population bracket. As such, the increase in FPM transfers was moderate (from R\$2,862,273 to R\$3,304,312), simply reflecting the overall raise in the total pot of funds of the FPM programme. On the other hand, *Caetanopolis* population increased again only slightly, by 178 inhabitants from 10,040 to 10,218 which. While the population increase was similar to the increase in *Pedralva*, it was just enough to move *Caetonopolis* up to a higher population bracket. Accordingly, FPM transfers increased considerably, from R\$2,146,705 to R\$3,304,312, in a combination of strong national growth and movemnet to a higher population bracket.

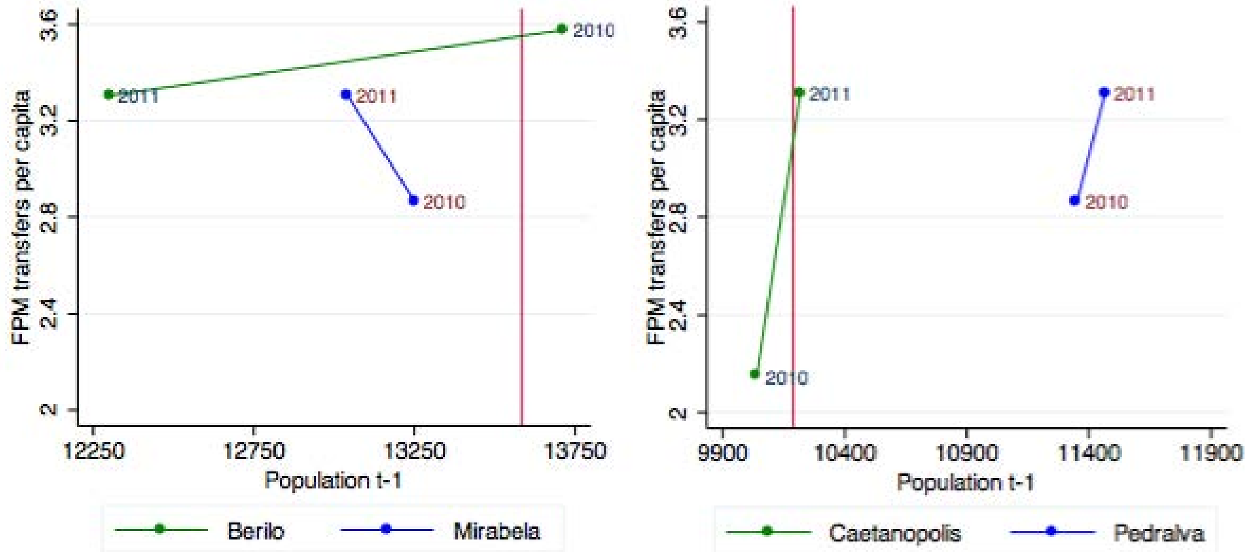


Figure 1: Example of the FPM allocation mechanism

As detailed in the main text (Section 2), our "fuzzy" regression discontinuity setup exploits this type of population changes close to the discontinuities to identify the causal effect of federal transfers on municipal economic activity. In addition, our empirical strategy blends the RD design with a classical difference-in-difference approach. In the context of our examples, the comparison of the change in transfers of $-R\$273,529$ for *Berilo* (i.e. $R\$3,577,842$ to $R\$3,304,312$) with the change in transfers of $+R\$442,038$ for *Mirabela* (i.e. $R\$2,862,273$ to $R\$3,304,312$) provides us with a (locally) exogenous change in federal transfers of $-R\$476,549$ (i.e. $R\$442,038$-$R\$273,529$). Similarly, the relative change in federal transfers of $+R\$715,569$ between *Caetanopolis* and *Pedralva* (i.e. $R\$1,157,607$-$R\$442,038$) offers another example of the exogenous variation we exploit to identify the causal effects of federal transfers on local economic activity.

2 Descriptive and Summary Statistics

Appendix Table 1 reports some key characteristics for each Brazilian state. The table gives the fixed state shares (percentages) of the FPM program, the number of municipalities in our sample, average municipal population and GDP per capita, a proxy of trade openness (exports and imports to other Brazilian states as a share of state GDP in 1999 as estimated in Vasconcelos, 2001), and an index of financial development (the share of municipalities in each state with a bank branch in 2007).[1]

Appendix Table 2 gives descriptive evidence on the distribution of Brazilian municipalities around each FPM population cutoff. Panel A reports summary statistics for the sample that covers municipalities with a population between $6,793$ and $50,940$ inhabitants. The number of municipalities falls with population. Panel B presents data patterns for the restricted ("local") sample where we focus in the neighborhood of each of the seven discontinuities using a $1,000$ inhabitants bandwidth. With the exception of the two post-Census years (2008 and 2011), there seems to be little evidence of manipulative sorting: the number of municipalities seem evenly split between observations just above and observations just below the discontinuities for all cutoffs and years.

Appendix Table 3 (that "mirrors" Table 1-Panel A) reports the number of municipalities that move to a lower and higher FPM bracket ("treatment" group) and the number of municipalities that do not change population bracket ("control" group), when we restrict estimation in the neighborhood of the discontinuities using a 1000 bandwidth (Panel A) and a 500 bandwidth (Panel B). Panel A shows that approximately 57% (560 out of 985) of the restricted sample consists of municipalities whose population fluctuates around the cutoffs without crossing the discontinuities. Another 29% of the sample consists of municipalities moving to a higher bracket and 7% of municipalities move only to a lower FPM bracket. The remaining 7% (73 municipalities) experienced movements in both directions, as these municipalities entered a higher bracket in some years and then a lower bracket in other years. A similar pattern emerges when we restrict the sample to the 500 inhabitants bandwidth. 56% (231 out of 412) of the municipalities serve as the "control" group and 44% of the sample of municipalities have moved at least once to either a lower or a higher FPM category.

Appendix Table 4 gives summary statistics of the main variables in the "local" (close to the seven discontinuities) sample (using a $1,000$ inhabitants bandwidth). No discernible pattern emerges relative to the descriptive statistics of the full sample in Table 2.

[1]The banking penetration (financial development) index is retrieved from the Brazilian Central Bank's web-site (*Banco Central do Brasil*, at www.bcb.gov.br).

3 Law-Implied FPM Transfers, Actual Transfers and Municipal Government Spending

3.1 Law-Implied and Actual FPM Transfers ("First-Stage")

Appendix Tables 5, 6 and 7 provide further evidence that the FPM legislation shaping federal transfers to Brazilian municipalities is broadly (though not perfectly) enforced.

Appendix Table 5 replicates the estimates in Table 3 but with both the dependent variable (actual FPM transfers) and the independent variable (law-implied FPM transfers) expressed in logs. The LS elasticity is very close to unity ($0.94 - 0.98$) and the model fit is good (manifested in a high R^2). In an effort to account for extreme observations, we estimated the specification with Least Absolute Deviation (LAD) and Huber (robust) procedures. The LAD and Huber estimates are virtually one across all bandwidths, suggesting that the allocation mechanism is broadly enforced.

In Appendix Table 6 - Panel A we report specifications in (non-log) first-differences. These models associate the change in realized FPM transfers (the dependent variable) to changes in law-implied ("theoretical") FPM transfers (the independent variable) in four restricted "local" samples (columns (2)-(5)) and for comparability also in the full sample (column (1)) which includes municipalities both close and far from the seven FPM discontinuities. The OLS estimates in our preferred specifications with a 500 bandwidth (column (4)) are around 0.85 (and highly significant). The small attenuation compared to the level specifications in Table 3 is to be expected, as the statistics do contain some noise and differencing often increases the noise-to-signal ratio (Griliches and Hausman (1986)). The within R^2 is also high (0.43) but far from one. In rows (3) and (4) we report LAD and Huber estimates to account for outliers. The coefficients are now one, further suggesting that the legislation tends to be enforced, albeit imperfectly.

Since in many specifications we apply a logarithmic transformation, Appendix Table 6-Panel B gives estimates associating the logarithmic change of realized FPM transfers to the logarithmic change of law-implied (theoretical) FPM transfers. The results are similar to the level specifications (in Table 3) or the difference specifications (without the logarithmic transformation) in Appendix Table 6 - Panel A. The OLS coefficient is highly significant, though somewhat lower than one. LAD and Huber estimates are again virtually one.

In Appendix Table 7 we allow the elasticity of realized and law-implied FPM transfers to differ for municipalities around each of the seven discontinuities. Both the log level (Panel A) and the log difference (Panel B) specifications show that the FPM allocation mechanism tends to be enforced across all cutoffs.

3.2 Law-Implied FPM Transfers and Local Government Spending

Besides examining the strength of the relationship between realized (actual) and law-implied (theoretical) FPM transfers, we have also explored the link between (realized/actual) municipal government spending and (actual and law-implied) federal transfers (see also Figure 6 in the main part of the paper).

In Appendix Table 8 we regress municipal government spending per capita on law-implied FPM transfers per capita in the full sample (column (1)) and in the four "local" samples (columns (2)-(5)). Panel A reports estimates from the level specifications, while first-difference estimates are in Panel B.

The OLS estimates in Panel A are in the range $0.77 - 0.83$ and highly significant across all specifications. The least-absolute-deviation and the Huber estimates -that account for outliers- are close to one. The coefficient in the first-difference specifications is somewhat lower, around $0.7 - 0.88$ implying that a 10 reais change in law-implied FPM transfers are associated with a change in local government spending of approximately 8 reais. The elasticity of municipal public spending to law-implied FPM transfers is around $0.25 - 0.35$, quite similar to the "theoretical" value of 0.29 (the ratio of FPM transfers to local spending (3.5/12.1): see Panel B of Table 2 and Appendix Table 4).

Appendix Table 9 reports cutoff-specific estimates of the elasticity of local government spending (per capita) and law-implied FPM transfers (per capita) in the neighborhood of each of the seven discontinuities using four different bandwidths (specifications (2)-(5)) and the full sample (specification (1)). Changes in FPM transfers are associated with significant variation in local government spending across all population cutoffs. In line with the descriptive evidence of Table 2 (and Appendix Table 4) showing that municipal governments run balanced budgets, there is a strong link between law-implied FPM transfers and realized (actual) government spending. In the local regressions, the elasticity is around 0.3 across all cutoffs.

Appendix Table 10 displays two-stage-least-squares (2SLS) "local" regression estimates associating municipal government spending with the component of realized federal transfers driven by the law governing FPM allocation. Panel A gives level specifications (with municipality fixed effects, year constants and state-specific linear time trends) while Panel B reports first-difference specifications (with state fixed effects and year constants). The estimates in Panel A show that there exists virtually a one-to-one mapping from the component of actual FPM transfers shaped by the discontinuous allocation of funds to municipal government spending. The 2SLS estimates in the difference specifications are also close to one.

4 Sensitivity Analysis on the Link between Municipal Output and Law-Implied FPM Transfers

We have performed various perturbations and checks to assess the robustness of the "reduced-form" relationship that links municipal output and law-implied (theoretical) FPM transfers.

Dynamics. We estimated log difference specifications without controlling for lagged output dynamics. As the results in Appendix Table 11-Panel A show the implied effect of law-implied FPM transfers on local output is highly significant and if anything somewhat larger (as compared to the estimates in Table 5). This is because municipal output growth is a highly mean-reverting variable (with an auto-regressive persistence parameter of around -0.2). The results are also similar if we include one, two or even three lags of the dependent variable (Appendix Table 11, Panels B, C, and D).

Outliers. To account for outliers, which seems a feature of (Brazilian) municipal output data, we estimate median effects (using least-absolute-deviation) and Huber-robust specifications, which are less sensitive (than OLS) to extreme observations. The "reduced-form" coefficients reported in Appendix Table 12 are similar to the OLS estimates (Table 5-Panel B). The elasticity in our preferred specifications at the 500 bandwidth is around $0.063-0.072$. Moreover, and consistent with the presence of fat tails, these regression methods yield more accurate estimates, as exemplified by far smaller standard errors relative to OLS.

Non-Logarithmic Specifications. We also provide non-logarithmic specification estimates, as this allows to assess the output impact in local currency of a change in transfers of one unit of local currency, i.e. the estimates can be directly interpreted as a multiplier. This is because the (first-stage) relationship between law-implied and actual transfers is indistinguishable from one. A possible limitation with this approach is that since the distribution GDP has a long right tail, the average effect recovered by OLS estimation may be tilted towards these outliers. Thus Appendix Table 13 reports Huber estimates (that complement the median regression estimates in Table 5-Panel C). Huber estimates imply that a 10 Brazilian reais increase in law-implied transfers is associated with an approximately $12-18$ reais increase in GDP per capita.

Cutoff-Specific Analysis. We also examine whether the link between law-implied federal transfers and municipal output in the neighborhood of the seven FPM discontinuities is stronger/weaker for smaller/larger cities. Appendix Table 14 gives "reduced-form" estimates that allow the output-FPM transfers elasticity to differ at each cutoff. The significance of the 'reduced-form' association is present across all cutoffs, though –as expected– it is stronger (and more precisely estimated) in the initial four discontinuities (population $9,000-25,000$), which are characterized by a relatively larger number of municipalities.

Regression Discontinuity with a Global High-Order Control Function Approach. Some previous works in political economy that exploit the non-linear allocation of federal transfers to Brazilian municipalities apply a regression discontinuity approach that uses all observations, both close and far from the cutoffs. Brollo, Nannicini, Tabellini, and Perotti (2013)) condition on high-order polynomials (of population) to control for the continuous part of the allocation mechanism. While this approach is sensitive to the polynomial order and tends to make inference challenging (Gelman and Imbens (2014)), Appendix Table 15 reports the "global control function" RD estimates with GDP and law-implied FPM transfers expressed in logs (Panel A) and log differences (Panel B), controlling for high-order cutoff-specific polynomials. The link between municipal output and law-implied FPM transfers is present when we use observations both close and relatively further away from the seven discontinuities. If anything, the estimates are larger. For example the coefficient in the log difference specification that includes a fourth-order cutoff-specific polynomial on population implies that a 10 percent increase in federal transfers is associated with an increase of per capita GDP of approximately 1.3 percent.

Excluding Observations around Cutoff 1. A key identifying identification assumption is that no other features than federal transfers change abruptly at the FPM discontinuities. As detailed in Section 2, this is the case in our sample of relatively small Brazilian municipalities, with one, however, exception: A 2000 Constitutional amendment -that was enforced in 2005- placed caps on the salaries of local council members that change discontinuously at some population cutoffs. While most of these cutoffs are only relevant for large cities (not included in our sample), the first cutoff of the FPM transfer allocation mechanism $(10,188)$ is close to the first discontinuity on the salary cap $(10,000)$.[2] While it is unclear how this policy change might affect our results, to minimize concerns that our estimates are confounded by this effect, we repeated estimation excluding observations of municipalities around the $10,188$ cutoff. The results are reported in Appendix Table 16. The coefficient on law-implied (theoretical) transfers in our preferred specifications at the 500 bandwidth (in columns (4) and (9)) is 0.07 in the log level specifications (Panel A) and around 0.05 in the log difference specifications (Panel B). These estimates are thus similar to the baseline results (in Table 5), which use municipalities from all seven cutoffs. In Panel C we report median regression difference specifications (without the logarithmic transformation) as this enables getting a rough estimate of the "multiplier". Increases in law-implied transfers in the neighborhood of the seven discontinuities of one real are associated with increases in municipal GDP of approximately $1.2 - 1.7$ reais.

Excluding Observations in 2008 and 2008-2011. Another identification assumption is that local authorities should not be in a position to perfectly manipulate population estimates so as to receive more FPM transfers. [Lee and Lemieux (2014) write: "*If individuals – even while having some influence – are unable to precisely manipulate the assignment variable, a consequence of this is that the variation in treatment near the threshold is randomized as though from a randomized experiment.*"]. While there is ample evidence suggesting that precise manipulation is not present, we further explored this issue.[3] Appendix Figure

[2] Ferraz and Finan (2011) employ a "fuzzy" RD design to assess the impact of local councilors pay on various proxies of local efficiency. The authors also provide details on the specificities of this legislation and its implementation.

[3] As we discuss in the paper (Section 2) systematic perfect manipulation is unlikely. First, as we include municipality fixed-effects (in the log level specifications) or express the model in first-differences, we account for time-invariant features that may raise the propensity of some municipalities to receive more transfers from the federal government. Second, previous works that exploit cross-sectional variation on FPM transfers and other outcomes show that there is little manipulation (Brollo, Nannicini, Tabellini, and Perotti (2013),

2 records the McCrary (2008) density plots by year. There is little evidence of bunching of municipalities in the right of the cutoffs for each year but 2008 and 2011. Population in these two years reflect the special and regular Census of 2008 and 2010 and are not based on IBGE estimates. In Appendix Table 17 we thus report local regression estimates excluding 2008. This has little effect on our results. The local regression estimates at the 500 bandwidth suggest that a one Brazilian real increase in law-implied FPM transfers is associated with an increase of municipal GDP p.c. of 1.7 reais.

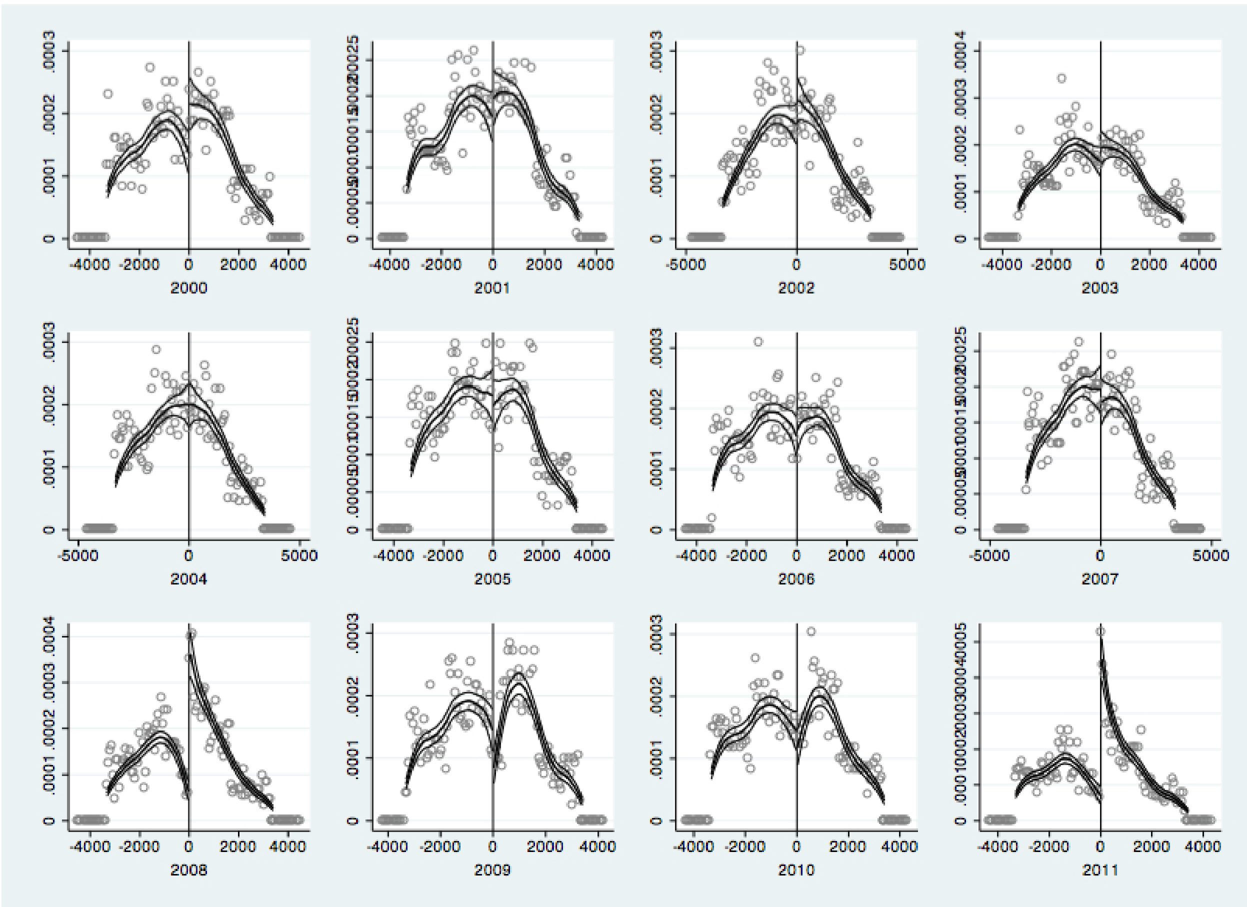


Figure 2: McCrary Density Test, by year

To further minimize concerns of manipulative sorting in Appendix Table 18 we exclude all post-2007 observations ($2008-2011$). While these estimates come at an efficiency loss, in all

Gadenne (2014)). Third, population estimates are produced by an independent federal agency and supervised by the Federal Court of Auditors. And since our sample includes small cities, it is unlikely that local politicians can influence these independent federal institutions. Fourth, approximately $20\%-35\%$ of our sample includes municipalities moving to lower population brackets.

permutations the elasticity of municipal output to law-implied (theoretical) FPM transfers retains its statistical and economic significance. This applies both for the log level (Panel A) and the log difference specifications (Panel B). If anything the estimate increases (from around 0.07 in the full sample to 0.09). The least-absolute-deviation (median) estimates in differences in Panel C imply that a one real increase in law-implied transfers in the neighborhood of the FPM population cutoffs is associated with an increase of municipal GDP of approximately two reais.

Spillovers. In keeping with other studies on 'local' fiscal multipliers (e.g., Serrato and Wingender (2014), Acconcia, Corsetti, and Simonelli (2014), Shoag (2012)), we examined whether there are spillover effects of federal transfers in nearby municipalities. In this regard, we augment the baseline specifications with a variable that sums up real per-capita FPM transfers in all other municipalities within the same micro region. The analysis, reported in Appendix Table 19, reveals that spillovers are small and in most permutations statistically indistinguishable from zero.

Migration. Spillovers may also arise because of labor relocation and migration. Since we do not have data on inter-municipality migration, directly tackling this issue is challenging. Yet, socio-demographic analyses of the Brazilian labour market reveal that the migration trends from small rural areas to large cities that were evident in the 1980s and 1990s slowed down considerably to in 2000s (Brito and Carvalho (2006) and Filho and Horridge (2010)). Furthermore, as our sample consists of small municipalities (less than $51,000$ inhabitants), significant migration between such small cities is unlikely, especially at the annual frequency. To account for migration trends within micro-regions, in Appendix Table 20 we augment the baseline specification with three lags of population growth in the micro-region (that includes geographically and economically proximate municipalities). The results remain intact.[4]

[4] Similar results are obtained aggregating population growth at the state level, which is meant to absorb also migration trends across micro-regions within the same state.

5 Results with an Improved Measure of Local Economic Activity

5.1 Motivation

Municipal GDP numbers may contain non-negligible error-in-variables. In general, measuring local economic activity can be quite challenging, even in advanced countries. Furthermore, the economic and geographic landscape in Brazil present additional challenges, as many municipalities are isolated and a sizable fraction of the economy may not be recorded. To account for this, in Table 7 we report results using nighttime satellite image data on light density that are available at a fine geographical level as an alternative measure of municipal economic activity. This approach builds on the important work of Henderson, Storeygard, and Weil (2012) and subsequent works (e.g., Chen and Nordhaus (2011), Pinkovskiy (2013), Michalopoulos and Papaioannou (2013, 2014)), who proposed using luminosity to proxy local economic activity, especially for countries/regions with not-available or low-quality statistics. While luminosity data is not a panacea, it is quite reassuring that the link between law-implied FPM transfers and output is present with this alternative proxy of economic activity which is not based on any extrapolation, survey, or projection.

In this Section, following closely Henderson, Storeygard, and Weil (2012), we first construct a combined lights-GDP series which aims to minimize noise in both series (as the errors in the two proxies of local output are most likely orthogonal) and then repeat estimation using the newly-constructed series.

5.2 A Combined Luminosity-GDP Measure

Appendix Figure 3a and Appendix Figure 3b depict municipal GDP p.c. (using the IBGE statistics) and luminosity per capita across Brazilian municipalities in our sample. A clear positive, though far from perfect, correlation is evident ($\rho = 0.3$). As the two series are significantly correlated and since both are likely to capture (with noise) actual output, then one can combine municipal value added from IBGE and luminosity data to construct a less noisy measure of local economic activity.

In this sub-section we briefly discuss the methodology of Henderson, Storeygard, and Weil (2012) in our context.

Let y be the growth (log difference) of "true" actual GDP, which is, however, unobserved.

(a) GDP (b) Luminosity

Figure 3: Average Municipal GDP *vs* Light in our sample

z denotes the growth (log difference) of real GDP, as compiled by the IBGE; and x denotes the logarithmic growth of light density at night (luminosity). For each municipality j, one can realistically assume that recorded GDP reflects with some noise ($\epsilon_{z,j}$) actual output.

$$z_j = y_j + \epsilon_{z,j}$$

where the variance of $\epsilon_{z,j}$ is denoted by σ_z^2.

Similarly, the relationship between luminosity log growth and log growth of true income is given by

$$x_j = y_j + \epsilon_{x,j}$$

where $\epsilon_{x,j}$ denotes the noise of luminosity data in capturing actual output and ${\sigma^2}_x$ is the variance.

As there are no obvious reasons to think that noise in the GDP statistics (produced by the National Statistical agency) is related in any systematic way to the error in the luminosity-output equation, Henderson *et al.* (2012) assume that $Cov(\epsilon_x, \epsilon_z) = 0$.

The starting point of the analysis is constructing a luminosity-based index of municipal GDP. First, we regress GDP on luminosity

$$z_j = \hat{\psi} x_j + e_j \tag{1}$$

and estimate the elasticity parameter $\hat{\psi}$.

By construction $\hat{\psi}$ is a biased estimate of the inverse of the elasticity of lights with respect to income (the bias comes from noise in luminosity). However, as the main interest here is to produce a proxy for income growth, equation (1) still represents the best linear projection of output (z_j) on luminosity (x_j). Second, we use the projection of GDP growth on lights growth, $\hat{z}_j = \hat{\psi} x_j$, to improve the precision of estimated income growth. So, $\hat{z}_j$ becomes now a (separate to log GDP growth) estimate of log income growth based on luminosity. The third step combines the newly-constructed lights-based proxy of local output with the reported GDP statistics to generate an improved measure of local economic activity. Henderson *et al.* (2012) consider a generic composite estimate of income growth ($\hat{y}$):

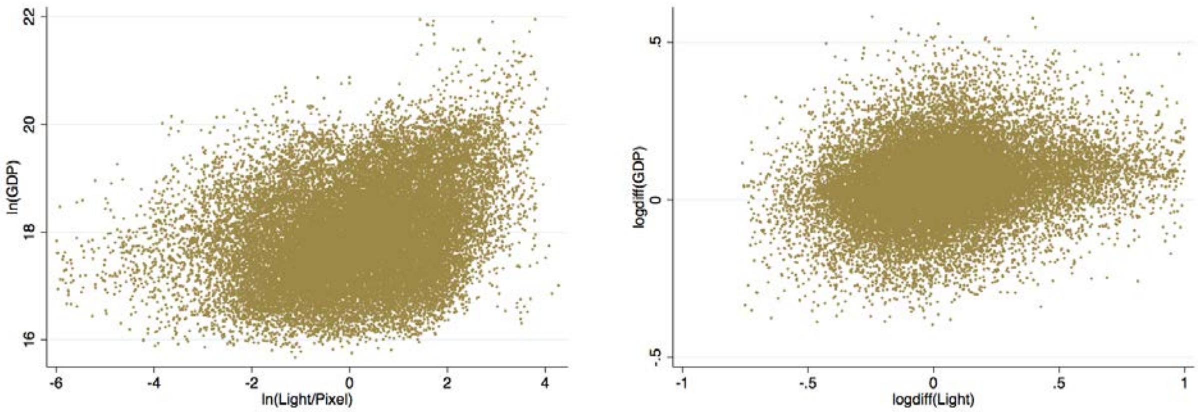
$$\hat{y}_j = \lambda z_j + (1 - \lambda)\hat{z}_j$$

where λ is the weight given to GDP as recorded in national income accounts and $(1 - \lambda)$ is the weight on the light-based projection of GDP. Henderson *et al.* (2012) show that the optimal weight minimizes the variance of the measurement error in this combined estimate to the true value of income growth.

To calculate the optimal weight, one needs to make assumptions about the ratio of signal to total variance in measured GDP growth. Working with cross-country data, Henderson *et al.* (2012) follow a recursive approach that assumes a high ratio of signal to total variance for countries with high quality data to back out the other parameters that constitute the optimal weight. Even though we could in principle follow a similar strategy by considering state-level output as high-quality and municipal-level as low-quality data, we prefer to take a simpler (and more transparent) approach and set $\lambda = 0.5$ for municipalities, as Henderson *et al.* (2012) argue this is likely to be a good point estimate for low-quality data.[5]

Appendix Table 21 presents the results of the projection of GDP on lights for our sample of small Brazilian municipalities (standard errors are clustered at the micro-region level as this account both for serial correlation and spatial correlation). All specifications include year dummies. Column (1), (2), and (3) report log level specification estimates controlling for state, micro-region and municipality fixed effects, respectively. As expected, the R^2 increases as we progressively account for unobservables (and heterogeneity). The estimate in columns (1)-(2) is around $0.2 - 0.28$, quite similar to the cross-country fit of Henderson *et al.*

[5]Our results are not qualitatively sensitive to this particular choice of λ.



(a) GDP (b) Luminosity

Figure 4: Municipal GDP *vs* Light - log-levels and log-differences

(2012).[6] Conditioning on municipality fixed-effects lowers the coefficient from $0.20 - 0.28$ to 0.07, which suggests that the municipality constants capture most of the variation. Column (4) report results including state-specific time-trends, as a way to investigate deviations from regional business cycles. The estimate (0.19) retains significance. Finally, columns (6) and (7) show that the coefficient estimates on long-differences are still positive and highly significant though somewhat smaller in magnitude ($0.13 - 0.14$).

Appendix Figure 4*a* and 4*b* plot GDP versus luminosity in (log) levels and (log) differences. Similarly to the pattern reported in Henderson *et al.* (2012), the pictured plot indicates that a linear specification in the growth rates is a good approximation. A similar linear specification in levels however does not seem to adequately capture the empirical relationship. In order to take that into account and provide a better fit to the data, we also construct a piecewise linear projection of GDP on lights, allowing the coefficient on lights to vary by quintiles of the luminosity distribution. Such projection (illustrated in Figure 6) is then combined with standard GDP to form the combined measure discussed above.

5.3 Estimates based on the combined Luminosity-GDP measure

Average Effect. Appendix Table 22 reports "reduced-form" estimates using the improved proxy of local economic activity that combines information in luminosity and the IBGE GDP estimates. Panel *A* reports log level specifications and Panel *B* reports log-difference

[6]Estimating cross-country panel regressions covering 188 countries over 17 years, Hendesron *et al.* (2012) report elasticities ranging from0.26 to 0.28 (see Table 2 of their paper).

specifications. In all local samples, the elasticity of municipal output and law-implied FPM transfers is positive and highly significant. The estimates in our preferred specification, which restricts estimation in the neighborhood of the seven FPM cutoffs using a 500 inhabitants bandwidth, are around $0.085 - 0.11$, which is similar -though somewhat larger- than the baseline "reduced-form" estimates in Table 5. The key difference in the two tables is not the coefficient estimates, but the associated standard errors, which are much lower when we use the combined luminosity-GDP proxy of local economic activity (in Appendix Table 22). Since the inverse of the ratio of FPM transfers to GDP is around 21 (and the link between actual FPM transfers and law-implied transfers is almost one), these estimates imply "multipliers" around 2.

Heterogeneity. In Appendix Table 23 we examine regional heterogeneity in the link between municipal output and law-implied FPM transfers in the neighborhood of the discontinuities proxying municipal output with the combined lights-GDP measure. As in Table 8, the elasticity is much higher for municipalities in the Northern states, which are more isolated and less economically and financially developed.

In Appendix Table 24 we explore whether the link between law-implied FPM transfers and the combined lights-GDP proxy of municipal output close to the FPM cutoffs is higher for municipalities in relatively closed states. In line with the evidence in Table 9, the elasticity is always higher for states relatively more closed to trade. Since the standard errors fall, in the log difference specifications we can also reject the null hypothesis of coefficient equality at the 95% confidence level.

In Appendix Table 25 we investigate whether the "reduced-form" relationship between municipal output and law-implied FPM transfers differs Brazilian municipalities according to whether or not they have a bank branch. The coefficient for the sample of low-level financial constraints is much smaller than in the sample of high-level of financial constraints. As in all estimates with the output proxy that combines GDP and luminosity to account for error-in-variables, standard errors tend to become smaller. Accordingly, in all specifications, we can comfortably reject the null hypothesis that the two estimates are statistically similar.

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Appendix Table 1 – State Characteristics

	State	Macro Region	State FPM fixed share	Number of municipalities	Average Population	GDP per capita	Trade Openness	Financial Development
AC	Acre	North	0.263	15	17,426	4,704	0.42	0.74
AM	Amazonas	North	1.245	54	22,252	2,471	1.58	0.54
AP	Amapá	North	0.139	7	14,646	4,932	0.30	0.43
PA	Pará	North	3.295	103	26,243	2,434	0.44	0.58
RO	Rondônia	North	0.746	36	21,447	5,980	0.67	0.78
RR	Roraima	North	0.085	7	12,266	5,286	0.41	0.44
TO	Tocantins	North	1.296	38	14,896	4,820	0.83	0.67
AL	Alagoas	Northeast	2.088	81	20,474	2,225	0.72	0.52
BA	Bahia	Northeast	9.270	359	19,760	2,673	0.79	0.69
CE	Ceará	Northeast	4.586	153	21,812	2,078	0.81	0.57
MA	Maranhão	Northeast	3.972	161	20,216	2,008	0.58	0.51
PB	Paraíba	Northeast	3.194	114	15,284	2,350	0.91	0.56
PE	Pernambuco	Northeast	4.795	148	20,775	2,325	0.91	0.66
PI	Piauí	Northeast	2.402	89	15,929	1,898	0.67	0.51
RN	Rio Grande do Norte	Northeast	2.432	85	15,142	3,110	0.78	0.45
SE	Sergipe	Northeast	1.334	51	18,000	4,626	0.91	0.82
GO	Goiás	Center-West	3.732	104	18,378	6,582	1.21	0.98
MS	Mato Grosso do Sul	Center-West	1.500	56	18,457	7,352	1.21	0.92
MT	Mato Grosso	Center-West	1.895	74	18,031	9,420	1.30	0.89
ES	Espírito Santo	Southeast	1.760	62	18,450	5,783	1.36	1.00
MG	Minas Gerais	Southeast	14.184	432	17,017	4,957	1.11	0.87
RJ	Rio de Janeiro	Southeast	2.738	59	21,707	9,690	0.72	0.98
SP	São Paulo	Southeast	14.262	316	20,708	8,564	0.75	0.98
PR	Paraná	South	7.286	218	17,234	6,507	1.26	0.94
RS	Rio Grande do Sul	South	7.301	176	17,996	8,745	0.82	0.99
SC	Santa Catarina	South	4.200	141	16,977	9,020	1.38	0.97

The table reports the number of municipalities per state in our sample, average municipal population and average GDP per capita in R$ (2000) throughout the 2000-2011 sample. Trade Openness represents the share of "imports" plus "exports" over GDP (at the state-level) in 1999. Financial Development stands for the share of municipalities with at least one bank branch in 2011 in a given state. State FPM share is the predetermined share of the FPM funds each state receives every year.

Appendix Table 2 - Distribution of Municipalities around Each Discontinuity

Panel A: Full Sample

Population Intervals	threshold 1 6793-11886		threshold 2 11887-15282		threshold 3 15283-20376		threshold 4 20377-27168		threshold 5 27169-33960		threshold 6 33961-40752		threshold 7 40753-50940	
year	below	above	below	above	below	above	below	above	below	above	below	above	below	above
2000	445	216	142	161	112	220	137	121	91	73	47	47	37	51
2001	567	262	188	188	151	269	182	147	102	96	65	58	45	62
2002	500	242	205	187	143	282	168	157	114	97	72	52	55	62
2003	568	248	218	186	156	266	164	166	128	95	71	59	54	73
2004	538	226	205	183	147	262	182	147	125	95	59	53	56	64
2005	512	202	190	173	130	267	178	130	121	95	54	53	54	60
2006	540	219	199	195	139	279	201	141	124	99	63	59	60	67
2007	602	236	204	201	158	273	213	149	133	106	73	56	57	76
2008	449	282	162	217	141	281	174	152	93	108	65	77	28	59
2009	477	263	195	201	154	280	193	157	93	105	72	67	46	73
2010	559	262	201	207	150	280	202	174	101	117	74	64	55	77
2011	432	288	141	202	115	284	176	160	78	120	66	76	41	68
Total	6,189	2,946	2,250	2,301	1,696	3,243	2,170	1,801	1,303	1,206	781	721	588	792

Appendix Table 2 - Distribution of Municipalities around Each Discontinuity (cont.)

Panel B: Restricted Sample in the Neighborhood of the FPM Cutoffs (<1000 Inhabitants)

Population Intervals	threshold 1		threshold 2		threshold 3		threshold 4		threshold 5		threshold 6		threshold 7	
	9188-11188		12584-14584		15980-17980		22772-24772		29564-31564		36356-38356		43148-45148	
year	below	above	below	above	below	above	below	above	below	above	below	above	below	above
2000	109	147	87	90	62	70	44	43	21	28	10	11	7	4
2001	154	171	109	106	85	98	51	49	32	36	19	16	12	3
2002	141	145	116	109	74	91	40	55	29	35	24	18	14	9
2003	132	153	117	104	74	83	37	58	42	26	23	20	10	12
2004	140	141	109	104	81	86	49	57	37	26	21	21	15	9
2005	136	124	111	96	71	79	41	47	27	32	9	15	12	8
2006	136	134	116	109	77	87	45	41	30	31	12	19	15	8
2007	168	149	121	115	89	85	50	48	36	30	26	14	13	11
2008	86	191	79	152	71	99	27	62	24	50	18	30	10	19
2009	111	149	115	113	92	85	52	40	30	27	12	13	16	7
2010	126	153	108	113	85	75	48	53	29	34	17	13	15	11
2011	66	203	82	145	51	102	29	63	15	47	12	30	7	10
Total	1,505	1,860	1,270	1,356	912	1,040	513	616	352	402	203	220	146	111

Panel A gives the count of observations (municipalities) per year in our sample below and above each of the seven FPM population thresholds (10188, 13584, 16980, 23772, 30564, 37356 and 44148). Panel B gives the count of observations (municipalities) per year in our sample below and above each of the seven FPM population thresholds within a 1000-neighbourhood of the closest threshold.

Appendix Table 3
Distribution of Municipalities in the Neighborhood of the FPM Cutoffs

Panel A: "Control" and "Treatment" Groups - Local Sample (<1000 Inhabitants)

	No Movement	Moves to Higher Bracket	Total
No Movement	560	286	846
Moves to Lower Bracket	66	73	139
Total	626	359	985

Panel B: "Control" and "Treatment" Groups - Local Sample (<500 Inhabitants)

	No Movement	Moves to Higher Bracket	Total
No Movement	231	119	350
Moves to Lower Bracket	39	23	62
Total	270	142	412

Both Panels report the number of municipalities that move across FPM population brackets and the number of municipalities that stay in the same FPM population bracket across the sample period 2000-2011. In Panel A we inlcude observations (municipalities) whose population is within a 1000-inhabitants neighbourhood (bandwidth) to the closest FPM population threshold. In Panel B we inlcude observations (municipalities) whose population is within a 500-inhabitants neighbourhood (bandwidth) to the closest FPM population threshold. See Table 1 Panel A for a similar tabulation for the full sample that inlcudes municipalities both relatively close and relatively far to the FPM cutoffs.

Appendix Table 4 - Summary Statistics in the Neighborhood of the FPM Cutoffs (Local Sample <1000 Inhabitants)

Panel A: Municipal Output and Population

	Output			Population			Output projected on lights		
Population Bracket	Mean GDP p.c. Growth	Median GDP p.c. Growth	Std. Dev. GDP Growth	Mean Pop. Growth	Median Pop. Growth	Std. Dev. Pop. Growth	Mean GDP p.c. Growth	Median GDP p.c. Growth	Std. Dev. GDP Growth
6,793–10,188	4.9%	4.8%	11.9%	0.3%	0.5%	4.1%	4.1%	4.1%	8.2%
10,189–13,584	5.3%	4.9%	11.3%	0.8%	0.7%	4.9%	4.7%	4.3%	7.8%
13,585–16,980	5.0%	5.3%	11.2%	0.9%	0.8%	4.8%	4.6%	4.4%	7.5%
16,981–23,772	4.9%	4.8%	11.2%	1.1%	0.8%	4.6%	4.2%	4.1%	7.4%
23,773–30,564	4.2%	4.9%	11.0%	1.0%	0.8%	4.5%	4.1%	3.8%	7.0%
30,565–37,356	5.6%	5.6%	10.8%	1.1%	0.9%	4.2%	4.1%	3.4%	6.7%
37,357–44,148	4.6%	4.6%	9.6%	1.1%	0.8%	4.2%	4.3%	4.3%	6.2%
44,149–50,939	5.4%	5.5%	10.1%	1.4%	1.3%	3.6%	4.2%	4.7%	6.2%
Total	5.0%	5.0%	11.3%	0.8%	0.7%	4.6%	4.4%	4.2%	7.5%

Panel B: Fiscal Measures (Transfers, Tax Reveues, and Expenditure)

	Sources of Revenue			Fiscal Position		Categories of Expenditures (% of Total)			
Population Bracket	FPM Transfers / GDP	Other Transfers / GDP	Local Taxes / GDP	Budget Surplus / GDP	Expenditure / GDP	Public Administration	Education	Housing & Urbanism	Health & Sanitation
6,793–10,188	4.0%	7.9%	0.7%	0.2%	13.0%	16.6%	30.5%	9.4%	22.1%
10,189–13,584	4.4%	8.1%	0.8%	0.3%	13.8%	16.5%	32.0%	9.6%	22.1%
13,585–16,980	3.8%	7.5%	0.8%	0.2%	12.4%	15.6%	32.2%	9.9%	22.7%
16,981–23,772	3.4%	7.1%	0.8%	0.2%	11.7%	15.9%	32.3%	9.9%	22.5%
23,773–30,564	2.6%	6.5%	0.8%	0.4%	10.2%	15.8%	32.6%	10.4%	22.2%
30,565–37,356	2.4%	6.3%	1.0%	0.2%	10.0%	15.7%	32.6%	10.6%	22.8%
37,357–44,148	2.2%	6.6%	1.1%	0.2%	10.2%	15.2%	31.4%	10.9%	23.5%
44,149–50,939	2.2%	6.6%	1.1%	0.2%	10.3%	14.9%	33.0%	11.0%	23.8%
Total	3.7%	7.5%	0.8%	0.2%	12.5%	16.0%	31.9%	9.8%	22.4%

The table reports summary statistics for the main variables employed in the empirical analysis for municipalities whose population estimate in a given year is within a 1000-inhabitants neighbourhood ti the closest FPM population threshold. In total we have 10,587 yearly observations covering 985 Brazilian municipalities over the period 2000-2011. Panel A reports the mean, median, and standard deviation of municipal GDP, population, and an alternative measure of local GDP that combines GDP series with satellite image data on light density at night (see the appendix). Panel B reports summary statistics on fiscal revenue and expenditure for the municipalities in our sample by FPM population bracket. Section 2 gives details on the FPM allocation mechanism.

Appendix Table 5 - Actual and Law Implied (Theoretical) FPM Transfers
Logarithmic Specifications

		Local Linear Regressions			
Bandwidth	All	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)
(1) Log Level	0.965***	0.947***	0.941***	0.94***	0.938***
	(0.002)	(0.004)	(0.005)	(0.006)	(0.006)
within (marginal) R^2	0.628	0.552	0.542	0.532	0.500
(2) Log Levels per capita	1.021***	0.984***	0.978***	0.971***	0.963***
	(0.004)	(0.006)	(0.006)	(0.007)	(0.008)
within (marginal) R^2	0.377	0.294	0.295	0.303	0.291
(3) Log per capita - Median	1.000***	1.000***	1.000***	1.000***	1.000***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
within (marginal) R^2	0.376	0.294	0.298	0.311	0.302
(4) Log Level per capita - Robust (Huber)	1.000***	1.001***	1.001***	1.001***	1.001***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
within (marginal) R^2	0.434	0.343	0.351	0.364	0.349
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	27976	10503	7840	5092	2538

The table reports regression estimates associating actual (realized) municipal FPM transfers to law-implied (theoretical) FPM Transfers. The table gives four specifications, all in logarithmic form. Row (1) reports OLS coefficient estimates when both the dependent and the independent variable are expressed in log-levels. Row (2) reports OLS coefficient estimates when both actual FPM transfers (the dependent variable) and law-implied (theoretical) transfers (the independent variable) are expressed in log per capita terms. Row (3) reports least-absolute-deviation (median) estimates associating actual FPM transfers per capita with law-implied FPM transfers per capita. Row (4) reports Huber ("robust regression") estimates associating actual FPM transfers per capita with law-implied FPM transfers per capita.
Column (1) reports estimates in the full sample that includes municipalities both close and far from the seven FPM discontinuities. Columns (2)-(5) report local regression estimates that restrict estimation in the neighborhood of the FPM cutoffs using four bandwidths, 1000 inhabitants (column (2)), 750 inhabitants (column (3)), 500 inhabitants (column (4)), and 250 inhabitants (column (5)). All specifications include state fixed effects and year fixed-effects (constants not reported). The table also reports the within (marginal) R2. Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Appendix Table 6 - Actual and Law-Implied (Theoretical) FPM Transfers
Specifications in First-Differences

Panel A: Specifications in First-Differences (Dependent Variable: Δ(FPM Transfers))

			Local Linear Regressions			
	Bandwidth	All	<1000	<750	<500	<250
		(1)	(2)	(3)	(4)	(5)
(1)	Levels	0.913***	0.898***	0.894***	0.87***	0.811***
		(0.006)	(0.008)	(0.009)	(0.012)	(0.020)
	within (marginal) R^2	0.263	0.370	0.401	0.424	0.380
(2)	Levels per capita	0.877***	0.863***	0.857***	0.833***	0.777***
		(0.007)	(0.010)	(0.012)	(0.015)	(0.023)
	within (marginal) R^2	0.283	0.378	0.401	0.434	0.406
(3)	Level per capita - Median	0.992***	0.993***	0.992***	0.989***	0.933***
		(0.001)	(0.001)	(0.001)	(0.003)	(0.028)
	within (marginal) R^2	0.277	0.377	0.402	0.438	0.420
(4)	Level per capita - Robust (Huber)	0.995***	0.993***	0.993***	0.992***	0.916***
		(0.001)	(0.002)	(0.003)	(0.004)	(0.008)
	within (marginal) R^2	0.161	0.168	0.190	0.257	0.316
	Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
	State Fixed Effects	Yes	Yes	Yes	Yes	Yes
	Observations	27976	8209	5641	3167	1116

Appendix Table 6 - Actual and Law-Implied (Theoretical) FPM Transfers
Specifications in First-Differences

Panel B: Specifications in First-Log-Differences (Dependent Variable: ΔLog(FPM Transfers))

(1) Log Level	0.726***	0.761***	0.756***	0.727***	0.649***
	(0.011)	(0.014)	(0.016)	(0.019)	(0.025)
within (marginal) R^2	0.133	0.253	0.280	0.315	0.299
(2) Log Level per capita	0.786***	0.784***	0.777***	0.749***	0.682***
	(0.008)	(0.011)	(0.013)	(0.016)	(0.024)
within (marginal) R^2	0.242	0.345	0.368	0.397	0.380
(3) Log Level per capita - Median	0.923***	0.906***	0.887***	0.871***	0.881***
	(0.006)	(0.005)	(0.004)	(0.004)	(0.004)
within (marginal) R^2	0.277	0.377	0.402	0.438	0.420
(4) Log Level per capita - Robust (Huber)	0.997***	0.987***	0.986***	0.983***	0.888***
	(0.001)	(0.003)	(0.003)	(0.004)	(0.009)
within (marginal) R^2	0.091	0.129	0.155	0.236	0.345
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	27976	8209	5641	3167	1116

The table reports regression estimates associating actual (realized) municipal FPM transfers to law-implied (theoretical) FPM Transfers. Each Panel reports four specifications, all in first-differences form (Panel A) or log-first-difference form (Panel B). Row (1) reports LS coefficient estimates when both the dependent and the independent variable are expressed in levels. Row (2) reports LS coefficient estimates when both actual FPM transfers (the dependent variable) and law-implied (theoretical) transfers (the independent variable) are expressed in per capita terms. Row (3) reports least-absolute-deviation (median) estimates associating actual FPM transfers per capita with law-implied FPM transfers per capita. Row (4) reports Huber ("robust regression") estimates associating actual FPM transfers per capita with law-implied FPM transfers per capita.

Column (1) reports estimates in the full sample that includes municipalities both close and far from the seven FPM discontinuities. Columns (2)-(5) report local regression estimates that restrict estimation in the neighborhood of the FPM cutoffs on both periods using four bandwidths, 1000 inhabitants (column (2)), 750 inhabitants (column (3)), 500 inhabitants (column (4)), and 250 inhabitants (column (5)). All specifications include state fixed effects and year fixed-effects (constants not reported). The table also reports the within (marginal) R2. Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Appendix Table 7 - Actual and Law-Implied (Theoretical) FPM Transfers by Cutoff

Panel A: Log Level Specifications

		Local Linear Regressions			
Bandwidth	All	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)
Cutoff 1	0.929***	0.879***	0.859***	0.843***	0.813***
	(0.005)	(0.009)	(0.011)	(0.013)	(0.016)
Cutoff 2	0.95***	0.922***	0.91***	0.903***	0.874***
	(0.005)	(0.008)	(0.009)	(0.010)	(0.013)
Cutoff 3	0.981***	0.949***	0.936***	0.925***	0.894***
	(0.005)	(0.007)	(0.008)	(0.009)	(0.013)
Cutoff 4	0.984***	0.961***	0.954***	0.948***	0.923***
	(0.005)	(0.007)	(0.009)	(0.010)	(0.013)
Cutoff 5	0.986***	0.966***	0.96***	0.95***	0.934***
	(0.006)	(0.009)	(0.010)	(0.011)	(0.011)
Cutoff 6	0.991***	0.978***	0.969***	0.964***	0.95***
	(0.006)	(0.007)	(0.008)	(0.008)	(0.010)
Cutoff 7	1.000***	0.976***	0.971***	0.968***	0.959***
	(0.005)	(0.012)	(0.013)	(0.013)	(0.011)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes

Appendix Table 7 - Actual and Law-Implied (Theoretical) FPM Transfers by Cutoff

Panel B: Log Difference Specifications

		Local Linear Regressions			
Bandwidth	All	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)
Cutoff 1	0.855***	0.774***	0.763***	0.757***	0.742***
	(0.010)	(0.015)	(0.017)	(0.019)	(0.020)
Cutoff 2	0.887***	0.829***	0.824***	0.823***	0.803***
	(0.010)	(0.012)	(0.013)	(0.014)	(0.018)
Cutoff 3	0.93***	0.858***	0.849***	0.84***	0.804***
	(0.010)	(0.012)	(0.013)	(0.015)	(0.022)
Cutoff 4	0.932***	0.867***	0.863***	0.858***	0.828***
	(0.011)	(0.013)	(0.014)	(0.017)	(0.019)
Cutoff 5	0.938***	0.878***	0.875***	0.863***	0.842***
	(0.010)	(0.014)	(0.014)	(0.017)	(0.019)
Cutoff 6	0.939***	0.886***	0.874***	0.869***	0.841***
	(0.011)	(0.014)	(0.015)	(0.016)	(0.020)
Cutoff 7	0.953***	0.883***	0.881***	0.876***	0.859***
	(0.011)	(0.018)	(0.020)	(0.020)	(0.020)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes

Appendix Table 7 - Actual and Law-Implied (Theoretical) FPM Transfers by Cutoff

Panel C: Log Difference Specifications - Robust Regression (Huber) Estimates

		Local Linear Regressions			
Bandwidth	All	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)
Cutoff 1	0.997***	0.992***	0.986***	0.982***	0.868***
	(0.001)	(0.003)	(0.004)	(0.006)	(0.013)
Cutoff 2	0.997***	0.993***	0.99***	0.987***	0.883***
	(0.001)	(0.004)	(0.005)	(0.007)	(0.014)
Cutoff 3	0.997***	0.991***	0.989***	0.989***	0.871***
	(0.001)	(0.004)	(0.006)	(0.009)	(0.019)
Cutoff 4	0.996***	0.99***	0.972***	0.953***	0.847***
	(0.001)	(0.006)	(0.008)	(0.012)	(0.028)
Cutoff 5	0.996***	0.991***	0.988***	0.986***	0.905***
	(0.001)	(0.008)	(0.011)	(0.018)	(0.043)
Cutoff 6	0.996***	0.986***	0.964***	0.931***	0.73***
	(0.001)	(0.013)	(0.018)	(0.028)	(0.084)
Cutoff 7	0.999***	1.003***	0.999***	0.979***	0.599***
	(0.001)	(0.017)	(0.025)	(0.045)	(0.106)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes

he table reports regression estimates associating actual (realized) municipal FPM transfers to law-implied (theoretical) FPM Transfers, allowing the coefficients to differ across the different FPM cutoffs. Panel A report log-levels LS estimates, Panel B report LS estimates from log-difference especifications and Pancel C reports Huber (robust regression) estimates of the log-differece specification. Column (1) reports estimates in the full sample that includes municipalities both close and far from the seven FPM discontinuities. Columns (2)-(5) report local regression estimates that restrict estimation in the neighborhood of the FPM cutoffs (on both periods when in differences) using four bandwidths, 1000 inhabitants (column (2)), 750 inhabitants (column (3)), 500 inhabitants (column (4)), and 250 inhabitants (column (5)). All specifications include state fixed effects and year fixed-effects (constants not reported). Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Appendix Table 8 - Expenditure around FPM Population Cutoffs

Panel A - Expenditure level

Bandwidth	All	Local Linear Regressions			
		<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)
(1) Levels per capita	1.146***	0.799***	0.831***	0.773***	0.68***
	(0.108)	(0.139)	(0.142)	(0.149)	(0.192)
within (marginal) R^2	0.015	0.005	0.006	0.006	0.005
(2) Level per capita - Median	1.269***	1.021***	1.014***	1.017***	1.000***
	(0.055)	(0.084)	(0.085)	(0.089)	(0.098)
within (marginal) R^2	0.012	0.003	0.006	0.002	0.003
(3) Level per capita - Huber (Robust)	1.265***	1.037***	1.039***	0.991***	0.983***
	(0.019)	(0.034)	(0.038)	(0.045)	(0.061)
within (marginal) R^2	0.049	0.024	0.026	0.024	0.024
(4) Log Levels per capita	0.415***	0.337***	0.343***	0.325***	0.333***
	(0.024)	(0.031)	(0.032)	(0.035)	(0.042)
within (marginal) R^2	0.036	0.019	0.021	0.020	0.021
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes
State-Time Trends	Yes	Yes	Yes	Yes	Yes
Observations	27976	10503	7840	5092	2538

Appendix Table 8 - Expenditure around FPM Population Cutoffs

Panel B - Expenditure in differences

		Local Regressions in Differences			
Bandwidth	All	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)
(1) Differences per capita	1.109***	0.886***	0.885***	0.836***	0.88***
	(0.04)	(0.056)	(0.063)	(0.074)	(0.112)
within (marginal) R^2	0.027	0.030	0.034	0.037	0.051
(2) Differences per capita - Median	1.091***	0.867***	0.819***	0.685***	0.671***
	(0.041)	(0.056)	(0.071)	(0.066)	(0.108)
within (marginal) R^2	0.026	0.030	0.034	0.037	0.053
(3) Differences per capita - Huber	1.075***	0.846***	0.809***	0.698***	0.775***
	(0.027)	(0.038)	(0.043)	(0.052)	(0.079)
within (marginal) R^2	0.037	0.039	0.038	0.032	0.044
(4) Log-Differences per capita	0.462***	0.373***	0.371***	0.342***	0.37***
	(0.016)	(0.022)	(0.024)	(0.028)	(0.047)
within (marginal) R^2	0.032	0.034	0.036	0.036	0.052
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	27976	8209	5641	3166	1116

The table reports regression estimates associating municipal expenditure to law-implied (theoretical) FPM Transfers. Panel A reports estimates of the log-level specifications. Panel B reports estimates of the log-difference specifications. Each Panel gives four specifications. Row (1) reports OLS coefficient estimates. Row (2) reports least-absolute-deviation (median) coefficient estimates. Row (3) reports Huber ("robust regression") estimates. Row (4) reports OLS estimates associating expenditure and law-implied FPM transfers in log per capita form. Panel A reports estimates in levels and Panel B in differences.

Column (1) reports estimates in the full sample that includes municipalities both close and far from the seven FPM discontinuities. Columns (2)-(5) report local regression estimates that restrict estimation in the neighborhood of the FPM cutoffs using four bandwidths (for both periods when in differences), 1000 inhabitants (column (2)), 750 inhabitants (column (3)), 500 inhabitants (column (4)), and 250 inhabitants (column (5)). All specifications include state fixed effects and year fixed-effects (constants not reported). The table also reports the within (marginal) R2. Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Appendix Table 9 - Expenditure around FPM Population Cutoffs
Cutoff Specific Regression Estimates

Log Level Specifications

		Local Linear Regressions			
Bandwidth	All	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)
Cutoff 1	0.383***	0.320***	0.300***	0.299***	0.255***
	(0.022)	(0.026)	(0.029)	(0.033)	(0.041)
Cutoff 2	0.405***	0.331***	0.321***	0.338***	0.289***
	(0.022)	(0.026)	(0.030)	(0.036)	(0.049)
Cutoff 3	0.456***	0.362***	0.346***	0.386***	0.326***
	(0.023)	(0.030)	(0.034)	(0.039)	(0.053)
Cutoff 4	0.467***	0.368***	0.357***	0.366***	0.283***
	(0.026)	(0.042)	(0.044)	(0.049)	(0.065)
Cutoff 5	0.492***	0.362***	0.332***	0.236***	0.202***
	(0.032)	(0.043)	(0.048)	(0.052)	(0.077)
Cutoff 6	0.462***	0.35***	0.259***	0.141**	-0.026
	(0.033)	(0.058)	(0.066)	(0.070)	(0.118)
Cutoff 7	0.456***	0.344***	0.359***	0.369***	0.607***
	(0.035)	(0.067)	(0.076)	(0.120)	(0.124)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Municipality Fixed Effects	Yes	Yes	Yes	Yes	Yes
State-Time Trend	Yes	Yes	Yes	Yes	Yes
Observations	27976	10503	7840	5092	2538

The table reports regression estimates associating municipal expenditure to law-implied (theoretical) FPM transfers, allowing the coefficients to differ across the different FPM cutoffs. All estimates are based on a log-level especification. Column (1) reports estimates in the full sample that includes municipalities both close and far from the seven FPM discontinuities. Columns (2)-(5) report local regression estimates that restrict estimation in the neighborhood of the FPM cutoffs (on both periods when in differences) using four bandwidths, 1000 inhabitants (column (2)), 750 inhabitants (column (3)), 500 inhabitants (column (4)), and 250 inhabitants (column (5)). All specifications include municipality fixed effects, year fixed-effects and state-time trends (constants not reported). Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Appendix Table 10
Local Expenditure, Federal Transfers and Law-Implied FPM Transfers

Panel A - 2SLS Level Regressions

		Local Linear Regressions			
Bandwidth	All	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)
Local Expenditure pc	0.992***	0.911***	0.854***	0.96***	1.01***
	(0.084)	(0.096)	(0.104)	(0.121)	(0.126)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Municipality Fixed Effects	Yes	Yes	Yes	Yes	Yes
State-Specific Time Trends	Yes	Yes	Yes	Yes	Yes
Observations	27976	10181	7417	4561	1901

Panel B - 2SLS Difference Specifications

		Local Linear Regressions			
Bandwidth	All	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)
Δ(Local Expenditure pc)	1.064***	0.847***	0.837***	0.778***	0.863***
	(0.044)	(0.065)	(0.075)	(0.090)	(0.135)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	23696	6758	4622	2561	889

The table reports 2SLS estimates associating municipal government spending with the component of actual (realized) federal transfers driven by the law governing FPM allocation. Panel A gives level specifications (with municipality fixed effects, year constants and state-specific linear time trends). Panel B reports first-difference 2SLS specifications (with state fixed effects and year constants).
Column (1) reports estimates in the full sample that includes municipalities both close and far from the seven FPM discontinuities. Columns (2)-(5) report local regression estimates that restrict estimation in the neighborhood of the FPM cutoffs (on both periods when in differences) using four bandwidths, 1000 inhabitants (column (2)), 750 inhabitants (column (3)), 500 inhabitants (column (4)), and 250 inhabitants (column (5)). Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Appendix Table 11 - Reduced-form Estimates. Law-Implied Federal Transfers and Municipal Output in the Neighborhood of FPM Cutoffs
Log-Differences specification with 0,1,2,3 lags of dependent variable

Panel A: No Lags

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δlog(LAW-FPM p.c.), φ	0.373***	0.275***	0.256***	0.2***	0.172***	0.267***	0.248***	0.181***	0.143***
	(0.013)	(0.017)	(0.019)	(0.024)	(0.034)	(0.017)	(0.019)	(0.024)	(0.035)
Observations	27976	8209	5641	3167	1116	8209	5641	3167	1116
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

Appendix Table 11 - Reduced-form Estimates. Law-Implied Federal Transfers and Municipal Output in the Neighborhood of FPM Cutoffs
Log-Differences specification with 0,1,2,3 lags of dependent variable

Panel B: One Lag

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δlog(LAW-FPM p.c.), φ	0.342***	0.262***	0.246***	0.2***	0.18***	0.256***	0.241***	0.178***	0.154***
	(0.013)	(0.017)	(0.019)	(0.025)	(0.036)	(0.017)	(0.019)	(0.025)	(0.037)
$\Delta\log_{t-1}$(GDP p.c.), ρ	-0.118***	-0.128***	-0.141***	-0.161***	-0.152***	-0.126***	-0.142***	-0.161***	-0.157***
	(0.009)	(0.014)	(0.017)	(0.022)	(0.039)	(0.014)	(0.017)	(0.022)	(0.039)
Cumulated Δlog(LAW-FPM p.c.),	0.306***	0.232***	0.216***	0.172***	0.156***	0.227***	0.211***	0.153***	0.133***
φ/(1-ρ)	(0.012)	(0.015)	(0.017)	(0.021)	(0.032)	(0.016)	(0.017)	(0.021)	(0.033)
Observations	26077	7576	5194	2895	1011	7576	5194	2895	1011
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

Appendix Table 11 - Reduced-form Estimates. Law-Implied Federal Transfers and Municipal Output in the Neighborhood of FPM Cutoffs
Log-Differences specification with 0,1,2,3 lags of dependent variable

Panel C: Two Lags

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δlog(LAW-FPM p.c.), φ	0.209***	0.145***	0.13***	0.087***	0.113***	0.14***	0.127***	0.077***	0.091***
	(0.013)	(0.017)	(0.02)	(0.027)	(0.042)	(0.018)	(0.021)	(0.027)	(0.041)
$\Delta\log_{t-1}$(GDP p.c.), ρ_1	-0.131***	-0.14***	-0.154***	-0.167***	-0.142***	-0.14***	-0.156***	-0.168***	-0.148***
	(0.01)	(0.015)	(0.018)	(0.023)	(0.039)	(0.015)	(0.018)	(0.023)	(0.04)
$\Delta\log_{t-2}$(GDP p.c.), ρ_2	-0.101***	-0.103***	-0.103***	-0.107***	-0.095***	-0.104***	-0.104***	-0.102***	-0.094***
	(0.009)	(0.013)	(0.016)	(0.019)	(0.032)	(0.013)	(0.016)	(0.019)	(0.034)
Cumulated Δlog(LAW-FPM p.c.),	0.17***	0.116***	0.104***	0.068***	0.091***	0.113***	0.101***	0.061***	0.073***
$\varphi/(1-\rho_1-\rho_2)$	(0.011)	(0.014)	(0.016)	(0.021)	(0.034)	(0.014)	(0.017)	(0.021)	(0.033)
Observations	23696	6758	4622	2561	889	6758	4622	2561	889
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

Appendix Table 11 - Reduced-form Estimates. Law-Implied Federal Transfers and Municipal Output in the Neighborhood of FPM Cutoffs
Log-Differences specification with 0,1,2,3 lags of dependent variable

Panel D: Three Lags

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δlog(LAW-FPM p.c.), φ	0.273***	0.169***	0.155***	0.116***	0.137***	0.167***	0.152***	0.107***	0.115***
	(0.015)	(0.019)	(0.021)	(0.028)	(0.041)	(0.02)	(0.022)	(0.029)	(0.041)
$\Delta\log_{t-1}$(GDP p.c.), ρ_1	-0.15***	-0.156***	-0.166***	-0.185***	-0.174***	-0.156***	-0.168***	-0.188***	-0.182***
	(0.011)	(0.016)	(0.018)	(0.023)	(0.04)	(0.016)	(0.019)	(0.024)	(0.042)
$\Delta\log_{t-2}$(GDP p.c.), ρ_2	-0.119***	-0.128***	-0.125***	-0.133***	-0.125***	-0.13***	-0.127***	-0.13***	-0.129***
	(0.01)	(0.014)	(0.017)	(0.02)	(0.031)	(0.014)	(0.017)	(0.02)	(0.032)
$\Delta\log_{t-3}$(GDP p.c.), ρ_3	-0.08***	-0.097***	-0.092***	-0.105***	-0.113***	-0.098***	-0.093***	-0.106***	-0.12***
	(0.008)	(0.013)	(0.017)	(0.021)	(0.032)	(0.013)	(0.017)	(0.021)	(0.033)
Cumulated Δlog(LAW-FPM p.c.),	0.203***	0.123***	0.112***	0.082***	0.097***	0.12***	0.11***	0.075***	0.08***
$\varphi/(1-\rho_1-\rho_2-\rho_3)$	(0.011)	(0.014)	(0.016)	(0.02)	(0.029)	(0.015)	(0.017)	(0.021)	(0.028)
Observations	21361	6288	4331	2413	854	6288	4331	2413	854
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

All four Panels report "reduced-form" estimates associating the log-difference of municipal GDP per capita to the log-difference of law-implied (theoretical) FPM transfers per capita in the neighborhood of the FPM cut-offs. Panels A, B,C, and D include 0, 1,2, and 3 lags of the dependent variable. Panels B, C, and D also report the cumulated effect (taking into consideration the lags) with standard errors calculated using the Delta method. All specifications in all panels include state fixed-effects and year fixed-effects (constants not reported).

Column (1) reports estimates in the full sample that includes municipalities both close and far from the seven FPM discontinuities. Columns (2)-(9) report local regression estimates that restrict estimation in the neighborhood of the FPM cutoffs using four bandwidths, 1000 inhabitants (columns (2) and (6)), 750 inhabitants (columns (3) and (7)), 500 inhabitants (columns (4) and (8)), and 250 inhabitants (columns (5) and (9)). The specifications in columns (6)-(9) include cutoff-specific 1st-order regression-discontinuity polynomials on absolute distance to the closest threshold (the "running-forcing" variable). The RD polynomial allows coefficients to differ at each side (below/above) of each cutoff and also include cutoff-specific constants ("rectangular kernel"). Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Appendix Table 12 - Reduced-form Estimates. Law-Implied Federal Transfers and Municipal Output in the Neighborhood of FPM Cutoffs

Panel A: Log Difference Specifications - Robust Estimates (Huber) - *Δ Log (GDP p.c.)*

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δlog(LAW-FPM p.c.)	0.162***	0.101***	0.13***	0.072***	0.077***	0.112***	0.096***	0.065***	0.072***
	(0.008)	(0.013)	(0.017)	(0.017)	(0.026)	(0.012)	(0.014)	(0.018)	(0.029)
Observations	23693	6753	4617	2560	889	6753	4617	2560	889
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

Appendix Table 12 - Reduced-form Estimates. Law-Implied Federal Transfers and Municipal Output in the Neighborhood of FPM Cutoffs

Panel B: Log Difference Specifications - Median (Least Absolute Deviation) - *Δ Log (GDP p.c.)*

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δlog(LAW-FPM p.c.)	0.162***	0.094***	0.12***	0.063***	0.079***	0.111***	0.09***	0.069***	0.08***
	(0.009)	(0.015)	(0.019)	(0.013)	(0.02)	(0.015)	(0.014)	(0.024)	(0.027)
Observations	23693	6753	4617	2560	889	6753	4617	2560	889
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

The table reports "reduced-form" estimates associating the natural logarithm of municipal GDP per capita to the natural logarithm of law-implied (theoretical) FPM transfers per capita in the neighborhood of the FPM cut-offs. Panel A reports log difference robust regression (Huber) estimates. Panel B reports least-absolute-deviation (median) log-difference specifications estimates. All models in both panels include state fixed-effects and year fixed-effects (constants not reported), as well as two lags of the dependent variable (logarithmic growth of municipal GDP p.c.). The reported coefficients represent the cumulated effect (taking into consideration the lags). Standard errors are calculated using the Delta method.

Column (1) reports estimates in the full sample that includes municipalities both close and far from the seven FPM discontinuities. Columns (2)-(9) report local regression estimates that restrict estimation in the neighborhood of the FPM cutoffs using four bandwidths, 1000 inhabitants (columns (2) and (6)), 750 inhabitants (columns (3) and (7)), 500 inhabitants (columns (4) and (8)), and 250 inhabitants (columns (5) and (9)). The specifications in columns (6)-(9) include cutoff-specific 1st-order regression-discontinuity polynomials on absolute distance to the closest threshold (the "running-forcing" variable). The RD polynomial allows coefficients to differ at each side (below/above) of each cutoff and also include cutoff-specific constants ("rectangular kernel"). Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Appendix Table 13 - Reduced-form Estimates. Law-Implied Federal Transfers and Municipal Output in the Neighborhood of FPM Cutoffs

Panel A: Difference Specifications - Δ *(GDP p.c.)*

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δ(LAW-FPM p.c.)	3.489***	3.196***	2.686***	2.046***	1.041***	3.248***	2.657***	1.693***	0.661***
	(0.572)	(0.654)	(0.676)	(0.874)	(1.013)	(0.701)	(0.703)	(0.869)	(1.08)
Observations	23696	6758	4622	2561	889	6758	4622	2561	889
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

Appendix Table 13 - Reduced-form Estimates. Law-Implied Federal Transfers and Municipal Output in the Neighborhood of FPM Cutoffs

Panel B: Difference Specifications - Robust Estimates (Huber) - Δ *(GDP p.c.)*

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δ(LAW-FPM p.c.)	2.255***	1.471***	1.814***	1.142***	1.633***	1.467***	1.471***	1.221***	1.598***
	(0.147)	(0.234)	(0.288)	(0.277)	(0.45)	(0.215)	(0.25)	(0.3)	(0.513)
Observations	23696	6758	4622	2561	889	6758	4622	2561	889
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

The table reports “reduced-form” estimates associating municipal GDP per capita to law-implied (theoretical) FPM transfers per capita in the neighborhood of the FPM cut-offs. Panel A reports first-difference OLS estimates. Panel B reports robust regression (Huber) first-difference specifications estimates. All models in both panels include state fixed-effects and year fixed-effects (constants not reported), as well as two lags of the dependent variable (logarithmic growth of municipal GDP p.c.). The reported coefficients represent the cumulated effect (taking into consideration the lags). Standard errors are calculated using the Delta method.

Column (1) reports estimates in the full sample that includes municipalities both close and far from the seven FPM discontinuities. Columns (2)-(9) report local regression estimates that restrict estimation in the neighborhood of the FPM cutoffs using four bandwidths, 1000 inhabitants (columns (2) and (6)), 750 inhabitants (columns (3) and (7)), 500 inhabitants (columns (4) and (8)), and 250 inhabitants (columns (5) and (9)). The specifications in columns (6)-(9) include cutoff-specific 1st-order regression-discontinuity polynomials on absolute distance to the closest threshold (the “running-forcing” variable). The RD polynomial allows coefficients to differ at each side (below/above) of each cutoff and also include cutoff-specific constants (“rectangular kernel”). Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence-level.

Appendix Table 14 -Law-Implied Federal Transfers and Municipal Output in the Neighborhood of FPM Cutoffs
Cutoff-Specific Estimates

Panel A - Log-level Specifications

		Local Linear Regressions			
Bandwidth	All	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)
Cutoff 1	0.200***	0.098***	0.075***	0.06**	0.078***
	(0.021)	(0.024)	(0.025)	(0.027)	(0.033)
Cutoff 2	0.203***	0.102***	0.074***	0.065*	0.094**
	(0.023)	(0.029)	(0.031)	(0.039)	(0.042)
Cutoff 3	0.214***	0.095***	0.076**	0.063*	0.103**
	(0.023)	(0.031)	(0.036)	(0.037)	(0.045)
Cutoff 4	0.194***	0.066**	0.022	0.047	0.108
	(0.024)	(0.032)	(0.038)	(0.047)	(0.068)
Cutoff 5	0.208***	0.037	0.012	-0.035	0.079
	(0.028)	(0.039)	(0.042)	(0.049)	(0.064)
Cutoff 6	0.184***	0.047	0.036	-0.09	-0.076
	(0.032)	(0.046)	(0.049)	(0.064)	(0.104)
Cutoff 7	0.234***	0.181***	0.183**	0.226*	0.134
	(0.033)	(0.065)	(0.089)	(0.143)	(0.121)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Municipality Fixed Effects	Yes	Yes	Yes	Yes	Yes
State-specific Time Trends	Yes	Yes	Yes	Yes	Yes
Observations	27976	10503	7840	5092	2538

Appendix Table 14 -Law-Implied Federal Transfers and Municipal Output in the Neighborhood of FPM Cutoffs
Cutoff-Specific Estimates

Panel B -Log-difference Specifications

		Local Linear Regressions			
Bandwidth	All	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)
Cutoff 1	0.172***	0.115***	0.105***	0.07***	0.04
	(0.013)	(0.017)	(0.02)	(0.028)	(0.041)
Cutoff 2	0.153***	0.126***	0.117***	0.073***	0.139***
	(0.015)	(0.02)	(0.024)	(0.031)	(0.049)
Cutoff 3	0.173***	0.119***	0.107**	0.069**	0.089**
	(0.016)	(0.024)	(0.027)	(0.034)	(0.048)
Cutoff 4	0.184***	0.088**	0.061***	0.033	0.002
	(0.015)	(0.024)	(0.026)	(0.033)	(0.058)
Cutoff 5	0.183***	0.13***	0.099***	0.079*	0.228***
	(0.017)	(0.028)	(0.034)	(0.043)	(0.071)
Cutoff 6	0.149***	0.093**	0.075	0.162***	0.3***
	(0.021)	(0.041)	(0.046)	(0.065)	(0.105)
Cutoff 7	0.198***	0.092**	0.114**	0.022	0.309**
	(0.02)	(0.046)	(0.055)	(0.079)	(0.142)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	23696	6758	4622	2561	889

The table reports “reduced-form” estimates associating municipal GDP per capita to law-implied (theoretical) FPM transfers per capita in the neighborhood of the FPM cut-offs, allowing the effect to differ across each FPM cutoff. Panel A reports log-level LS estimates. These specifications include municipality fixed-effects, year fixed-effects and state-specific linear time trends (coefficients not reported). Panel B reports log-difference specifications estimates. These models include state fixed-effects and year fixed-effects (constants not reported). These models also inlcude two lags of the dependent variable (logarithmic growth of municipal GDP p.c.). The reported coefficients represent the cumulated effect (taking into consideration the lags). Standard errors are calculated using the Delta method.
Column (1) reports estimates in the full sample that includes municipalities both close and far from the seven FPM discontinuities. Columns (2)-(5) report local regression estimates that restrict estimation in the neighborhood of the FPM cutoffs using four bandwidths, 1000 inhabitants (columns (2) and (6)), 750 inhabitants (columns (3) and (7)), 500 inhabitants (columns (4) and (8)), and 250 inhabitants (columns (5) and (9)). Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Appendix Table 15 - Reduced-Form Estimates
Global Control Function Regression Discontinuity Estimates

Panel A -Log Level Specifications

Cutoff-Specific RD Polynomial	No	1st order	2nd order	3rd order	4th order
	(1)	(2)	(3)	(4)	(5)
log(LAW-FPM p.c.)	0.253***	0.17***	0.151***	0.158***	0.163***
	(0.021)	(0.020)	(0.021)	(0.022)	(0.023)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Municipality Fixed Effects	Yes	Yes	Yes	Yes	Yes
State-specific Time Trends	Yes	Yes	Yes	Yes	Yes
Observations	27976	27976	27976	27976	27976

Panel B - Log Difference Specifications

Cutoff-Specific RD Polynomial	No	1st order	2nd order	3rd order	4th order
	(1)	(2)	(3)	(4)	(5)
Δlog(LAW-FPM p.c.)	0.17***	0.164***	0.147***	0.137***	0.127***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	23696	23696	23696	23696	23696

The table reports regression discontinuity (RD) estimates with a global control function approach. The “reduced-form” estimates associate municipal GDP per capita to law-implied (theoretical) FPM transfers per capita. All specifications use information from observations both far and close to the FPM population cutoffs. Panel A reports log-level estimates. These specifications include municipality fixed-effects, year fixed-effects, and state-specific linear time trends. Panel B reports log-difference specifications estimates. These models include state fixed-effects and year fixed-effects (constants not reported), as well as two lags (not reported) of the dependent variable (logarithmic growth of municipal GDP p.c.). The reported coefficients in Panel B represent the cumulated effect (taking into consideration the lags). Standard errors are calculated using the Delta method. Column (1) reports estimates without any RD polynomial. Columns (2)-(5) report global regression estimates that include cutoff-specific polynomials of 1st-4th order, respectively. Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Appendix Table 16 - Reduced-form Estimates. Law-Implied Federal Transfers and Municipal Output in the Neighborhood of FPM Cutoffs Excluding Observations (Municipalities) close to the Initial Cutoff

Panel A: Log Level Specifications - *Log (GDP p.c.)*

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
log(LAW-FPM p.c.)	0.26***	0.118***	0.094***	0.069***	0.147***	0.091***	0.085***	0.071***	0.139***
	(0.027)	(0.031)	(0.033)	(0.037)	(0.045)	(0.03)	(0.031)	(0.035)	(0.05)
Observations	18841	7138	5325	3494	1782	7138	5325	3494	1782
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-time Time Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

Appendix Table 16 - Reduced-form Estimates. Law-Implied Federal Transfers and Municipal Output in the Neighborhood of FPM Cutoffs Excluding Observations (Municipalities) close to the Initial Cutoff

Panel B: Log Difference Specifications - *Δ Log (GDP p.c.)*

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δlog(LAW-FPM p.c.)	0.158***	0.106***	0.09***	0.052***	0.111***	0.108***	0.093***	0.049***	0.097***
	(0.013)	(0.018)	(0.02)	(0.026)	(0.047)	(0.019)	(0.022)	(0.027)	(0.047)
Observations	16051	4392	2966	1649	576	4392	2966	1649	576
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

Appendix Table 16 - Reduced-form Estimates. Law-Implied Federal Transfers and Municipal Output in the Neighborhood of FPM Cutoffs Excluding Observations (Municipalities) close to the Initial Cutoff

Panel C: Difference Specifications - Least-Absolute-Deviation (Median) Regression Estimates - *Δ (GDP p.c.)*

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δ(LAW-FPM p.c.)	1.975***	1.419***	1.713***	1.31***	1.601***	1.387***	1.459***	1.218***	1.652***
	(0.159)	(0.23)	(0.277)	(0.33)	(0.615)	(0.234)	(0.254)	(0.305)	(0.375)
Observations	16051	4392	2965	1649	574	4392	2965	1649	574
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

All Panels report "reduced-form" estimates associating municipal GDP per capita to law-implied (theoretical) FPM transfers per capita in the neighborhood of the FPM cut-offs, excluding observations around the first cutoff (10,188 inhabitants). Panel A reports log-level OLS estimates. These specifications include municipality fixed-effects, year fixed-effects, and state-specific linear time trends. Panel B reports OLS log-differences estimates. Panel C reports least-absolute-deviation (median) log-difference estimates. All specifications in Panel B and C include state fixed-effects and year fixed-effects (constants not reported); these models also inlcude two lags of the dependent variable (logarithmic growth and annual change of municipal GDP p.c.). The coefficients reported on Panel B and C represent the cumulated effect (taking into consideration the lags). Standard errors are calculated using the Delta method.

Column (1) reports estimates in the full sample that includes municipalities both close and far from the seven FPM discontinuities. Columns (2)-(9) report local regression estimates that restrict estimation in the neighborhood of the FPM cutoffs using four bandwidths, 1000 inhabitants (columns (2) and (6)), 750 inhabitants (columns (3) and (7)), 500 inhabitants (columns (4) and (8)), and 250 inhabitants (columns (5) and (9)). The specifications in columns (6)-(9) include cutoff-specific 1st-order regression-discontinuity polynomials on absolute distance to the closest threshold (the "running-forcing" variable). The RD polynomial allows coefficients to differ at each side (below/above) of each cutoff and also include cutoff-specific constants ("rectangular kernel"). Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Appendix Table 17 - Reduced-form Estimates. Law-Implied Federal Transfers and Municipal Output in the Neighborhood of FPM Cutoffs Excluding Observations (Municipalities) in 2008

Panel A: Log Level Specifications - ***Log (GDP p.c.)***

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
log(LAW-FPM p.c.)	0.245***	0.127***	0.096***	0.083***	0.092***	0.093***	0.085***	0.067***	0.050
	(0.02)	(0.022)	(0.025)	(0.028)	(0.032)	(0.024)	(0.025)	(0.027)	(0.04)
Observations	25689	9586	7140	4628	2294	9586	7140	4628	2294
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-time Time Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

Appendix Table 17 - Reduced-form Estimates. Law-Implied Federal Transfers and Municipal Output in the Neighborhood of FPM Cutoffs Excluding Observations (Municipalities) in 2008

Panel B: Log Difference Specifications - *Δ Log (GDP p.c.)*

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δlog(LAW-FPM p.c.)	0.207**	0.141***	0.12***	0.08***	0.095***	0.139***	0.119***	0.073***	0.072**
	(0.013)	(0.016)	(0.018)	(0.023)	(0.036)	(0.017)	(0.019)	(0.024)	(0.035)
Observations	21409	6270	4313	2407	849	6270	4313	2407	849
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

Appendix Table 17 - Reduced-form Estimates. Law-Implied Federal Transfers and Municipal Output in the Neighborhood of FPM Cutoffs Excluding Observations (Municipalities) in 2008

Panel C: Difference Specifications - Least-Absolute-Deviation (Median) Regression Estimates - *Δ (GDP p.c.)*

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δ(LAW-FPM p.c.)	3.231***	2.228***	2.745***	1.801***	1.626***	2.258***	2.177***	1.689***	1.55***
	(0.132)	(0.231)	(0.285)	(0.27)	(0.476)	(0.195)	(0.243)	(0.338)	(0.398)
Observations	21409	6270	4310	2406	846	6270	4310	2406	846
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

The table reports "reduced-form" estimates associating municipal GDP per capita to law-implied (theoretical) FPM transfers per capita in the neighborhood of the FPM cut-offs, excluding the observations from 2008. Panel A reports log-level OLS estimates. These specifications include municipality fixed-effects, year fixed-effects, and state-specific linear time trends. Panel B reports OLS log-differences estimates. Panel C reports least-absolute-deviation (median) log-differences estimates. The models in Panel B and Panel C include state fixed-effects and year fixed-effects (constants not reported). These models also include two lags of the dependent variable (logarithmic growth and change of municipal GDP p.c.). The coefficients reported on Panel B and C represent the cumulated effect (taking into consideration the lags). Standard errors are calculated using the Delta method.

Column (1) reports estimates in the full sample that includes municipalities both close and far from the seven FPM discontinuities. Columns (2)-(9) report local regression estimates that restrict estimation in the neighborhood of the FPM cutoffs using four bandwidths, 1000 inhabitants (columns (2) and (6)), 750 inhabitants (columns (3) and (7)), 500 inhabitants (columns (4) and (8)), and 250 inhabitants (columns (5) and (9)). The specifications in columns (6)-(9) include cutoff-specific 1st-order regression-discontinuity polynomials on absolute distance to the closest threshold (the "running-forcing" variable). The RD polynomial allows coefficients to differ at each side (below/above) of each cutoff and also include cutoff-specific constants ("rectangular kernel"). Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Appendix Table 18 - Reduced-form Estimates. Law-Implied Federal Transfers and Municipal Output in the Neighborhood of FPM Cutoffs Excluding Observations (Municipalities) in 2008 to 2011

Panel A: Log Level Specifications - ***Log (GDP p.c.)***

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
log(LAW-FPM p.c.)	0.294***	0.163***	0.123***	0.12***	0.099***	0.135***	0.116***	0.098***	0.085***
	(0.022)	(0.025)	(0.026)	(0.027)	(0.032)	(0.027)	(0.029)	(0.032)	(0.046)
Observations	18546	6984	5199	3443	1680	6984	5199	3443	1680
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-time Time Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

Appendix Table 18 - Reduced-form Estimates. Law-Implied Federal Transfers and Municipal Output in the Neighborhood of FPM Cutoffs Excluding Observations (Municipalities) in 2008 to 2011

Panel B: Log Difference Specifications - *Δ Log (GDP p.c.)*

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δlog(LAW-FPM p.c.)	0.241***	0.169***	0.142***	0.097***	0.105***	0.167***	0.14***	0.091***	0.066*
	(0.017)	(0.021)	(0.023)	(0.027)	(0.038)	(0.022)	(0.025)	(0.029)	(0.039)
Observations	14266	4311	3039	1828	681	4311	3039	1828	681
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

Appendix Table 18 - Reduced-form Estimates. Law-Implied Federal Transfers and Municipal Output in the Neighborhood of FPM Cutoffs Excluding Observations (Municipalities) in 2008 to 2011

Panel C: Difference Specifications - Least-Absolute-Deviation Regression Estimates - *Δ (GDP p.c.)*

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δlog(LAW-FPM p.c.)	4.45***	3.256***	3.982***	2.672***	2.183***	3.614***	3.173***	2.49***	1.936***
	(0.195)	(0.242)	(0.295)	(0.328)	(0.436)	(0.3)	(0.287)	(0.444)	(0.544)
Observations	14266	4311	3038	1827	678	4311	3038	1827	678
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

The table reports “reduced-form” estimates associating municipal GDP per capita to law-implied (theoretical) FPM transfers per capita in the neighborhood of the FPM cut-offs, excluding observations from 2008-2011. Panel A reports log-level LS estimates. These specifications include municipality fixed-effects, year fixed-effects, and state-specific linear time trends. Panel B reports LS log-differences estimates. Panel C reports least-absolute-deviation (median) log-differences estimates. The models in Panel B and Pance include state fixed-effects and year fixed-effects (constants not reported). These models also include two lags of the dependent variable (logarithmic growth and annual change of municipal GDP p.c.). The coefficients reported on Panel B and C represent the cumulated effect (taking into consideration the lags). Standard errors are calculated using the Delta method.

Column (1) reports estimates in the full sample that includes municipalities both close and far from the seven FPM discontinuities. Columns (2)-(9) report local regression estimates that restrict estimation in the neighborhood of the FPM cutoffs using four bandwidths, 1000 inhabitants (columns (2) and (6)), 750 inhabitants (columns (3) and (7)), 500 inhabitants (columns (4) and (8)), and 250 inhabitants (columns (5) and (9)). The specifications in columns (6)-(9) include cutoff-specific 1st-order regression-discontinuity polynomials on absolute distance to the closest threshold (the “running-forcing” variable). The RD polynomial allows coefficients to differ at each side (below/above) of each cutoff and also include cutoff-specific constants (“rectangular kernel”). Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence.

Appendix Table 19 - Spillovers
Reduced-Form Estimates

Panel A - Log Level Specifications

		Local Linear Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
log(LAW-FPM p.c.)	0.242***	0.12***	0.086***	0.067***	0.091***	0.085***	0.073***	0.054**	0.064*
	(0.020)	(0.022)	(0.023)	(0.025)	(0.031)	(0.023)	(0.023)	(0.025)	(0.039)
Σ_{micro} [log(LAW-FPM p.c.)]	0.021	0.060	0.058**	0.026	-0.006	0.040	0.041	-0.005	-0.014
	(0.023)	(0.027)	(0.027)	(0.035)	(0.037)	(0.027)	(0.031)	(0.033)	(0.038)
Observations	27976	10503	7840	5092	2538	10503	7840	5092	2538
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-time Time Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

Appendix Table 19 - Spillovers
Reduced-Form Estimates

Panel B - Log Difference Specifications

		Local Linear Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
log(LAW-FPM p.c.)	0.208***	0.144***	0.129***	0.086***	0.113***	0.113***	0.101***	0.06***	0.073**
	(0.011)	(0.014)	(0.016)	(0.021)	(0.034)	(0.014)	(0.017)	(0.021)	(0.033)
Σ_{micro} [log(LAW-FPM p.c.)]	0.014***	0.021	0.022	0.037	0.034	0.042	0.035	0.040	0.007
	(0.005)	(0.013)	(0.013)	(0.026)	(0.031)	(0.021)	(0.023)	(0.037)	(0.034)
Observations	23693	6753	4617	2560	889	6753	4617	2560	889
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

The table reports "reduced-form" estimates associating the natural logarithm of municipal GDP per capita to the natural logarithm of law-implied (theoretical) FPM transfers per capita of the municipality and the micro-region. A micro-region is typically an agglomeration of economically integrated municipalities that share borders and structures of production (IBGE, 1910). Panel A reports OLS log-level estimates. These specifications include municipality fixed-effects, year fixed-effects, and state-specific linear time trends. Panel B reports OLS log-differences estimates. These models include state fixed-effects and year fixed-effects (constants not reported). These models also include two lags of the dependent variable (logarithmic growth of municipal GDP p.c.). The reported coefficients represent the cumulated effect (taking into consideration the lags). Standard errors are calculated using the Delta method. Column (1) reports estimates in the full sample that includes municipalities both close and far from the seven FPM discontinuities. Columns (2)-(9) report local regression estimates that restrict estimation in the neighborhood of the FPM cutoffs using four bandwidths, 1000 inhabitants (columns (2) and (6)), 750 inhabitants (columns (3) and (7)), 500 inhabitants (columns (4) and (8)), and 250 inhabitants (columns (5) and (9)). The specifications in columns (6)-(9) include cutoff-specific 1st-order regression-discontinuity polynomials on absolute distance to the closest threshold (the "running-forcing" variable). The RD polynomial allows coefficients to differ at each side (below/above) of each cutoff and also include cutoff-specific constants ("rectangular kernel"). Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Appendix Table 20 - Reduced-form Estimates. Law-Implied Federal Transfers and Municipal Output in the Neighborhood of FPM Cutoffs Accounting for Migration Trends

Panel A - Log Level Specifications

		Local Linear Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
log(LAW-FPM p.c.)	0.243***	0.12***	0.085***	0.065***	0.091***	0.085***	0.072***	0.053**	0.064*
	(0.02)	(0.022)	(0.024)	(0.026)	(0.031)	(0.023)	(0.023)	(0.025)	(0.039)
Observations	27976	10503	7840	5092	2538	10503	7840	5092	2538
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-specific Time Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

Panel B - Log Difference Specifications

		Local Linear Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
log(LAW-FPM p.c.)	0.169*	0.116***	0.103***	0.065***	0.09***	0.112***	0.1***	0.057***	0.071***
	(0.011)	(0.014)	(0.016)	(0.021)	(0.033)	(0.014)	(0.017)	(0.022)	(0.032)
Observations	23696	6758	4622	2561	889	6758	4622	2561	889
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

The table reports "reduced-form" estimates associating the natural logarithm of municipal GDP per capita to the natural logarithm of law-implied (theoretical) FPM transfers per capita in the neighborhood of the FPM cut-offs, controlling for current and lagged population growth in the micro-region. Panel A reports OLS log-level estimates. These specifications include municipality fixed-effects, year fixed-effects, and state-specific linear time trends. Panel B reports OLS log-differences estimates. These models include state fixed-effects and year fixed-effects (constants not reported). These models also include two lags of the dependent variable (logarithmic growth of municipal GDP p.c.). The reported coefficients represent the cumulated effect (taking into consideration the lags). Standard errors are calculated using the Delta method.

Column (1) reports estimates in the full sample that includes municipalities both close and far from the seven FPM discontinuities. Columns (2)-(9) report local regression estimates that restrict estimation in the neighborhood of the FPM cutoffs using four bandwidths, 1000 inhabitants (columns (2) and (6)), 750 inhabitants (columns (3) and (7)), 500 inhabitants (columns (4) and (8)), and 250 inhabitants (columns (5) and (9)). The specifications in columns (6)-(9) include cutoff-specific 1st-order regression-discontinuity polynomials on absolute distance to the closest threshold (the "running-forcing" variable). The RD polynomial allows coefficients to differ at each side (below/above) of each cutoff and also include cutoff-specific constants ("rectangular kernel"). Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Appendix Table 21 - Mapping of Municipal GDP onto Lights

Dependent Variable:	Level regressions ln(GDP)				Long Differences Change (11-years) ln(GDP)	
	(1)	(2)	(3)	(4)	(5)	(6)
ln(lights/area)	0.193***	0.278***	0.078***	0.193***	-	-
	(0.017)	(0.019)	(0.009)	(0.017)		
Change (11-years) ln(lights/area)	-	-	-	-	0.128***	0.140***
					(0.022)	(0.040)
State Fixed Effects	Yes	No	No	Yes	Yes	No
Micro-region Fixed Effects	No	Yes	No	No	No	Yes
Municipality Fixed Effects	No	No	Yes	No	No	No
Year Fixed Effects	Yes	Yes	Yes	Yes	No	No
State-time Time Trends	No	No	No	Yes	No	No
Observations	27987	27987	27987	27987	1413	1413
overall R-square	0.425	0.613	0.983	0.425	0.154	0.508
marginal R-square	0.053	0.044	0.000	0.053	0.022	0.015

The table reports estimates of the mapping of the natural logarithm of municipal GDP to the natural logarithm of municipal light density. Light density comes from nighttime daily satellite imagery per pixel and is averaged out yearly to match the sample frequency.

Columns (1)-(4) report estimates for the full sample that includes municipalities both close and far from the seven FPM discontinuities. All specifications include year fixed-effects. Columns (1)-(3) respectively add state, micro-region and municipality fixed effects. Column (4) also adds state-specific linear time trends. Columns (5) and (6) report long-difference (11-year) estimates. The table also reports the overall and the within (marginal) R2. Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Appendix Table 22 - Reduced-form Estimates Using Satellite Image Data on Light Density at Night

Panel A: Log Level Specifications - *Lights-Predicted Log (GDP p.c.)*

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
log(LAW-FPM p.c.)	0.331***	0.151***	0.122***	0.112***	0.137***	0.104***	0.099***	0.094***	0.115***
	(0.015)	(0.016)	(0.016)	(0.018)	(0.023)	(0.015)	(0.015)	(0.017)	(0.024)
Observations	27976	10503	7840	5092	2538	10503	7840	5092	2538
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-time Time Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

Panel B: Log Difference Specifications - Lights-Predicted *Δ Log (GDP p.c.)*

		Local Regressions				Local Regressions with Rectangular Kernel			
Bandwidth	All	<1000	<750	<500	<250	<1000	<750	<500	<250
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δlog(LAW-FPM p.c.)	0.217***	0.139***	0.124***	0.098***	0.104***	0.13***	0.115***	0.085***	0.079***
	(0.010)	(0.012)	(0.013)	(0.016)	(0.027)	(0.012)	(0.014)	(0.016)	(0.026)
Observations	23693	6753	4617	2560	889	6753	4617	2560	889
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	No	No	No	No	Yes	Yes	Yes	Yes

The table reports "reduced-form" estimates associating municipal loutput per capita to law-implied (theoretical) FPM transfers per capita in the neighborhood of the FPM cut-offs. The dependent variable combines local GDP estimates with satellite image data on light density at night so as to reduce error-in-variables. The Appendix gives details on the compilation of the combined GDP-luminosity measure. Panel A reports log-level OLS estimates. These specifications include municipality fixed-effects, year fixed-effects, and state-specific linear time trends. Panel B reports OLS log-differences estimates. These models include state fixed-effects and year fixed-effects (constants not reported). These models also inlcude two lags of the dependent variable (logarithmic growth of municipal output p.c.). The reported coefficients represent the cumulated effect (taking into consideration the lags). Standard errors are calculated using the Delta method.

Column (1) reports estimates in the full sample that includes municipalities both close and far from the seven FPM discontinuities. Columns (2)-(9) report local regression estimates that restrict estimation in the neighborhood of the FPM cutoffs using four bandwidths, 1000 inhabitants (columns (2) and (6)), 750 inhabitants (columns (3) and (7)), 500 inhabitants (columns (4) and (8)), and 250 inhabitants (columns (5) and (9)). The specifications in columns (6)-(9) include cutoff-specific 1st-order regression-discontinuity polynomials on absolute distance to the closest threshold (the "running-forcing" variable). The RD polynomial allows coefficients to differ at each side (below/above) of each cutoff and also include cutoff-specific constants ("rectangular kernel"). Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Appendix Table 23 - Heterogeneity across Main Brazilian Macro Regions (1000 bandwidth) Using Combined GDP-Luminosity Proxy of Municipal Output

	Log Level Specifications		Log Difference Specifications	
	(1)	(2)	(3)	(4)
NORTH	0.171***	0.175***	0.281***	0.26***
	(0.054)	(0.048)	(0.039)	(0.038)
NORTHEAST	0.198***	0.15***	0.202***	0.191***
	(0.018)	(0.017)	(0.018)	(0.018)
SOUTHEAST	0.094***	0.043***	0.053***	0.042***
	(0.018)	(0.018)	(0.017)	(0.018)
SOUTH	0.103***	0.058***	0.119***	0.106***
	(0.027)	(0.024)	(0.027)	(0.027)
CENTRE-WEST	0.134***	0.085***	0.169***	0.162***
	(0.018)	(0.018)	(0.015)	(0.015)
Year Fixed Effects	Yes	Yes	Yes	Yes
Municipality Fixed Effects	Yes	Yes	No	No
State-time Time Trends	Yes	Yes	No	No
State Fixed Effects	No	No	Yes	Yes
Linear Cutoff-Specific RD Polyn	No	Yes	No	Yes

The table reports "reduced-form" estimates associating the natural logarithm of municipal output per capita to the natural logarithm of law-implied (theoretical) FPM transfers per capita in the neighborhood of the FPM cut-offs using a 1000 inhabitants bandwidth, allowing the coefficient (elasticity) to differ across each of the five main Brazilian macro regions. The dependent variable is a combination of local GDP and luminosity and aims accounting for error-in-variables. The Appendix gives details on the compilation of this measure of local economic activity.

Columns (1) and (2) report log level OLS specifications. These models include municipality fixed-effects, year fixed-effects, and state-specific linear time trends (constants not reported). Columns (3) and (4) report log difference OLS specifications where both variables are expressed in first-differences. These models include state fixed-effects and year fixed-effects (constants not reported). The log difference specifications also include two lags of the dependent variable (logarithmic growth of municipal combined light-GDP p.c.). The reported coefficients represent the cumulated effect (taking into consideration the lags). Standard errors are calculated using the Delta method.

The specifications in columns (2) and (4) include cutoff-specific 1st-order regression-discontinuity polynomials on absolute distance to the closest threshold (the "running-forcing" variable). The RD polynomial allows coefficients to differ at each side (below/above) of each cutoff and also include cutoff-specific constants ("rectangular kernel"). Table 8 gives information on trade openness, financial development, income per capita and the number of municipalities in each of the five macro regions. Appendix Table 1 gives summary statistics at the state-level and also lists states by macro region. Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Appendix Table 24 - Heterogeneity w.r.t Trade Openness (500 bandwidth)
Using Combined GDP-Luminosity Proxy of Municipal Output

	Log Level Specifications		Log Difference Specifications	
	(1)	(2)	(3)	(4)
OPEN	0.103***	0.082***	0.084***	0.069***
	(0.019)	(0.018)	(0.022)	(0.019)
CLOSED	0.123***	0.109***	0.158***	0.140***
	(0.019)	(0.019)	(0.019)	(0.019)
Year Fixed Effects	Yes	Yes	Yes	Yes
Municipality Fixed Effects	Yes	Yes	No	No
State-time Time Trends	Yes	Yes	No	No
State Fixed Effects	No	No	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	Yes	No	Yes

The table reports "reduced-form" estimates associating the natural logarithm of municipal output per capita to the natural logarithm of law-implied (theoretical) FPM transfers per capita in the neighborhood of the FPM cut-offs using a 500 inhabitants bandwidth, allowing the coefficient (elasticity) to differ across municipalities in states that are more/less closed to trade. The dependent variable is a combination of local GDP and luminosity that aims accounting for error-in-variables. The Appendix gives details on the compilation of this measure of local economic activity. Columns (1) and (2) report log level OLS specifications. These models include municipality fixed-effects, year fixed-effects, and state-specific linear time trends (constants not reported). Columns (3) and (4) report log difference OLS specifications where both variables are expressed in first-differences. These models include state fixed-effects and year fixed-effects (constants not reported). The log difference specifications also include two lags of the dependent variable (logarithmic growth of municipal output p.c.). The reported coefficients represent the cumulated effect (taking into consideration the lags). Standard errors are calculated using the Delta method.
The specifications in columns (2) and (4) include cutoff-specific 1st-order regression-discontinuity polynomials on absolute distance to the closest threshold (the "running-forcing" variable). The RD polynomial allows coefficients to differ at each side (below/above) of each cutoff and also include cutoff-specific constants ("rectangular kernel"). Appendix Table 1 gives summary statistics at the state-level on trade openness, financial development, income per capita and the number of municipalities. Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Appendix Table 25 - Heterogeneity according to Financial Constraints (500 bandwidth)
Using Combined GDP-Luminosity Proxy of Municipal Output

	Log Level Specifications		Log Difference Specifications	
	(1)	(2)	(3)	(4)
Low Level Financial Constraints	0.097***	0.077***	0.099***	0.082***
	(0.019)	(0.018)	(0.021)	(0.021)
High Level Financial Constraints	0.149***	0.144***	0.177***	0.16***
	(0.022)	(0.021)	(0.026)	(0.025)
Year Fixed Effects	Yes	Yes	Yes	Yes
Municipality Fixed Effects	Yes	Yes	No	No
State-time Time Trends	Yes	Yes	No	No
State Fixed Effects	No	No	Yes	Yes
Linear Cutoff-Specific RD Polynomial	No	Yes	No	Yes

The table reports "reduced-form" estimates associating the natural logarithm of municipal output per capita to the natural logarithm of law-implied (theoretical) FPM transfers per capita in the neighborhood of the FPM cut-offs using a 500 inhabitants bandwidth, allowing the coefficient (elasticity) to differ across municipalities that have/do not have a banck branch (low/high level of financial constraint). The dependent variable is a combination of local GDP and luminosity that aims accounting for error-in-variables. The Appendix gives details on the compilation of this measure of local economic activity. Columns (1) and (2) report log level OLS specifications. These models include municipality fixed-effects, year fixed-effects, and state-specific linear time trends (constants not reported). Columns (3) and (4) report log difference OLS specifications where both variables are expressed in first-differences. These models include state fixed-effects and year fixed-effects (constants not reported). The log difference specifications also include two lags of the dependent variable (logarithmic growth of municipal output p.c.). The reported coefficients represent the cumulated effect (taking into consideration the lags). Standard errors are calculated using the Delta method.
The specifications in columns (2) and (4) include cutoff-specific 1st-order regression-discontinuity polynomials on absolute distance to the closest threshold (the "running-forcing" variable). The RD polynomial allows coefficients to differ at each side (below/above) of each cutoff and also include cutoff-specific constants ("rectangular kernel"). Appendix Table 1 gives summary statistics at the state-level on trade openness, financial development, income per capita and the number of municipalities. Heteroskedasticity-adjusted standard errors clustered at the micro-region are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.