The Effects of Fiscal Equalization on Housing Markets: Evidence from Brazil *

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Abstract

This paper seeks to understand how local government policies on housing stimulus and city growth are affected by intergovernmental transfers. Cities receiving smaller amounts of fiscal transfers may have more incentives to stimulate housing growth to increase local revenue and, as a result, they end-up attracting more people and having a faster-growing housing sector. By contrast, lack of windfalls may also generate lower provision of local public goods, emigration of current residents, and stagnated housing markets. Quasi-experimental evidence from the distribution of intergovernmental transfers to Brazilian municipalities shows that locations less dependent on federal grants have a faster-growing housing sector.

Keywords: Intergovernmental Transfers; Housing Markets; City Growth.

JEL Classification: H70, H77, R31.

1 Introduction

This paper studies the impact of intergovernmental transfers on housing markets. The objective is to verify whether local governments less dependent on intergovernmental transfers have faster-growing housing markets. The idea is to study how resource windfalls influence local governments' behavior regarding housing markets. Do cities that receive a smaller amount of fiscal transfers have more incentives to stimulate housing growth to increase their local revenue and, as a result, they end-up attracting more people and having a

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faster-growing housing sector? Or does the lack of fiscal windfalls generate lower provision of local public goods and, as a result, generate emigration of current residents and a stagnated housing market?

Take the case of a federal country where the local government is able to raise revenue only through property taxation and where the local government does not receive any intergovernmental transfers from the national government. In this scenario, the local government has to provide public goods and services to its citizens by financing them through its single instrument (property tax). When increasing the property tax rate and cutting expenditures are politically costly, it is possible to argue that the local government has incentives to boost the local housing market since this is the only viable source of revenue. In other words, the local government has incentives to establish a "friendly" urban regulation so as to favor housing growth. Alternatively, if the local government receives a significant amount of intergovernmental transfers, then the local government might have lower incentives to collect property tax efficiently and, therefore, it might not provide the right incentives to housing development. In this scenario, fiscal transfers may generate a moral hazard behavior from policy makers and consequently grants may act as a "curse" on the housing market: urban regulation can be counterproductive, highly influenced by interest groups, and it may even stimulate informal housing (in cases where there is a lack of law enforcement).

I present three stylized facts on the relationship between intergovernmental transfers, housing policy instruments, and the housing market using data from Brazilian municipalities[1]. The first fact shows that fiscal transfers are an important component of the municipalities' budget. The second one tries to understand the relationship between fiscal transfers and housing markets and shows that greater dependency on fiscal windfalls is correlated with slower housing growth. The third fact points out that fiscal windfalls seem to impact housing policy indicators. A greater share of intergovernmental transfers is correlated with the adoption of adverse land use parameters (i.e., parameters that hamper housing development). On the other hand, municipalities that receive fewer fiscal transfers try to stimulate their housing markets by providing a more pro-development market (for instance, issuing a greater number of building permits) as well as by adopting public policies related to the donation of houses and land plots. This type of behavior associated with fiscal transfers may indicate the channels through which transfers impact housing markets.

I develop a simple conceptual framework which aims at deriving basic predictions regarding the impact of grants on local regulation and on migration. A local government can apply policies to attract migrants, but it faces a trade-off: more people makes it cheaper

[1] Brazil has formally three administrative levels: national government, states, and municipalities. Municipalities or "Municípios" are the lowest administrative units in Brazil. In this dissertation, I use "local government", "local jurisdiction", and "local economies" as synonyms for municipality.

to provide public goods (due to economies of scale), but more people also means extra expenditures on police and redistribution policies. The framework shows how intergovernmental transfers alter the incentives governing zoning policies and the attraction of migrants. Pro-development regulation will only pass when its benefit (marginal benefit accruing from attracting people) surpasses its cost (marginal cost related to redistribution policies). Local governments have incentives to stimulate housing growth so as to attract residents when intergovernmental transfers are an increasing function of the population size of the location (i.e., when transfers alter the marginal benefit of attracting people). Rules governing intergovernmental transfers may induce some locations to adopt a pro-development regulation to attract more people.

In order to identify the impact of intergovernmental redistribution on housing markets, I use a Brazilian federal decree that changed entirely the rule to distribute the main intergovernmental transfer in Brazil. In 1981, Federal Decree n. 1,881/81 changed how the FPM fund (in Portuguese, "Fundo de Participação dos Municípios") was distributed among Brazilian municipalities. The main features of the FPM fund are: (i) it allocates part of two important federal taxes (Income Tax and Industrial-Product Tax) to municipalities; (ii) it is an unconditional intergovernmental equalization grant; and (iii) more importantly for the identification strategy, its sharing mechanism consists of a *step function* depending on the *population size* of the local jurisdiction[2]. The Federal Decree n. 1,881/81 was established during the military dictatorship period in Brazil and, therefore, I argue that this FPM distribution rule was exogenous to municipalities' control. Due to this federal decree, two municipalities that received a similar amount of federal funding in 1981 (prior to the decree) could receive a completely different amount of fiscal transfers in 1982 (after the decree). The variations created by this quasi-experiment will be "treatment" or "intervention" employed to verify whether the new revenue sharing mechanism had any impact over the municipalities' housing sector growth[3].

The institutions regarding the distribution of intergovernmental grants in Brazil generate a treatment assignment mechanism that leads to an application of a regression discontinuity design (RDD). Since Federal Decree 1,881/81 created several population cutoffs to distribute FPM, there are several ways of defining the "treatment" and "control" groups, as discussed in Section 5. I perform several exercises comparing housing growth of "treated" and "control" municipalities. The data show some non-compliance, i.e., some municipalities have received a different amount of grants compared to the one stipulated by the FPM distribution rule (according to the federal decree) and thus the data show

[2]Section 2 and Appendix A detail the revenue sharing rules in Brazil.

[3]Litschig and Morrison (2013) applied this FPM distribution rule to verify whether discontinuities in federal funding to local government had any impact over education and poverty. de Carvalho Filho and Litschig (2013) analyzed the impact of the FPM on long-term education outcomes. Brollo, Nannicini, Perotti, and Tabellini (2013) used the FPM distribution to study whether an increase in grants leads to an increase in the number of corruption irregularities in the municipal administration.

non-perfect discontinuities. As a result, I use a Fuzzy RDD: I apply the "treatment assignment" mechanism (the amount a location would receive according to the federal decree) as an instrumental variable for the "actual treatment" (the distributed amount of FPM according to the data). The design allows one to analyze several issues related to the internal validity of the results, but I also discuss their external validity. Thus, exploiting the quasi-experimental nature of the data, I use another instrumental variable generated by the Federal Decree 1,881/81 to discuss the external validity: the *change* in the amount of predicted FPM, i.e., the difference between the predicted FPM generated by the federal decree and the one dictated by FPM's previous allocation rule (the 1967 Federal Constitution).

The findings of this study provide evidence on how intergovernmental transfers impact housing markets: I find that cities less dependent on grants have faster-growing housing sectors. I analyzed the impact of fiscal transfers in 1982 (right after the Federal Decree 1,881/81) on housing growth during 1980-1991. The effects of intergovernmental transfers were robust to a battery of robustness exercises. The benchmark results hold when I consider the long-run impact of fiscal transfers on housing growth (20 years, from 1980 to 2000). The results are virtually the same when I consider population growth instead of the growth in the number of housing units. I add several covariates (such as income level and education attainment) so as to control for potential determinants of housing growth. The results were again virtually the same. Additionally, in order to check the robustness of the results, I run a placebo test using fake population thresholds: I found that placebo treatments are not associated with housing growth in the following decades.

All the results of this paper are for the group of municipalities belonging to São Paulo state in Brazil. São Paulo state had 645 municipalities in 2010 and it is the largest state both in terms of population (22% of the Brazilian total population in 2010) and gross domestic product (33% of the Brazilian total GDP in 2008).[4] The main reason why I use only municipalities from São Paulo state is that the discontinuities created by the Federal Decree 1,881/81 were *permanent* for those municipalities. In the empirical analysis, one potential confounder is the creation of new municipalities that took place in Brazil: during the 1980's roughly 500 new municipalities were created from existing ones, which could lead to changes in municipality population and, as a result, could obscure the effects of the federal decree (recall that the distribution of grants depends on population size of the location). Creation of municipalities is endogenous because municipalities have incentives to split to receive more FPM *per capita*[5]. In São Paulo state, only one new municipality was created in the same decade because the state law that allowed detachments and creation

[4] Figure A.1 in Appendix A shows the location of São Paulo state in Brazilian territory.

[5] As shown below in Figure 3 (Section 2), *per capita* FPM is a decreasing function (with jumps) of population size.

of new municipalities in São Paulo came only in 1990.[6] Therefore, the use of São Paulo's municipalities is useful because I automatically isolate this confounder. The timing of the events after the Federal Decree 1,881/81 illustrates this point. By and large, this federal decree (enacted in 1981) stipulated that the FPM should be distributed during 1982-1985 using the numbers from the 1980 Population Census and that in 1985 another population count should be carried out. The idea was to reallocate FPM grants according to updated population figures. In 1985, a population estimate (but not an official population count) was carried out to reallocate FPM grants. As shown in Table A.4 in Appendix A, the population estimate of 1985 did not affect the position of the municipalities of São Paulo state regarding the distribution of FPM. Therefore, municipalities in São Paulo state near the FPM population thresholds receiving less grants had clear incentives to grow by the next population count (the next official population census took place in 1991).

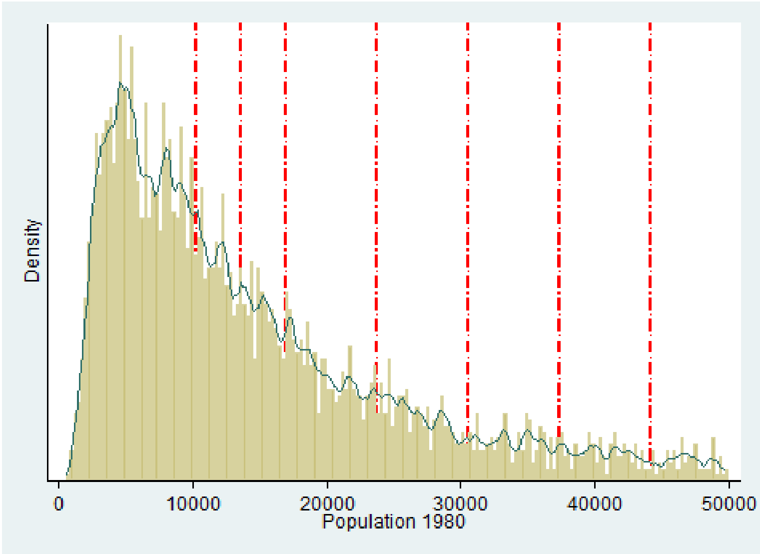
Figure 1 provides a clear view of the analysis. The histogram in Figure 1(a) corresponds to the distribution of population in 1980 (the "treatment-determining variable"), while the histogram in Figure 1(b) shows the population density in 1991. The dotted red bars are the population thresholds created by Federal Decree 1,881/81. The incentives to grow created by the federal decree are striking in some cases: at the first cutoff an additional person causes an increase of 33% of intergovernmental transfers. The Population Census of 1980 took place before the publication of the Federal Decree 1,881/81. Therefore, in 1980 municipalities were not able to sort around the population cutoffs to obtain more intergovernmental transfers (see Figure 1(a)). But in 1991 one can observe several municipalities bunching after the population cutoffs (see Figure 1(b)). I argue in this study that municipalities had incentives to apply several housing policy measures to attract people so as to jump to the other side of the cutoff.

The majority of the data used in this paper (e.g. housing, income, and population) come from the Brazilian Bureau of Statistics (IBGE) Population Censuses (1970, 1980, 1991, 2000 and 2010). Fiscal data come from the Brazilian Ministry of Finance and Fundação Seade in São Paulo. Novel data on actual housing policy instruments used by local governments come from IBGE's Municipalities Profile of 1999 (IBGE (2001)). See Section 3 for more details on the data.

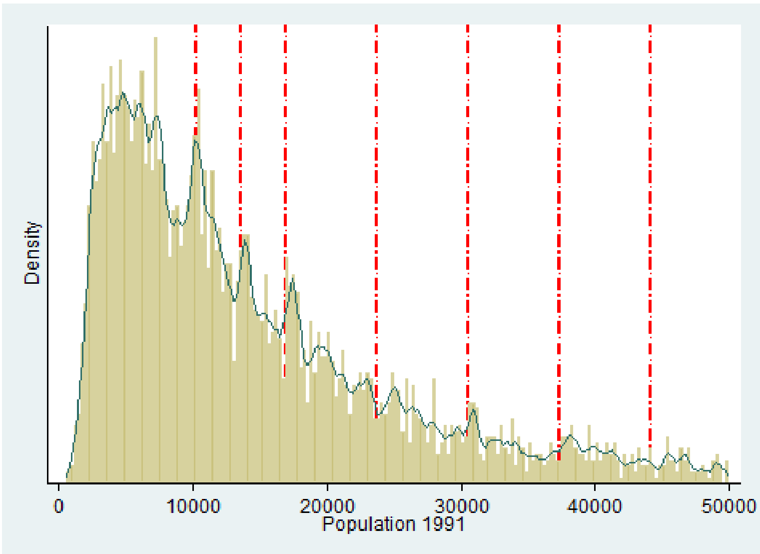
This paper is related to several lines of research. There is an extensive literature on the impacts of intergovernmental transfers. Several papers have studied the effects of grants on local governments' decisions or on local economic performance. Some of them have applied a regression discontinuity design to verify the impact of intergovernmental transfers on *per capita* GDP and employment (Becker, Egger, and von Ehrlich (2010) for the European Union), on local taxes and/or spending (Gordon (2004) for the United

[6]Supplementary Law n. 651/90, July 1990. The timing of this Supplementary Law explains why there was only one new municipality created during 1980-1991 in São Paulo state. Several states in Brazil authorized detachments during the 1980's.

Fig. 1: Histograms: Population in 1980 and 1991



(a) 1980



(b) 1991

Notes. Figure 1(a) shows the population density in 1980 for municipalities with population up to 50,000 people, while Figure 1(b) shows the population density in 1991. Dotted red bars are the population thresholds created by Federal Decree 1,881/81.

States, Buettner (2006) for Germany, Dahlberg, Mörk, Rattsø, and Ågren (2008) for Sweden, Litschig and Morrison (2013) and de Carvalho Filho and Litschig (2013) for Brazil) and on corruption (Brollo, Nannicini, Perotti, and Tabellini (2013) for Brazil). This paper is especially related to papers which have studied mobility and intergovernmental redistribution (e.g., Kessler, Hansen, and Lessmann (2011)), the ones that have studied the relationship between zoning and fiscal federalism (Hamilton (1975), Fernandez and Rogerson (1997)), and the ones on the incentive effects of revenue sources (Borge and Ratts (2008), Glaeser (1996), Gadenne (2012)). This work differs from the existing literature as (to my knowledge) none of the papers on intergovernmental transfers use a regression discontinuity design to identify the effects of grants on housing markets and on city growth. Moreover, this work contributes by studying the effects of grants on actual policy instruments, whereas the literature tends to focus on fiscal variables.

Additionally, several papers have studied the interaction between urban regulation and housing markets: the literature shows that inappropriate urban regulations have negative impacts on housing markets. For example, inappropriate regulation is associated with increasing housing costs (e.g., Malpezzi and Mayo (1997) for Malaysia) and increasing housing prices (e.g., Glaeser, Gyourko, and Saks (2005) and Ihlanfeldt (2007)). I contribute by studying an additional incentive to regulate land, which is the creation of a pro-development housing market to increase local revenue. I argue that fiscal transfers to local government aim to combat regional inequality, but they can have an (unintended) impact on housing and population growth: they may create incentives or disincentives to stimulate housing growth.

This paper proceeds as follows. Section 2 details how revenue sharing and housing policy work in Brazil. Section 3 describes the data used in this paper and three stylized facts regarding revenue sharing, housing policy instruments, and housing markets. Section 4 describes the conceptual framework. Section 5 discusses the empirical strategy. Section 6 shows the results and the robustness analysis. Finally, Section 7 concludes.

2 Rules governing Revenue Sharing and Housing Policy in Brazil

2.1 Revenue Sharing in Brazil

Revenue sharing in Brazil started in 1934. Apart from stipulating the competence regarding the collection of each of the existing taxes, the Constitution of 1934 stipulated that if a new tax would be created by the national government or by states, it would have to be divided with the municipalities (Varsano (1996)). However, it was during the 1960's that revenue sharing in Brazil increased in importance. In 1965, the Constitutional Amendment 18/1965 created the FPM fund (Fundo de Participação dos Municípios), the most important fiscal transfer from the national government to municipalities to date.

The FPM fund was created during the military dictatorship period in Brazil (1964-85) as a part of a strategy to concentrate tax collection and influence local governments through revenue sharing mechanisms. The FPM fund transfers part of two important federal taxes (Income Tax and Industrial-Product Tax) to municipalities. The distribution rule of FPM has changed over the years, but its main feature remains: the sharing mechanism for the majority of the municipalities depends on an objective criterion, that is, the population size of the municipality. Only state capitals and very big (non-capital) municipalities receive FPM based on both their population size and *per capita* income level.

Historically, the distribution rule is as follows. According to the 1967 Constitution, 10% of the resources of the FPM fund should be allocated to state capitals[7] and 90% to other (non-capital) municipalities. The state capitals would share their part of the federal windfalls according to their population and *per capita* income. For all other municipalities, the FPM sharing mechanism consisted of a step function, depending on the population size of the municipality. Each municipality received a coefficient (there were 20 coefficients in total) in accordance with the size of its population and the coefficient stipulated how much of FPM each municipality would receive. Figure 2(a) and Table A.2 in Appendix A show how the step function of the 1967 Constitution worked.

In 1981, Federal Decree n. 1,881/81 reformulated the rules concerning the distribution of FPM resources. The two main modifications were: (i) a new step function with new population ranges was created to distribute the resources among the non-capital municipalities and (ii) out of the 90% of the FPM resources allocated to the non-capital municipalities, 86.4 percentage points were allocated to all non-capital municipalities and the remaining 3.6 percentage points went only to the big non-capital municipalities[8]. Figure 2(b) and Table A.3 in Appendix A display the population ranges and their respective coefficients of this new FPM distribution rule. Figure 2(c) compares the before and after distribution rules (Figures 2(a) and 2(b) respectively). The distribution rule of FPM creates exogenous cutoffs which I exploit in the empirical strategy of this paper (see Section 5)[9]. Figure 3 shows the behavior of *per capita* FPM within and between the population cutoffs according to rules from the Federal Decree 1,881/81.

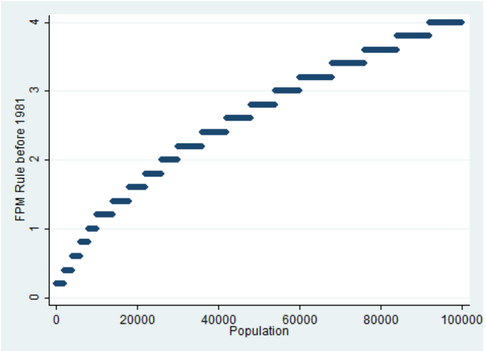
There are other types of fiscal transfers in Brazil, such as oil royalties and the division

[7]According to the 1988 Constitution, Brazil has 26 states and a Federal District and so there are 27 state capitals in Brazil.

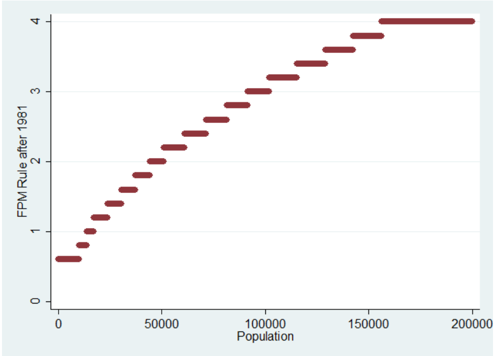
[8]Therefore, the big non-capital municipalities, on top of their share of the 86.4%, receive an additional 3.6% of the FPM fund.

[9]Every year several municipalities go to court against the federal government to try to change their FPM amount. Usually, the municipalities complain that their official population and/or their FPM coefficients are wrong. For instance, in 2007 and 2011 there were, respectively, 174 and 21 judiciary cases regarding the FPM distribution. According to the Brazilian Court of Audit, the majority of the judiciary decisions is against the municipalities.

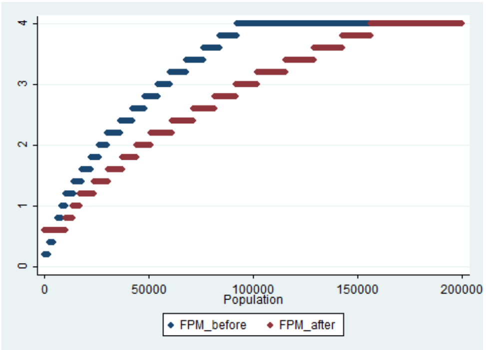
Fig. 2: FPM Distribution Rules



(a) FPM before 1981



(b) FPM after 1981



(c) FPM before and after 1981

Notes. Figure 2(a) shows the distribution rule of FPM according to the Federal Constitution of 1967, while Figure 2(b) shows new distribution rule according to the Federal Decree n. 1,881/81 of 1981.

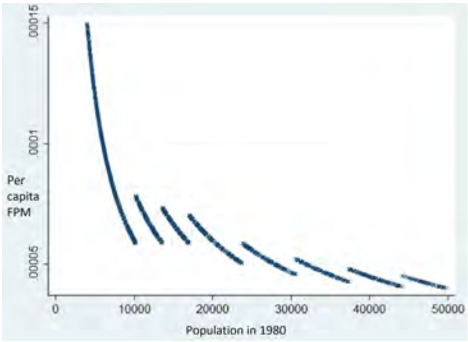
of other federal and state taxes with municipalities. Nevertheless, the most important fiscal transfer is the FPM. In 2010, the total amount of the FPM fund was R$ 43 billions (approximately US$ 25 billions). In some cases, FPM can represent more than 70% of the total revenue of local governments. FPM is even more important than official statistics report because its sharing mechanism is applied to distribute other federal and state transfers, such as the distribution of part of oil windfalls in Brazil. Appendix A explains the revenue sharing rules of FPM in greater details.

2.2 Housing Policy

The basic law governing land policy in Brazil is the 1979 federal land use law (Federal Law n. 6,766/79). Federal Law 6,766/79 established the basic legislation at the national level for developing, approving and registering urban land subdivisions. It has defined the role of states and municipalities regarding land subdivision. For instance, building permits should be certified by the municipality.

Federal Law 6,766/79 stipulated that developers must follow federally-mandated con-

Fig. 3: Per Capita FPM



Notes. Distribution of *per capita* FPM according to the Federal Decree n. 1,881/81 of 1981. Only the first 8 population cutoffs are shown.

struction parameters and basic infrastructure standards to guarantee the adequate density, ventilation, lighting, etc. Examples of construction parameters of the federal land-use law include a minimum lot size of 125 square meters and a minimum frontage of five meters. In addition, Federal Law 6,766/79 allowed municipalities to enact their own land use law in order to create locally-suitable land use parameters for specific urbanization projects to build public housing. In other words, Federal Law 6,766/79 allowed municipalities to waive federal subdivision regulations by passing their own land use law to change the land use parameters stipulated in the federal law. As a result, several municipalities have created their own land use law. During 1979 and 1999, out of the 5,507 municipalities in Brazil, 27% (1,482 municipalities) moved away from the federally mandated regulations and developed their own land use laws and zoning plans.

The institutional arrangement in Brazil allows the municipalities to use several housing policy instruments, which includes issuing building permits, creating their own land use law and stipulating the size of the minimum lot[10]. The institutional arrangement does not refrain municipalities from donating land plots, housing units, and material for building houses. In the next section, I discuss stylized facts on housing policy instruments and I show that several municipalities actually donate land and material.

3 Data and Stylized Facts

3.1 Data

The basic spatial unit of analysis is the "município". The majority of the data stems from the Brazilian Bureau of Statistics (IBGE) Brazilian Population Censuses microdata

[10]More recently, the overall role of each federative unit on housing policy was stipulated by the 1988 Brazilian Constitution. The 1988 Constitution did not alter the content of the Federal Law 6,766/79. In 2001, Federal Law 10,257/01 (known as the City Statute) added new policy instruments (such as the progressive property taxation) that can be used by municipalities.

of 1970, 1980, 1991, 2000, and 2010. The key variables of interest from the Censuses are: total population, number of housing units, housing rents, *per capita* income, and education attainment (average years of schooling by municipality). IBGE's Municipalities Profile of 1999 (IBGE (2001)) provided novel data on housing and land policy instruments, such as the number of building permits, the minimum lot size, the existence of land use laws in the location, and donation of land and housing units[11]. Fiscal data, including FPM and property tax data, are from the National Treasury, Ministry of Finance in Brazil and Fundação Seade/São Paulo.

More specifically, all the above data are for municipalities in São Paulo state. One advantage is that using data of municipalities belonging to the same state controls for some fixed and time-varying unobservable variables. Another advantage is that I deal more easily with the creation of new municipalities that took place in Brazil during the last four decades. The creation of new municipalities was significant during the period: there were 3,951 municipalities in 1970, 3,991 municipalities in 1980, 4,491 in 1991, 5,507 in 2000 and 5,565 in 2010. According to Table A.3 in Appendix A, at least in São Paulo state (i.e., in my sample of municipalities) detachments are not a major concern in the 1970's and 1980's. Precisely, in the 1970's there was no detachment in the state and during the 1980's only one municipality was created[12]. However, when it comes to the whole of Brazil, detachment of municipalities is an issue. In the 1980's, after redemocratization, hundreds of new municipalities were created (500 new local governments). In complicated cases, two municipalities were reorganized into three. Even though detachments are not a major concern (because I am working with municipalities in São Paulo state), municípios are merged into Minimum Comparable Areas (MCAs). MCAs consist of sets of municípios whose borders were constant over the study period[13]. Taking into account all detachments for an extended period of time, from 1970 to 2010, there are 567 MCAs in my sample of São Paulo municipalities.

Table 1 reports descriptive statistics for the set of variables I use in this paper.

3.2 Stylized Facts

In this part I present three stylized facts regarding housing markets in Brazil and the distribution of federal windfalls. Throughout this section I use data on the FPM fund.

Fact 1. The first stylized fact is that transfers from the national government represent a significant portion of municipalities' total revenue. Table 2 shows the participation of FPM

[11]One caveat of using the housing policy data is that it is from the late 1990's, while the institutions aspects regarding intergovernmental transfers are from the early 1980's.

[12]The only municipality created during the 1980's in São Paulo state was "Vargem Grande Paulista" (15,870 inhabitants in 1991), which stemmed from the municipality "Cotia" (107,453 inhabitants in 1991). "Vargem Grande Paulista" was created after a plebiscite that took place in 1980's.

[13]For more details on MCA aggregation see Da Mata, Deichmann, Henderson, Lall, and Wang (2007).

Table 1: Summary Statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
Housing growth 1980-1991	0.034	0.021	-0.009	0.147	567
Housing growth 1980-2000	0.031	0.016	-0.010	0.122	567
Housing growth 2000-2010	0.021	0.012	-0.056	0.075	567
Population growth 1980-1991	0.018	0.022	-0.032	0.141	567
Per capita FPM 1980 (R$ 2000)	84.28	56.79	0.16	374.44	567
Per capita FPM 1982 (R$ 2000)	136.66	118.82	0.03	1244.68	567
Per capita FPM 1985 (R$ 2000)	315.89	249.99	0.17	2465.75	567
Per capita FPM 1991 (R$ 2000)	347.25	270.20	22.96	3220.56	567
Per capita FPM 2000 (R$ 2000)	505.32	434.25	0.03	3822.45	560
FPM/Total Revenue 1982	0.192	0.124	0.003	0.625	567
FPM/Total Revenue 1991	0.309	0.141	0.015	0.694	567
FPM/Total Revenue 2000	0.265	0.127	0.003	0.683	560
Avr. years of schooling 1980	2.901	0.763	1.2	5.9	567
Avr. years of schooling 1991	4.234	0.823	2.2	7.6	567
Avr. years of schooling 2000	5.365	0.857	3.3	8.7	567
Per capita Income 1980 (R$ 2000)	239.14	78.68	93.91	617.18	567
Per capita Income 1991 (R$ 2000)	224.87	79.03	86.09	643.19	567
Per capita Income 2000 (R$ 2000)	284.86	96.05	112.51	923.45	567
Population 1980	4,4165.91	361,259.7	866	8,493,217	567
Population 1991	5,5712.21	412,312.61	716	9,646,186	567
Population 2000	6,5318.26	448,321.58	795	10,435,546	567
# of Permits in 1997	186.623	443.098	0	4591	567
Dummy: whether MLS is bigger than federal one	0.34	0.47	0	1	567
Dummy: Own Land Law in 1999	0.746	0.432	0	1	567
Dummy: whether municipality donates land	0.214	0.403	0	1	567
Number of land plots donated	92.67	439.882	0	6573	567
Dummy: whether municipality donates housing units	0.554	0.49	0	1	567
Number of housing units donated	202.095	972.887	0	18896	567

in total revenue. The importance of federal grants is more evident for small municipalities in Brazil, especially those with fewer than 10,000 inhabitants (see Table 2). For instance, in 1991 only FPM represented virtually 40% of the total revenue of these municipalities. From 1980 to 1991, the participation of federal windfalls in the total revenue more than doubled across cities of different population sizes. Moreover, Table 2 reveals that the share of federal grants varies more for smaller municipalities vis-à-vis bigger ones (Table 2 shows the standard deviations in parenthesis).

Table 2: FPM Share of Total Revenue by Population Size

Population Size	1980	1991	2000	2008
Up to 10,000	0.197 (0.106)	0.394 (0.117)	0.345 (0.106)	0.390 (0.116)
10,000-20,000	0.165 (0.085)	0.307 (0.092)	0.245 (0.081)	0.280 (0.077)
20,000-50,000	0.097 (0.064)	0.216 (0.082)	0.184 (0.070)	0.211 (0.063)
50,000-100,000	0.050 (0.034)	0.153 (0.058)	0.122 (0.049)	0.146 (0.047)
Above 100,000	0.024 (0.022)	0.083 (0.051)	0.272 (0.197)	0.306 (0.212)
Total	0.152 (0.105)	0.309 (0.140)	0.275 (0.135)	0.311 (0.146)

Notes. Standard deviations in parenthesis.

Some examples also help to illustrate how important the population censuses (which dictate how much FPM transfer the location will receive) are. Municipalities usually put effort to make sure their population is properly counted (Monasterio (2013)). Some municipalities have written messages in their official homepages asking the population to receive the census interviewers with “affection” and to answer the questions with “commitment” and “accuracy”. Others have asked the population to “spend a little time with the interviewers which have an electronic equipment to speed up the data collection”[14]. Some municipalities provided a special telephone number so that a person could call the National Bureau of Statistics to schedule a visit[15]. Municipalities have also phoned directly part of their population to be interviewed[16]. Moreover, newspapers show that municipalities try to carry out their own population count to certify (to themselves) the accuracy of the official census[17].

Fact 2. The second fact is that higher (lower) dependence on fiscal windfalls is correlated with lower (higher) future housing growth. Table 3 suggests that there might be an association between the amount of intergovernmental transfers and the performance of local housing markets. Table 3 displays several OLS regressions showing that a higher ratio of FPM to the total revenue in the beginning of the 1980's is associated with a lower growth in the number of housing units in the following decades. It suggests that fiscal transfers adversely impact housing markets. Alternatively, this may suggest that in places where the housing market is more relevant in terms of revenue collection (i.e., when property taxation is relatively more important) the housing market is more dynamic (faster-growing). In other words, this correlation may suggest that where there is necessity to collect property tax, there is a growing housing market. The negative correlation between federal money dependence and housing growth holds after controlling for some key variables. Table 3 displays information about two additional covariates: income and population size. Greater income in the beginning of the 1980's is positively correlated with higher housing growth during the following decade. Population has an opposite effect. Table 3 also shows that regression results are the same after using *per capita* FPM (total FPM revenue divided by total population of the municipality) instead of the ratio of FPM to the total revenue. Figure 4 expands the explanation of the story behind Fact 2: it shows that while there is a negative relationship between fiscal transfers and housing growth, there exists a positive association between the importance of property tax revenues in 1980 and the growth of housing units during 1980-2000[18].

Fact 3. My third stylized fact is that greater fiscal transfers seem to impact (adversely) zoning regulations adopted by Brazilian cities. Table 4 shows that fiscal transfers seem

[14] http://www.ourinhos.sp.gov.br/noticia/6118/Prefeito+Toshio+Misato+elogia+trabalho+do+IBGE+e+contribui+com+o+Censo+2010

[15] http://www.cuiaba.mt.gov.br/noticias?id=962

[16] http://www.setelagoas.com.br/noticias/cidade/8527-prefeitura-convoca-populacao-que-ainda-nao-foi-recenseada

[17] http://www.dgabc.com.br/News/5840539/prefeito-contesta-ibge-e-faz-censo-paralelo-em-tiete-sp.aspx

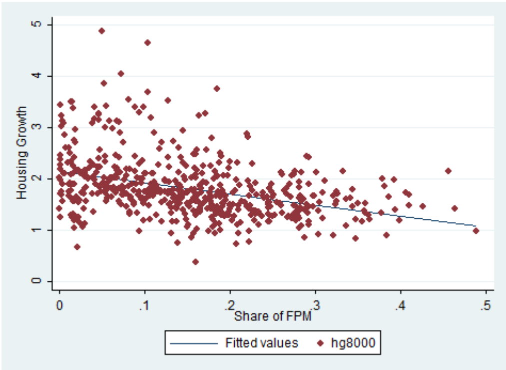
[18] See also results from equations (vii) and (viii) of Table 3.

Table 3: OLS Regressions: Fiscal Transfers and Housing Growth

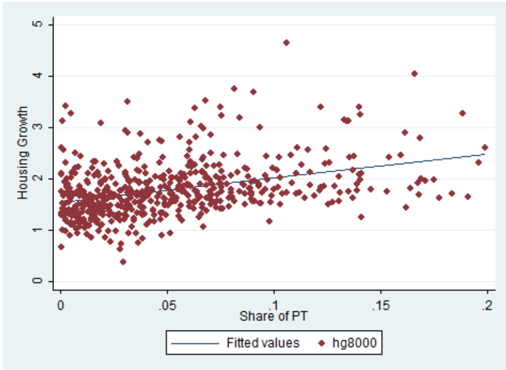
	Housing Growth							
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
VARIABLES	1980-1991		1980-2000		1980-1991	1980-2000	1980-1991	1980-2000
FPM/Revenue 1980	-0.0730***	-0.0387***	-0.0587***	-0.0357***				
	(0.00725)	(0.00832)	(0.00560)	(0.00658)				
Per capita FPM 1980					-0.000053***	-0.000063***		
					(0.000017)	(0.000013)		
PT/Revenue 1980							0.0802***	0.0816***
							(0.0123)	(0.0113)
Population 1980		0.000238		-0.000283	-0.000292	-0.00119	-0.00136*	-0.000678
		(0.000999)		(0.000749)	(0.00111)	(0.000860)	(0.000822)	(0.000762)
Per capita Income 1980		0.0205***		0.0154***	0.0243***	0.0188***	0.0109***	0.0150***
		(0.00343)		(0.00256)	(0.00343)	(0.00255)	(0.00299)	(0.00237)
Constant	0.0449***	-0.0737***	0.0399***	-0.0443***	-0.0906***	-0.0546***	-0.0195	-0.0492***
	(0.00146)	(0.0157)	(0.00117)	(0.0124)	(0.0156)	(0.0119)	(0.0128)	(0.0104)
Observations	567	567	567	567	567	567	567	567
R-squared	0.139	0.217	0.148	0.213	0.203	0.205	0.156	0.270

Notes. Robust standard errors in parentheses. The dependent variable is the growth rate in housing units. The variable "FPM/Revenue" is the ratio of FPM transfer over the total revenue of the municipality. "*Per cp.* FPM 1980" is the total FPM revenue divided by the number of the residents of the municipality. "PT/Revenue" is the share of property tax as of the total revenue of the local jurisdiction.
*** p<0.01, ** p<0.05, * p<0.1

Fig. 4: Relationship between (a) Fiscal Windfalls and Housing Growth and (b) Property Tax and Housing Growth



(a) Fiscal Windfalls vs Housing Growth



(b) Property Tax vs Housing Growth

Notes. The horizontal axis depicts the share of FPM out of total revenue (left) and the share of property tax of the total revenue (right). The vertical axis shows the growth in the number of housing units from 1980 to 1991.

to affect urban policy[19]. Urban policy data are for 1999. Regression (i) shows that there is a negative correlation between intergovernmental transfers and the amount of building permits: locations where intergovernmental transfers are more important issue fewer building permits. This result is also verified after controlling for the number of housing units in the jurisdiction (see regression (ii)). The dependent variable in regressions (iii) and (iv) is related to local land laws. The variable “Own Land Law?” is an indicator variable which equals 1 if the municipality has its own land use law. Land use laws are important instruments to boost local housing markets. Regressions (iii) and (iv) suggest that the greater the share of fiscal transfers, the less likely the presence of land use laws in the municipalities. The indicator variable “Bigger lot size?” (columns (v) and (vi)) takes value 1 if the minimum lot size (MLS) of the municipality is above 125 square meters (i.e., land use regulation stricter than the national requirements). Regression (v) and (vi) suggest that where fiscal transfers are more important as a revenue source, stricter urban regulations take place[20]. The correlation indicates that intergovernmental transfers may influence land use regulations in Brazilian cities.

Saiz (2008) argues that there are four origins of land use regulation: (a) correction of market failures in order to obtain an optimal land management; (b) hysteresis, when zoning and growth controls are used as devices to maintain high prices in valuable areas; (c) racial and income heterogeneity, when land regulation serves to deter poor or minority groups from moving to some city or some specific area within a city (“snob zoning theory”); and (d) social and political factors, when different cultural and political background may

[19]See Subsection 2.2 for details on housing policy in Brazil.

[20]It is important to differentiate between the adoption of stricter parameter and their actual enforcement. Unfortunately the data lack any information on enforcement.

Table 4: Fiscal Transfers and Urban Regulation

	Negative Binomial		Probit			
Dependent Variable	# of Permits		Own Land Law?		Bigger Lot Size?	
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
FPM/Revenue in 1980	-10.322***	-9.238***	-3.583***	-3.039***	1.307**	1.919***
	(0.6001)	(0.717)	(0.592)	(0.707)	(0.641)	(0.707)
Houses 1980		1.38e-05**		1.51e-05		8.57e-06**
		(5.39e-06)		(2.00e-08)		(4.20e-06)
Constant	6.219***	5.891***	1.286***	1.125***	-0.247**	-0.401***
	(0.117)	(0.1613)	(0.114)	(0.173)	(0.105)	(0.127)
Observations	567	567	561	561	427	427
R-squared / Pseudo R-squared	0.0296	-	0.0634	0.0731	0.0073	0.0173

Notes. Robust standard errors in parentheses. The dependent variable "# of Permits" is a count variable with 126 zeros. The dependent variable "Own Land Law?" equals 1 if in 1999 the municipality has its own land use law and equals 0 otherwise. "Bigger Lot Size?" takes value 1 if in 1999 the minimum lot size (MLS) of the municipality is stricter than the national requirements and takes 0 if the minimum lot size is equal or below the federally-mandated MLS.
*** p<0.01, ** p<0.05, * p<0.1

generate distinct desire for the type of regulation. Table 4 suggests an additional reason to regulate: the need to collect property tax may influence the decisions regarding the type of land use regulation. The association between intergovernmental transfers and land use regulation may indicate the channels through which fiscal transfers impact housing markets.

Another important characteristic of the municipalities that receive fewer fiscal transfers is regarding the donation of land and housing units. In 1999, out of the existing 645 municipalities in São Paulo state, more than 20% (137 municipalities) had some program of land donation and more than half (348) engaged in donations of housing units[21]. Table 5 shows several regressions pointing out that municipalities which donate land and housing units are exactly the ones that have a lower share of fiscal transfers[22]. This adds to the story behind the third stylized fact: municipalities that receive fewer fiscal transfers try to stimulate their housing markets by providing a more pro-development market (according to the results of Table 4) as well as by adopting public policies related to the donation of houses and land plots (see Table 5)[23].

It is possible to summarize the main implications of the stylized facts:

- i Fiscal windfalls represent a significant share of municipalities' total revenue (Fact 1)
- ii Higher dependency on fiscal transfers is correlated with lower future housing growth. The greater the reliance on property taxes, the greater the housing growth. (Fact 2)

[21] According to tabulations from Munic dataset, municipalities belonging to São Paulo state have donated on average 1.8% of their housing stock.

[22] Land and/or housing donation can be regarded as strategy to attract migrants and to receive more FPM resources in the future (recall that FPM distribution depends on the population size of the municipality).

[23] The explanatory variables in Tables 4 and 5 are all for 1980. The results are virtually the same when I use the explanatory variables in 1991 instead.

Table 5: Fiscal Transfers and Instruments to Attract People

	Probit		Neg. Binomial		Probit		Neg. Binomial	
Dependent variable:	Land Donation?		# of land donations		Housing donation?		# of housing donations	
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
FPM/Revenue in 1980	-2.109***	-2.122***	-6.998***	-5.584***	-0.988*	-0.562	-6.892***	-4.698***
	(0.702)	(0.709)	(1.203)	(1.671)	(0.512)	(0.556)	(1.015)	(1.473)
# of Housing units in 1980		-1.20e-07		0.00002		8.19e-06		0.00002
		(4.59e-07)		(0.00002)		(5.55e-06)		(0.00002)
Constant	-0.422***	-0.418***	5.178***	4.614***	0.335***	0.217*	5.957***	5.217***
	(0.112)	(0.113)	(0.2322)	(0.5054)	(0.0939)	(0.115)	(0.210)	(0.416)
Observations	567	567	567	567	567	567	567	567
R-squared	0.0224	0.0224	0.035	0.035	0.005	0.01	0.035	0.712

Notes. Robust standard errors in parentheses. The dependent variable "Land Donation" takes value 1 if the municipality had engaged in donation of land plots between 1998 and 2000. The variable "# of land donations" shows the number of land plots donations. "Housing donation?" takes value 1 if the municipality has donated (constructed) housing units between 1998 and 2000. The variable "# of housing donations" shows the number of housing units donation.
*** p<0.01, ** p<0.05, * p<0.1

iii Fiscal windfalls seem to adversely impact housing market indicators: a greater share of federal transfers is associated with fewer building permits and the adoption of adverse land use parameters (i.e., parameters that do not stimulate housing development) (Fact 3);

The stylized facts suggest an association between fiscal transfers, land and housing policy, and housing market growth. The next section will link those factors in a simple conceptual framework. The empirical strategy (shown in Section 5) will discuss the identification to capture the causal impact of revenue sharing mechanism on housing markets.

4 Conceptual Framework

The main goal of this conceptual framework is to organize the key ideas in order to provide intuition on how the institutions regarding intergovernmental transfers impact housing markets and city growth. The idea is to build a simple model to derive basic predictions. Migration plays an important role in the following analysis because agents migrating from one jurisdiction to another as a reaction to a change in local policies (e.g., zoning) impact revenue and expenditures of local governments. I aim at deriving two simple predictions regarding the impact of intergovernmental transfers on local regulation and on migration.

Environment

Suppose one person equals one (homogeneous) housing unit, i.e., identical houses contain only one person each. As a result, the total number of people (N) corresponds to the total number of houses (H) in the city. There is a finite number of communities and mobility between communities is costless. The agents are free to move to other jurisdictions, but they can only live in one location.

The local government aims at maximizing $\xi(y, U) = \Gamma y + (1-\Gamma)U(h)$, where y represents public expenditure (in *per capita* terms) that benefits only the policy maker, $U(\cdot)$ is the utility of the representative household and Γ is a weighting factor (Edwards and Keen (1996)). The representative household derives utility over housing services h. Given $\xi(y, U)$, the objective of the local government can vary: one can assume that the local government aims at maximizing its own benefit (when $\Gamma = 1$), the utility of the representative agent (when $\Gamma = 0$) or an intermediate case.

I assume that the government uses a local policy (zoning θ) so as to maximize its objective. The parameter θ can be interpreted as the type of land use regulation chosen by the local jurisdiction: pro-development or not. Let $\theta > 0$ and let higher values of θ represent more pro-development zoning policy. Land use regulation might impact the local economy in various forms. For instance, regulation can create public good type benefits, such as open space (Bates and Santerre (2001)) and stricter land use regulation increases existing home prices (Hamilton (1978)). As shown below, I model urban regulation as interfering with construction costs and housing prices.

Assume that the local government budget constraint in *per capita* terms is as follows:

$$R(\tau(N), \epsilon) = y + G(S_c(N), D_r(N)),$$

where the left-hand side (LHS) represents the local government's *per capita* revenue and the right-hand side (RHS) its *per capita* expenditure. *Per capita* revenue $R(\tau(N), \epsilon)$ depends on the amount of *per capita* intergovernmental transfers τ and on other forms of revenue the local government may have (represented by ϵ). I assume a specific behavior for the revenue function in order to incorporate certain Brazilian institutional characteristics. In order to approximate the Brazilian institutional arrangement, intergovernmental transfer τ depends on the total number of people N in the community. Recall that in Brazil the distribution of the FPM fund follows a step function. I approximate federal grants distribution in the model by using a single "population threshold": to the left of that threshold, $\frac{\partial \tau}{\partial N} > 0$, while to the right of the cutoff $\frac{\partial \tau}{\partial N} < 0$. Other forms of revenue ϵ are assumed to be fixed to simplify the analysis, but assuming a positive relationship between ϵ and population N would generate similar results.

Per capita government cost is divided into expenditures that benefit only the policy maker (y) and running costs $G(\cdot)$. The function $G(S_c(N), D_r(N))$ maps population size to the amount of local costs. Running costs affected by the number of people N are divided into internal economies of scale $S_c(N)$ and deregulation costs $D_r(N)$. On the economies of scale side, the greater the population size, the smaller the *per capita* running costs (i.e., $\frac{\partial S_c(N)}{\partial N} < 0$). Deregulations costs are increasing costs associated with congestion such as the ones to combat increasing population heterogeneity (police, housing policy or other redistribution policies) so $\frac{\partial D_r(N)}{\partial N} > 0$.

A key assumption is that community size N is influenced by local zoning policy θ. Specifically, I assume that $\frac{\partial N}{\partial \theta} > 0$, i.e., pro-development regulation is associated with more migration to the community. This relationship can be derived from (i) representative households maximizing their utility over housing services ($U(h)$) and from (ii) competitive developers whose costs are influenced by the type of local regulation θ. In a general equilibrium setting, pro-development regulation would decrease construction costs, impacting housing prices and rents. Cheaper housing would alter the spatial equilibrium condition and induce migration to the location so that $\frac{\partial N}{\partial \theta} > 0$. Deriving such general equilibrium setting is beyond the scope of the present conceptual framework, so I keep things simple by assuming a reduced-form behavior for $N(\theta)$.

I assume that the local government knows how zoning influences migration decision and therefore the local government considers $N(\theta)$ when choosing its zoning policy. Given the relationship between zoning and population size, pro-development local regulation has an ambiguous effect on the cost side of the local government: pro-development zoning attracts more people, reducing $S_c(N)$ due to economies of scale but increasing $D_r(N)$ due to congestion costs.

The decision problem of the local government can be summarized as

$$M(\cdot) = \max_{\theta} \ \xi(y, U) = \max_{\theta} \ [\Gamma y + (1 - \Gamma) U(h)] \tag{1}$$

subject to

$$R(\tau, \epsilon) = y + G(S_c(N(\theta)), D_r(N(\theta))).$$

The choice regarding the type of zoning has the following effect: an increase in θ (a more pro-development zoning) attracts people (N) affecting ambiguously both local revenue (the direction depends on which side of the population cutoff the municipality is located) and costs (the net effect depends on economies of scale and congestion costs).

Predictions

To keep things simple, I assume a Leviathan local government that maximizes its own benefit (i.e., $\Gamma = 1$ in Equation (1)). The local government then chooses θ in order to maximize its "surplus" which is given by $R(\tau, \epsilon) - G(S_c(N(\theta)), D_r(N(\theta)))$. The desired optimal zoning equation is the first order condition (F.O.C.) of the local government problem with respect to θ and it shows that the government will choose its zoning policy type θ so as to guarantee the usual equivalence between marginal revenue and marginal cost:

$$\frac{\partial \tau}{\partial N}\frac{\partial N}{\partial \theta} = \frac{\partial S_c}{\partial N}\frac{\partial N}{\partial \theta} + \frac{\partial D_r}{\partial N}\frac{\partial N}{\partial \theta}. \tag{2}$$

Equation (2) generates the main predictions of the model. Let's first get intuition by analyzing the F.O.C without the revenue side. Without fiscal transfers, the optimal zoning θ is the one in which the condition $-\frac{\partial S_c}{\partial N}\frac{\partial N}{\partial \theta} = \frac{\partial D_r}{\partial N}\frac{\partial N}{\partial \theta}$ is valid, i.e., when the marginal benefit (the reduction of expenditures due to economies of scale) equals the marginal cost of additional inhabitants (spending more due to congestion). With intergovernmental transfers, the magnitude of zoning θ changes. Rearranging Equation (2) generates the following marginal benefit and marginal cost equivalence:

$$\underset{(+) or (-)}{\frac{\partial \tau}{\partial N}} \ \underset{(+)}{\frac{\partial N}{\partial \theta}} - \underset{(-)}{\frac{\partial S_c}{\partial N}} \underset{(+)}{\frac{\partial N}{\partial \theta}} = \underset{(+)}{\frac{\partial D_r}{\partial N}} \underset{(+)}{\frac{\partial N}{\partial \theta}}. \tag{3}$$

Equation (3) shows that locations at different sides of the threshold will have distinct zoning policies. The marginal benefit of pro-development zoning is greater for municipalities to the left of the population threshold because $\frac{\partial \tau}{\partial N} > 0$. On the other hand, communities to the right of the population threshold will adopt "unfriendlier" zoning because their marginal benefit of attracting people is negatively affected because of $\frac{\partial \tau}{\partial N} < 0$. After an exogenous variation of intergovernmental transfer, a city has incentives to change the zoning ordinances that govern future construction. As a result, Equation (3) points out that the local jurisdiction to the left of the population cutoff will create a pro-development land use law and end-up growing more. In sum, institutions regarding intergovernmental transfers will influence the type of regulation and consequently the population size of the location.

This simple conceptual framework highlights why a city would pass a land use law focusing on keeping (or even attracting) people. Notice that the pro-development type of land regulation will only pass when its benefit (marginal benefit accruing from people attraction) surpasses its cost (marginal cost related to zoning). In the model, fiscal transfers may increase or decrease the marginal benefit of performing a pro-development zoning. In a system of cities, the optimal response of every jurisdiction is to change its zoning ordinances, but cities that depend less on grants (to the left of the population cutoff) will enact a more pro-development zoning.

The comparison of costs and benefits of adopting land use regulations illustrates the type of behavior associated with fiscal windfalls. Suppose that the local government receives more intergovernmental transfers, the model shows that the local government will adopt a counterproductive land law. In the Brazilian case, it means fewer building permits, lack of own land use law, and bigger minimum lot sizes (as pointed out by stylized fact 3 in Section 3). In short, this simple conceptual framework shows that the lack of fiscal windfalls changes local government zoning decisions (the municipality does adopt a "friendly" urban regulation and does not hamper future housing constructions).

5 Identification

This section discusses the empirical strategy used to identify the causal effect of fiscal transfers on housing market growth. I focus on a reduced-form relationship between intergovernmental transfers and housing growth to disentangle the impact of fiscal transfers. The institutions regarding the distribution of fiscal grants in Brazil generate a treatment assignment mechanism that leads to an application of a regression discontinuity design (RDD). I follow the treatment effect literature that have largely focused on average treatment effects (Imbens and Wooldridge (2009)).

Let $W_i \in \{0, 1\}$ be the treatment indicator, with $W_i = 1$ if unit i received the treatment and $W_i = 0$ otherwise. Recall that FPM grants are distributed according to a step function depending on the population size of the local jurisdiction. Therefore, the treatment-determining variable (or running variable) is the population size of the municipality and is denoted by X_i. In a Sharp RDD, there is no difference between being assigned/eligible to treatment and receiving the treatment, i.e., W_i is a deterministic function of the treatment-determining variable X_i. In a Fuzzy RDD, treatment eligibility is not equal to actually receiving the treatment, i.e., the probability of receiving the treatment W_i does not change from zero to one.

In this paper, the RDD setting is a fuzzy one because there is imperfect compliance to the treatment. Figure 5 supports the Fuzzy RDD approach. Figure 5 shows that the FPM distribution rule is observed because in each year one can see a step function. However, it also shows that there are some municipalities that are outside the step function, i.e., some municipalities did not receive FPM according to its formal distribution rule. I use this information in the identification strategy: since the cutoffs are not strictly enforced, the data show non-perfect discontinuities. In other words, the discontinuity is fuzzy. The Fuzzy RDD uses the fact that the greater the population, the higher the probability of receiving more FPM resources. Even though the data show that there is imperfect compliance, the non-compliance tends to disappear when one considers the period from 1982 to 1988. Notice that the causal interpretation of an IV estimand relies on key assumptions such as monotonicity. The improving compliance during 1982 to 1988 is reassuring for the IV's monotonicity assumption[24].

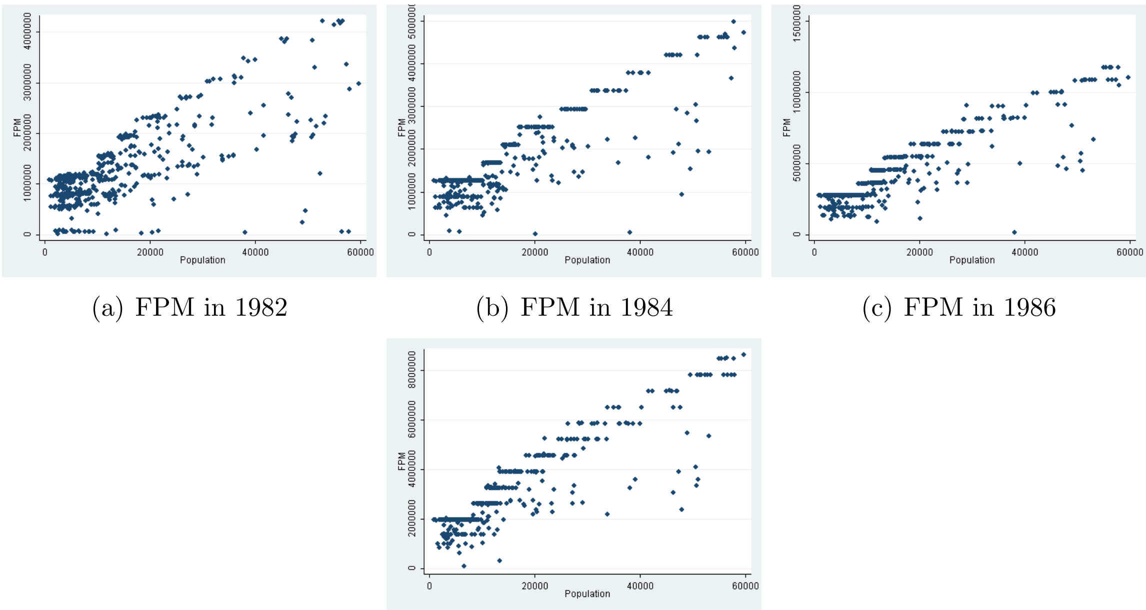
The Fuzzy RDD can be implemented via a two-stage least squares (2SLS) estimator. There are two approaches for estimation: global methods (global polynomial estimators) or local methods (local linear regression). Each one has strengths and weaknesses. The idea of applying local linear regressions in the present setting is challenging because of sample size limitations: FPM distribution rule generates 17 cutoffs and I am dealing only with municipalities from São Paulo state. By applying local methods, one obtains low bias because those observations near the cutoff are exchangeable, but one gets very high variance estimates. For the application of local linear regressions to have a useful interpretation, the sample of observations around the cutoffs should be as dense as possible. In the present application, the sample is not sufficiently dense at the cutoffs so I cannot observe enough counterfactuals around the cutoff. Because of the lack of observations near the cutoffs, I use global polynomial estimators. I include up to a fourth-order polynomial in the regressions (spline polynomial approximation). Using a global method, there are two regressions to be estimated:

$$F_i = \beta_0 + \beta_1 \overline{F_i} + g(X_i) + e_i, \tag{4}$$

and

[24]The visible jumps in Figure 5 provide an indirect way to verify the monotonicity condition: during the 1980's, one can see that municipalities below a certain cutoff do not receive more transfers than they would have received in case they had been assigned above the cutoff.

Fig. 5: FPM Distribution in the 1980's



(a) FPM in 1982 (b) FPM in 1984 (c) FPM in 1986

(d) FPM in 1988

Notes. The figures show the amount of FPM received by each municipality during the period from 1982 to 1988.

$$y_i = \alpha + \gamma F_i + g(X_i) + u_i. \quad (5)$$

where y_i is the outcome variable, $g(\cdot)$ is a high-order polynomial, F_i is the amount of *per capita* FPM received by the municipality, $\overline{F_i}$ is the predicted *per capita* FPM amount each municipality would receive if the FPM distribution had complied perfectly with the Federal Decree 1,881/81, u_i stands for unobservable determinants of housing growth, such as the enforcement of local laws, and e_i is a error term. The first stage shown by Equation (4) estimates the effect of the predicted FPM amount (the instrumental variable) on the actual *per capita* FPM. The second stage in Equation (5) estimates the effect of the (fitted) *per capita* FPM on housing growth.

There are two relevant outcome variables to the present analysis: housing growth and housing policy instruments. Housing growth data is available to the period before and after 1981 (the year of the Federal Decree 1,881/81), while housing policy data are available only for the late 1990's. Therefore, a more convincing identification strategy is to use only housing growth during 1980 to 1991 (or from 1980 to 2000) as the outcome variable. Opposing forces explain the sign of γ when housing growth is the outcome variable in Equation (5): more fiscal transfer may induce more housing development (because more transfers attract migrants), but it may generate disincentives (the municipality does not adopt a friendly land-use law and loses population to other locations). Notice that covariates are not needed for identification, but I use covariates in some specifications to improve the precision of the estimates. There are several determinants of housing growth, and including them may improve precision.

Since the FPM distribution rule generates 17 cutoffs, there are several ways of defining the treatment and control groups. I define the treatment group as the municipalities that are on the right side of each population cutoff. Let $Y_i(1)$ be the potential outcome of the municipality i if the municipality is "treated", i.e., to the right of the population cutoff and let $Y_i(0)$ be the counterfactual outcome of the same municipality (i.e., if it is located to the left of the population cutoff). The problem is that I cannot observe both outcomes at a given point of time. The assumption of the identification strategy is that municipalities close to the discontinuity points are similar to each other but by chance some had a few more people than other so they receive a different level of FPM. I pool the observations (from different thresholds) together and normalize the population size as the distance to the closest threshold. Specifically, I analyze the observations pooling the thresholds 1 to 4 and thresholds 1 to 6. To deal with symmetric cutoffs, I restrict the analysis for municipalities with more than 6,792 people[25]. Pooled regressions assume that (i) each cutoff group has the same functional form; (ii) there is a constant treatment effects across cutoffs and (iii) centering assignment by cutoff group weighs units appropriately for estimating desired treatment effects. Other papers that use the FPM rule also apply a similar pooling approach to gain statistical power (e.g., Brollo, Nannicini, Perotti, and Tabellini (2013)).

External validity. I also use data from all 17 thresholds to improve external validity. Using an IV-style regression, the relationship I want to identify is a global polynomial similar to Equation (5), but looking at all cutoffs of the FPM distribution rule. I exploit two instrumental variables that can be generated from Federal Decree 1,881/81. First, assuming exogeneity of the federal decree, I can instrument *per capita* FPM with the theoretical *per capita* FPM. Four conditions must hold to estimate the parameter of interest (γ) consistently in the full sample IV setting: independence, monotonicity, inclusion restriction, and exclusion restriction. Independence means that the instrument should be as good as a random assignment. I discuss several issues regarding independence assumption shortly in Subsection (6.1). Monotonicity implies that treatment eligibility can only make actual treatment more likely, not less. I discussed the monotonicity assumption previously. Inclusion restriction means that the predicted amount of FPM in 1982 must be correlated with the *per capita* FPM. Besides, the predicted amount of FPM in 1982 must not be correlated with any unobservable determinant of housing growth, i.e, the exclusion restriction $Cov(u_i, FP_i|X_i) = 0$ must hold. Note that exclusion restriction may not be verified in

[25] The first cutoff separates two groups: municipalities with 0 to 10,188 people and municipalities with 10,189 to 13,584 (see Table A.3). I restricted the first group of municipalities to population between 6,792 and 10,188 to have a symmetric cutoff.

some cases. For example, knowledge that the municipality received more grants in 1982 might cause it to change its expenditure on education, which might influence migration and housing growth (as pointed out by Litschig and Morrison (2013)).

Additionally, I exploit another instrumental variable from the federal decree: the *change* in the amount of predicted FPM, i.e., the difference between the predicted FPM generated by Federal Decree 1,881/81 and the one dictated by the 1967 Federal Constitution (recall Figure 2 in Section 2). In the early 1980's, the municipalities were expecting a certain amount of transfers (because of the 1967 Constitutional rule) and received a different amount in 1982 because of the implementation of the federal decree. One could argue that the *total* amount of predicted FPM from the federal decree is not an *ideal* instrument because the FPM distribution rule existed since 1967 (even though with different cutoffs as shown in Section 2) and municipalities may have had several years to alter their population size so as to optimize the amount of FPM received at that time. I try to overcome this issue by applying a distinct instrumental variable in the regressions: instead of the total *per capita* amount of FPM predicted by Federal Decree 1,881/81, I use the *change* in the predicted *per capita* FPM.

Graphical Analysis. In the next section, I show several graphs of the outcome by the treatment-determining variable and of selected covariate by the treatment-determining variable. The "intent-to-treat" graphs were constructed using the following steps. Given a bandwidth h, let N_k be the number of the observation of the $k-th$ bin

$$N_k = \sum_{i=1}^{N} 1\{b_k < X_i \leq b_{k+1}\},$$

where $1\{\cdot\}$ is an indicator function that equals one if its argument is true and zero otherwise. The average outcome $\overline{Y_k}$ in the $k-th$ bin is calculated by:

$$\overline{Y_k} = \frac{1}{N_k} \sum_{i=1}^{N} Y_i \cdot 1\{b_k < X_i \leq b_{k+1}\}.$$

I plotted the value of Y_k against the mid-point of the bins. The graphs contain a local linear smother fit separately for each side of the population cutoff. The local linear smoother uses a rectangular kernel.

6 Results

6.1 Specification Tests

One important point for identification in the RDD approach is the assumption of continuity in the treatment-determining variable. I examine whether there is the threat of other policies changing at the same population thresholds. To be precise, there are other institutional discontinuities related to the population size of the municipality, but they are less relevant to the present analysis.[26]

Table 6: Pre-Treatment: Pooled 1-6 Thresholds

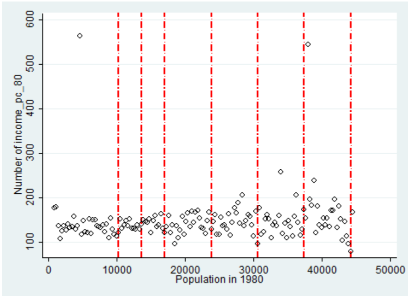
Spline Polynomial Order	*Per capita* Income 1980	*Per capita* Total Revenue 1981	Education Attainment 1980	Altitude	Total Area
1st-order	3.701	-19.98	0.0122	22.96	51.47
	(9.557)	(40.26)	(0.0864)	(34.44)	(65.02)
2nd-order	-3.859	-9.946	-0.079	25.8	34.63
	(13.05)	(67.66)	(0.121)	(49.2)	(94.64)
3rd-order	-6.826	65.29	-0.2	87.31	-148.9
	(16.63)	(86.27)	(0.145)	(62.51)	(119.3)
4th-order	4.907	12.31	-0.125	123.9*	-78.79
	(19.85)	(104.4)	(0.168)	(71.34)	(135.9)
Observations	458	458	458	458	458

Notes. Robust standard errors in parentheses. The dependent variables are pre-treatment variables. The estimated coefficient is the *per capita* FPM in 1982 instrumented with the theoretical FPM from the Federal Decree 1,881/81. The regressions represent different spline polynomial orders. The observations are pooled in the regressions. The results are for municipalities with population up to 37,356 ("Thresholds 1 to 6").
*** p<0.01, ** p<0.05, * p<0.1

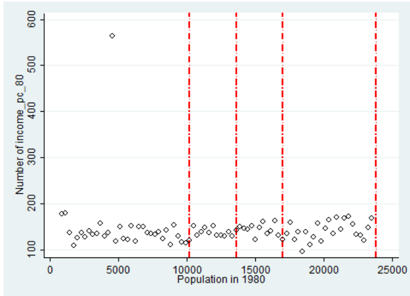
An additional important point underlying the RDD approach is that the population near the cutoffs should be "random", i.e., there is no manipulation of the running variable. One way to verify this assumption is to test whether pre-treatment observable characteristics are similar around the cutoff. Another way is to verify potential discontinuities in the density of the running variable. As for the pre-treatment variable, Table 6 shows no effect of the discontinuities on the value of selected pre-treatment variables. Table 6 shows the effect of *per capita* FPM on *per capita* income in 1980, total *per capita* revenue in 1981, education attainment in 1980, altitude, and total area of the location. I also constructed a graph of the *per capita* income by the treatment-determining variable. According to Figure 6, there is no clear sign of jumps in *per capita* income in 1980 when one looks at regions close to the population thresholds. By and large, Figure 6 points out that the relationship between *per capita* income and population size is almost a flat line.

[26]In 2000, the Constitutional Amendment n. 25 stipulated a cap to the salaries of city counselors as a percentage of state legislators' salary. For instance, in municipalities with population up to 10,000, local legislators must receive up to 20% of a state deputy's salary, while in places with population between 10,000 and 50,000, the cap is 30% (Ferraz and Finan (2008)). Since the focus of the present analysis is on the period between 1980 and 1991, the wage-cap discontinuities do not play an important role.

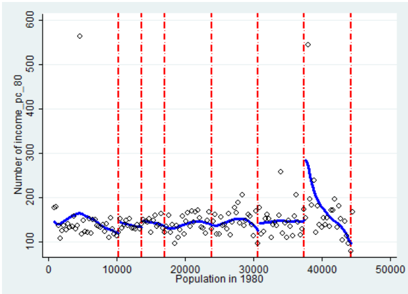
Fig. 6: *Per capita* Income in 1980 and FPM Thresholds



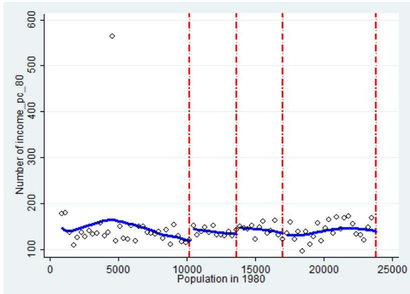
(a) 7 Cutoffs



(b) 4 Cutoffs



(c) 7 Cutoffs and Smoother

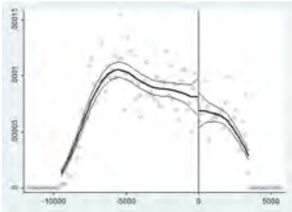


(d) 4 Cutoffs and Smoother

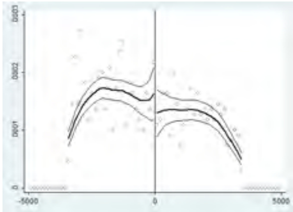
Notes: Each open circle represents the average *per capita* income in 1980 for the municipalities in each bin. Bin-width equals to 283. Solid curve - figures 6(c), 6(d) - is a local linear smoother fit separately for each population cutoff.

Another relevant point concerning the manipulation of the running variable is whether the FPM distribution rule really binding. One argument favoring the exogeneity of the FPM distribution rule is that several mayors complain that IBGE (the institution responsible for the population censuses) had underestimated the size of the city's population, a sign that the mayors cannot (fully) manipulate the results of the Census and thus the distribution of FPM grants. Recall that the FPM distribution rule was created during a military dictatorship and thus it was arguably exogenous to the municipalities' control. The treatment assignment rule (i.e., population cutoffs) was public knowledge in 1981 (after the publication of Federal Decree 1,881/1981) and the distribution of grants used population figures based on the 1980 Population Census. Therefore, one can argue that there was little room to manipulate the assignment rule, because the FPM amount to be distributed in 1982 was based on the 1980 population census.

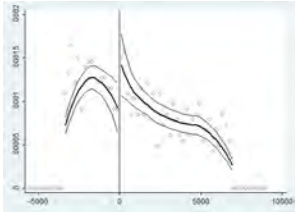
Fig. 7: McCrary Density Tests



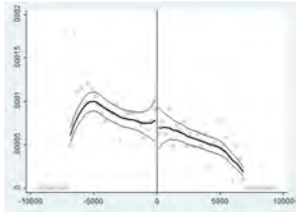
(a) Cutoff 1



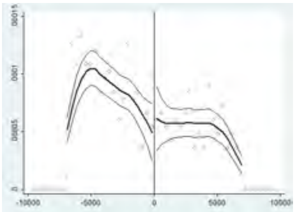
(b) Cutoff 2



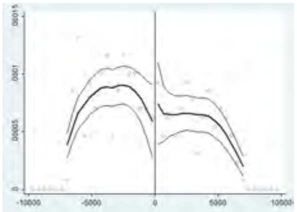
(c) Cutoff 3



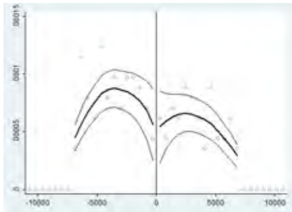
(d) Cutoff 4



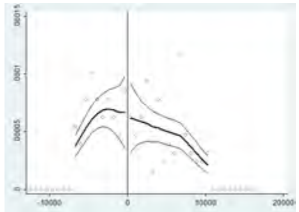
(e) Cutoff 5



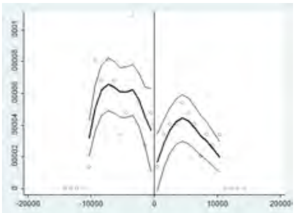
(f) Cutoff 6



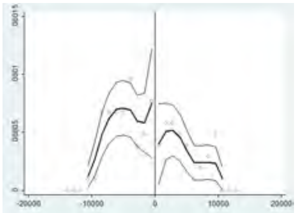
(g) Cutoff 7



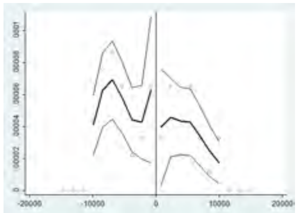
(h) Cutoff 8



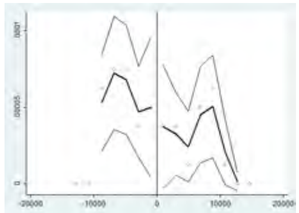
(i) Cutoff 9



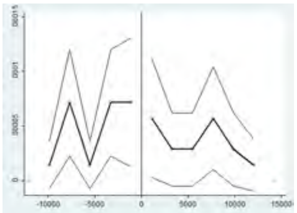
(j) Cutoff 10



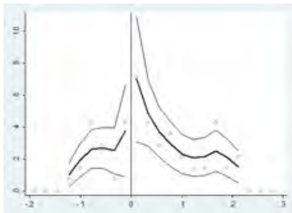
(k) Cutoff 11



(l) Cutoff 12



(m) Cutoff 13



(n) Cutoffs 14-17

Notes. Population density test with optimal binwidth and binsize as in McCrary (2008). Population density tests use population data from the 1980 Brazilian Census. According to Federal Decree 1,881/81, the FPM distribution rule comprises 17 population cutoffs.

Moreover, the no-bunching in the 1980 density graph (recall Figure 1) implies that the municipalities had imprecise control over the running variable. A more formal approach is to perform a density test for each cutoff to verify potential discontinuities in the conditional density of the forcing of the running variable (McCrary (2008)). Discontinuities in the density of the running variable (population size) would suggest that the value of the running variable was manipulated by municipalities to influence their treatment status (i.e., the amount of intergovernmental transfers they receive). Figure 7 depicts the density estimates for each one the 17 cutoffs generated by the FPM distribution rule and no clear discontinuities are shown, except for one cutoff[27].

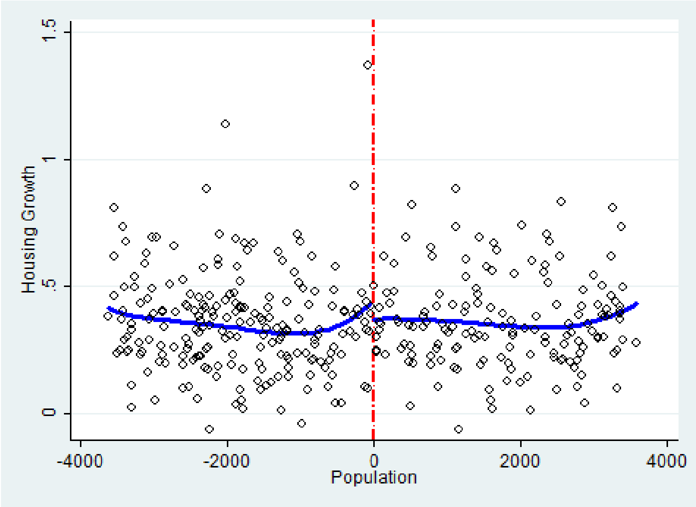
6.2 Reduced-form Results: Pooled Observations

I start by showing some intent-to-treat graphs of the outcome by the treatment-determining variable. Figure 8 shows the behavior of housing growth in 1980-1991 near the population cutoffs. Using different bin-widths, they show discontinuities near the population cutoffs. Figure 8 indicates two interesting patterns: (i) it seems that only municipalities very close to the cutoffs have a higher housing growth, while the rest of the municipalities present an average growth; and (ii) municipalities to the left of the cutoff (the ones that could benefit more from attracting people) present higher housing growth. A second way to verify jumps in the outcome variable is by comparing the density graphs in 1980 and 1991. In 1991, one can observe several municipalities bunching after the population cutoffs (see Figure 1(b)).

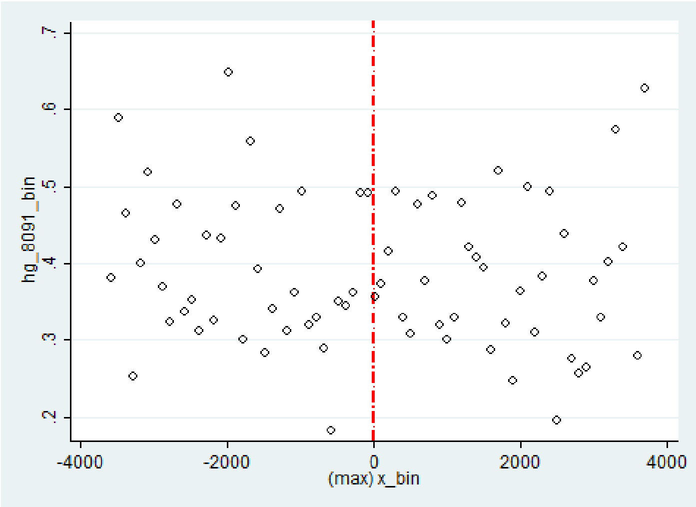
Housing policy variables are other potential outcome variables. Recall that housing policy data is available only from the late 1990's on, and that Figure 1(b) points out a population sorting around the cutoffs in 1991. Therefore, a RDD analysis using housing policy is not appropriate. Bearing in mind this limitation, I also show some graphs for one policy regarding housing markets: donation of material to construct housing units (see Figure 9). The graphs show jumps near the population cutoffs in 2000. The negative inclination indicates that municipalities to the right of the cutoff in 2000 donated more material in the late 1990's. A potential explanation is that municipalities might have used policy instruments to attract people to jump to the right-side of the population cutoff.

[27]Figure 7 comprises all 3991 Brazilian municipalities in 1980. I aggregate the last four cutoffs due to lack of observations. I cannot reject the null hypotheses of no height difference given the log discontinuity estimates, except for the cutoff number 3 (Figure 7(c)).

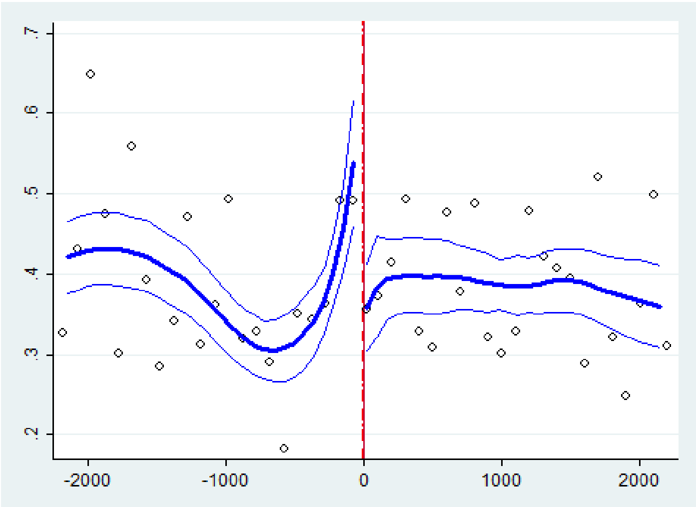
Fig. 8: Housing Growth from 1980 to 1991: Pooled Observations



(a) Bin-Width 1



(b) Bin-Width 100

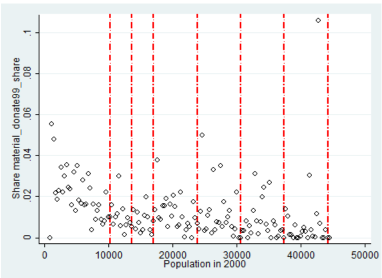


(c) Bin-Width 100

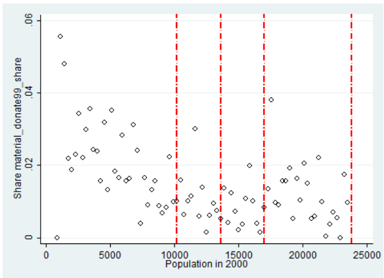
Notes: Each open circle represents the average housing growth from 1980 to 1991 for each bin. The observations are pooled (municipalities with population up to 37,356). Solid curve in Figure 8(c) is a fourth-order polynomial fit separately for each pooled population cutoff. The dashed lines are 95% confidence interval of the polynomial.

Table 7 shows the results of Fuzzy RDD regressions. The outcome variable is housing growth in 1980-1991, while the explanatory variable is *per capita* FPM in 1982 (instrumented by the theoretical *per capita* FPM). I use the 1982 *per capita* FPM values because of the Federal Decree 1,881/81, but it is important to note that 1982 FPM values were calculated using the 1980 Population Census information. Table 7 shows the impact of the *per capita* FPM on housing markets. Each cell of Table 7 shows the regression coefficient of *per capita* FPM (instrumented by the theoretical *per capita* FPM) for four different polynomial specifications (lines of Table 7) for pooled observations (columns of Table 7). More specifically, in column (i) the observations are pooled for cutoffs 1 to 6 (population up to 37,356) and column (ii) shows the results for the pooled observations of cutoffs 1 to 4 (population up to 23,772). As mentioned above, each line represents the polynomial specification used in the regression. In Table 7 I do not control for any covariates apart from the population polynomial functions.

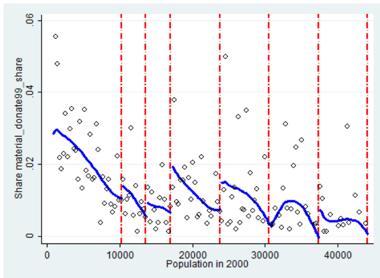
Fig. 9: Donation of Construction Material: Share of Total Housing Stock



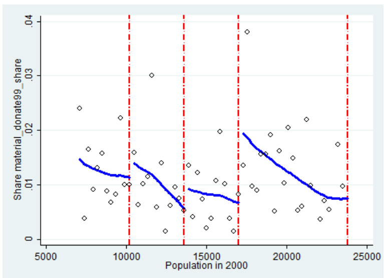
(a) 7 Cutoffs



(b) 4 Cutoffs



(c) 7 Cutoffs and Smoother



(d) 4 Cutoffs and Smoother

Notes: Each open circle represents the donation of material for constructing housing units (as a share of the total housing stock) in 1997-1999 for the municipalities in each bin. Bin-width equals to 283. Solid curve - figures 9(c), 9(d) - is a local linear smoother fit separately for each population cutoff.

The main result is that *per capita* FPM in 1982 has a negative and statistically significant impact on housing growth during 1980-1991. That is, the greater the amount of *per capita* FPM in 1982, the lower the housing growth during the 1980's. The effect sizes are economically relevant: an increase in transfers by R$ 100 (circa US$ 50) in *per capita* transfers (less than one standard deviation) is associated with a decrease in 2.2-2.6 percent in housing growth during 1980-1991. Table 7 indicates that the results are robust to several different sample sizes. Moreover, the results do not vary much when I add interaction and high-order terms.

Table 7: Global Estimates
Effects of FPM Transfers on Housing Growth

	(i)	(ii)
	Dependent variable: Housing Growth 1980-1991	
Spline Polynomial Order	Thresholds 1-6	Thresholds 1-4
1st-order	-0.000236***	-0.000218***
	(0.000062)	(0.000082)
2nd-order	-0.000234***	-0.000211***
	(0.000061)	(0.00008)
3rd-order	-0.000221***	-0.000220***
	(0.000063)	(0.000084)
4th-order	-0.000266***	-0.000268***
	(0.000069)	(0.000099)
Observations	458	390

Notes. Robust standard errors in parentheses. The dependent variable is housing growth during the period from 1980 to 1991. The estimated coefficient is the *per capita* FPM instrumented with the theoretical FPM from Federal Decree 1,881/81. The regressions represent different spline polynomial orders. The observations are pooled in the regressions. Column (i) shows the results for municipalities with population up to 37,356, while column (ii) is for locations with population up to 23,772.
*** p<0.01, ** p<0.05, * p<0.1

Robustness checks. I performed the following exercises in order to check for the robustness of the results.

Different time span: long run housing growth (1980-2010). Table 8 shows that the main results stay the same when I change the dependent variable. The dependent variable on columns (i) and (ii) is housing growth rate from 1980 to 2000. In columns (iii) and (iv), the dependent variable is housing growth during 1980 to 2010. The results show that *per capita* FPM still has a negative impact on housing market the period from 1980 to 2000, but the significance of the estimates vanish over a longer time span (1980-2010). Besides, the effect sizes are smaller than those for the baseline results. The results of Table 8 point out that intergovernmental transfers rule created by Federal Decree 1,881/81 had a 20-year impact on housing markets. However, the results also suggest that municipalities may "accommodate" once they reach the desired side of the population cutoff.

FPM from 1982-1985. In Table 9, I change the main explanatory variable: instead of using only *per capita* FPM in 1982, I use the total amount of *per capita* FPM from 1982 to 1985. There are two main reasons for this exercise. The first one is that the data from 1982-1985 present more compliance than the data from 1982 (see Figure 5). More importantly, the second reason is related to the timing of the events after the Federal Decree 1,881/81:

Table 8: Robustness 1
Different Time Span

Spline Polynomial Order	(i)	(ii)	(iii)	(iv)
	Housing Growth 1980-2000		Housing Growth 1980-2010	
	Thresholds 1-6	Thresholds 1-4	Thresholds 1-6	Thresholds 1-4
1st-order	-0.000116**	-0.000121*	-0.000075*	-0.000078
	(0.000056)	(0.000072)	(0.000045)	(0.00006)
2nd-order	-0.000115**	-0.000117*	-0.000074	-0.000073
	(0.000056)	(0.000071)	(0.000045)	(0.000059)
3rd-order	-0.000102*	-0.000129*	-0.000061	-0.000076
	(0.000058)	(0.000075)	(0.000047)	(0.000063)
4th-order	-0.000134**	-0.000173**	-0.000088*	-0.000111
	(0.000063)	(0.000088)	(0.00005)	(0.000072)
Observations	458	390	458	390

Notes. Robust standard errors in parentheses. In columns (i) and (ii), the dependent variable is housing growth during the period from 1980 to 2000. In columns (iii) and (iv), the period is from 1980 to 2010. The regressions are for different spline polynomial orders. The observations in the regressions are pooled. "Thresholds 1-6" shows the results for municipalities with population up to 37,356, while "Thresholds 1-4" is for locations with population up to 23,772.
*** p<0.01, ** p<0.05, * p<0.1

the decree stipulated that FPM should be distributed in 1982-1985 using the numbers from the 1980 Population Census and that in 1985 another population count should be carried out. The idea was to reallocate FPM grants according to updated population figures. In 1985, a population estimative (but not an official population count) was carried out to reallocate FPM grants. Therefore, municipalities were certain that the amount in 1982-1985 would be allocated according to the population figures of the 1980 population census, but they could be uncertain about the impacts of the population estimative of 1985. As shown in Table A.4 in Appendix A, municipalities of São Paulo state were not affected by the population estimate of 1985. Nonetheless, as a robustness check, I use the value of the amount of the "certain" *per capita* FPM during 1982-1985 as the explanatory variable. The results of Table 9 are basically the same as the ones from the baseline specification.

Adding controls. I now explore the sensitivity of the results to the inclusion of covariates. Unattractive, low-skilled cities may present low property values and low housing growth. Unattractive cities may receive more (equalization) intergovernmental transfers and then the negative coefficient of FPM may be associated with the fact that unattractive cities (with their low housing growth) receive more fiscal transfers. The RDD approach potentially isolates the effects of confounders, but I extended the number of explanatory variables as a robustness check. I use *per capita* income as one proxy for "city vibrancy". I try to capture two other aspects of vibrant cities as well: education and the composition of the municipality budget. I use one education indicator: the average years of schooling (labeled "education attainment"). As for the municipality budget, I use municipal total

Table 9: Robustness 2
FPM 1982-1985 as Explanatory Variable

	Housing Growth 1980-1991		Housing Growth 1980-2000		Housing Growth 1980-2010	
Polynomial Order	Thresholds 1-6	Thresholds 1-4	Thresholds 1-6	Thresholds 1-4	Thresholds 1-6	Thresholds 1-4
1st-order	-0.000188***	-0.000186***	-0.000092**	-0.000103*	-0.000060*	-0.000066
	(0.000049)	(0.00007)	(0.000045)	(0.000062)	(0.000036)	(0.000051)
2nd-order	-0.000188***	-0.000183***	-0.000093**	-0.000101	-0.000059	-0.000063
	(0.000049)	(0.000069)	(0.000045)	(0.000062)	(0.000036)	(0.000051)
3rd-order	-0.000177***	-0.000184***	-0.000081*	-0.000108*	-0.000049	-0.000064
	(0.00005)	(0.000071)	(0.000046)	(0.000063)	(0.000037)	(0.000053)
4th-order	-0.000220***	-0.000242***	-0.000111**	-0.000157*	-0.000073*	-0.000101
	(0.000058)	(0.00009)	(0.000053)	(0.00008)	(0.000042)	(0.000066)
Observations	458	390	458	390	458	390

Notes. Robust standard errors in parentheses. In columns 2 and 3, the dependent variable is housing growth during the period from 1980 to 2000. In columns 4 and 5, the period is from 1980 to 2010. The regressions are for different spline polynomial orders. The observations in the regressions are pooled. "Thresholds 1-6" shows the results for municipalities with population up to 37,356, while "Thresholds 1-4" is for locations with population up to 23,772.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

revenue in 1982 (*per capita*). The results in Table 10 show that the impact of intergovernmental transfers on housing growth stays the same as before. *Per capita* income and *per capita* revenue have a highly significant positive coefficient, while education attainment is not significant. It seems that the coefficient of *per capita* income is capturing the several dimensions of a vibrant city. Notice that both *per capita* income and education can be thought as proxies for city productivity. When assignment to treatment is random, the point estimate should not change after including control variables. In the present analysis, the point estimate is reduced by half when I include other potential determinants of housing growth. Besides, the FPM coefficient stays significant in the relevant period from 1980 to 1991, but it becomes insignificant in the longer period from 1980 to 2000. All the explanatory variables in Table 10 are (directly or indirectly) levels in 1980.

Attraction of migrants. An alternative measure related to both housing markets and city success is population growth (see Glaeser, Scheinkman, and Shleifer (1995) and, for Brazil, Da Mata, Deichmann, Henderson, Lall, and Wang (2007)). Since I am dealing with municipalities, it is useful to look at population growth as a measure of city growth because migration can offset any (positive or negative) effect of transfer on the location's *per capita* income or GDP. The regressions of Table 11 show that FPM *per capita* has a similar impact on *population growth* between 1980-1991. This is due to the striking correlation between housing growth and population growth in Brazil (see Appendix B). In sum, locations with higher *per capita* FPM end-up attracting fewer people.

Fake thresholds. I check whether the outcome variable is discontinuous at other values of the treatment-determining variable. Fake pooled thresholds are midpoints between real population cutoffs from Federal Decree 1,881/81[28]. The results shows that the regression coefficients are not significant in higher polynomial regressions when I apply the fake population cutoffs. See Table 12.

6.3 Reduced-form Results: Full Sample

Table 13 shows the results for all municipalities in São Paulo state. The regressions use a standard IV approach. The main result is that *per capita* FPM has a negative impact on housing growth[29]. The instrumental variable in regressions (i) to (vi) is the amount *per capita* of FPM predicted by Federal Decree 1,881/81, while the instrument in regressions (vii) and (viii) is the *change* in the predicted FPM amount given by the difference between the FPM predicted by the federal decree and by the 1967 Constitution (recall Figure 2 in Section 2).

The results are qualitatively similar even after controlling for several variables, but the magnitude of the coefficients differs with different controls. I add the following controls

[28]Midpoints are: 1^{st}) 11,887; 2^{nd}) 15,283; 3^{rd}) 20,337; 4^{th}) 27,169; 5^{th}) 33,961; 6^{th}) 40,753.

[29]The first stage results are shown in the last line of Table 13.

Table 10: Robustness 3: Adding Covariates

	Thresholds 1-6							
	Housing Growth 1980-1991				Housing Growth 1980-2000			
Spline polynomial:	1st-order	2nd-order	3rd-order	4th-order	1st-order	2nd-order	3rd-order	4th-order
Per capita FPM in 1982	-0.000144**	-0.000143**	-0.000144**	-0.000177**	-0.000002	-0.000002	-0.000001	-0.000021
	(0.000064)	(0.000064)	(0.000065)	(0.000071)	(0.000055)	(0.000055)	(0.000056)	(0.000062)
Per capita Income 1980	0.000064***	0.000065***	0.000065***	0.000066***	0.000081***	0.000081***	0.000081***	0.000081***
	(0.000019)	(0.000019)	(0.000019)	(0.000019)	(0.000019)	(0.000019)	(0.000019)	(0.000019)
Municipal Revenue 1982 pc	0.000021***	0.000021***	0.000021***	0.000020***	0.000020***	0.000020***	0.000020***	0.000019***
	(0.000005)	(0.000005)	(0.000005)	(0.000005)	(0.000004)	(0.000004)	(0.000004)	(0.000004)
Education attainment 1980	-0.000232	-0.000268	-0.000610	-0.000658	0.000325	0.000316	0.000032	0.000014
	(0.002118)	(0.002108)	(0.002125)	(0.002163)	(0.001857)	(0.001845)	(0.001839)	(0.001833)
Altitude	0.000009***	0.000009**	0.000009**	0.000009**	0.000010***	0.000010***	0.000010**	0.000010**
	(0.000004)	(0.000004)	(0.000004)	(0.000004)	(0.000004)	(0.000004)	(0.000004)	(0.000004)
Constant	yes	yes	yes	yes	yes	yes	yes	yes
Observations	458	458	458	458	458	458	458	458
R-squared	0.263	0.263	0.269	0.261	0.294	0.294	0.298	0.307

Notes. Robust standard errors in parentheses. In columns 2 to 5, the dependent variable is housing growth during the period from 1980 to 2000. In columns 6 to 9, the period is from 1980 to 2010. The regressions are for different spline polynomial orders. The observations in the regressions are pooled ("Thresholds 1-6", i.e., municipalities with population up to 37,356). The relevant coefficient is the *per capita* FPM instrumented with the theoretical FPM from the Federal Decree 1,881/81.
*** p<0.01, ** p<0.05, * p<0.1

Table 11: Robustness 4:
Population Growth

Spline Polynomial Order	Population Growth 1980-1991 Thresholds 1-6	Thresholds 1-4
1st-order	-0.000259***	-0.000227**
	(0.000067)	(0.00009)
2nd-order	-0.000254***	-0.000214**
	(0.000067)	(0.000088)
3rd-order	-0.000238***	-0.000214**
	(0.000069)	(0.000092)
4th-order	-0.000294***	-0.000276**
	(0.000075)	(0.000109)
Observations	458	390

Notes. Robust standard errors in parentheses. The dependent variable is population growth during the period from 1980 to 1991. The observations in the regressions are pooled. "Thresholds 1-6" shows the results for municipalities with population up to 37,356, while "Thresholds 1-4" is for locations with population up to 23,772.
*** p<0.01, ** p<0.05, * p<0.1

Table 12: Placebo Test
Effects of FPM Transfers on Housing Growth

Spline Polynomial Order	Fake Thresholds Thresholds 1-6	Thresholds 1-4
1st-order	-0.000398***	-0.000433***
	(0.000095)	(0.00015)
2nd-order	-0.000499*	-0.001204
	(0.00028)	(0.001652)
3rd-order	-0.00135	-0.003655
	(0.002343)	(0.021684)
4th-order	-0.005315	-0.001568
	(0.044422)	(0.003214)
Observations	458	390

Notes. Robust standard errors in parentheses. The dependent variable is housing growth during the period from 1980 to 1991. Fake pooled thresholds are midpoints between real population cutoffs from Federal Decree 1,881/81. Midpoints are: 1^{st}) 11,887; 2^{nd}) 15,283; 3^{rd}) 20,337; 4^{th}) 27,169; 5^{th}) 33,961; 6^{th}) 40,753. The observations in the regressions are pooled. "Thresholds 1-6" shows the results for municipalities with population up to 37,356, while "Thresholds 1-4" is for locations with population up to 23,772.
*** p<0.01, ** p<0.05, * p<0.1

Table 13: Full Sample Regression Results: IV

	Dependent Variable: Δ Housing 1980/1991							
	Instrument: Theoretical FPM						Instrument: Δ theoretical FPM	
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
Per capita FPM in 1982	-0.000048***	-0.000044***	-0.000031***	-0.000018*	-0.000007	-0.000026*	-0.000006	-0.000028*
	(0.000010)	(0.000011)	(0.000010)	(0.000010)	(0.000011)	(0.000014)	(0.000012)	(0.000016)
Population in 1980		0.000000	0.000000***	0.000000***	0.000001***	0.000000**	0.000001***	0.000000**
		(0.000000)	(0.000000)	(0.000000)	(0.000000)	(0.000000)	(0.000000)	(0.000000)
(Population in 1980)^2			-0.000000***	-0.000000***	-0.000000***	-0.000000***	-0.000000***	-0.000000***
			(0.000000)	(0.000000)	(0.000000)	(0.000000)	(0.000000)	(0.000000)
(Population in 1980)^3				0.000000***	0.000000***	0.000000**	0.000000***	0.000000**
				(0.000000)	(0.000000)	(0.000000)	(0.000000)	(0.000000)
(Population in 1980)^4					-0.000000***	-0.000000**	-0.000000***	-0.000000*
					(0.000000)	(0.000000)	(0.000000)	(0.000000)
Per capita Income 1980						0.000038**		0.000037**
						(0.000017)		(0.000017)
Municipal Revenue 1982 pc						0.000014***		0.000014***
						(0.000005)		(0.000005)
Education attainment 1980						0.000290		0.000261
						(0.001876)		(0.001876)
Altitude						-0.000000		-0.000000
						(0.000004)		(0.000004)
Distance to State Capital						-0.000046***		-0.000046***
						(0.000005)		(0.000005)
Constant	yes	yes	yes	yes	yes	yes	yes	yes
Observations	567	567	567	567	567	567	567	567
R-squared	0.071	0.075	0.097	0.121	0.131	0.355	0.131	0.35
	First Stage							
F	1751.78	875.19	583.07	437.02	349.55	181.17	280.53	144.03

Notes. Robust standard errors in parentheses. The dependent variable is the growth rate in housing units between 1980 and 1991. The endogenous variable is the *per capita FPM* in 1982. The instrument in regressions (i) to (vi) is the predicted amount of FPM according to Federal Decree 1,881/81 in Brazil. The instrument in regressions (vii) and (viii) is the difference between the FPM amount generated by Federal Decree 1,881/81 and the amount generated by the previous FPM distribution rule from the 1967 Brazilian Constitution.
*** p<0.01, ** p<0.05, * p<0.1

in the specifications: population size (up to fourth-order polynomial), *per capita* income, *per capita* municipal revenue, education attainment, and altitude. Some covariates that appear in the simple correlation exercises of Section 3 have the expected sign. For instance, *per capita* income has a positive and significant coefficient. According to the conceptual framework, cities with higher productive/income attract migrants and they have faster-growing housing markets. I use other proxies for city productivity and I find that education has a non-significant coefficient. It is useful to note that the results in the full sample IV regression are somewhat similar to the ones with the pooled observations.

A caveat is that the current analysis may be capturing "regional convergence" or mean-reversion instead of housing growth due to a lack of intergovernmental transfers. Lower population is associated with less FPM, but not necessarily with lower FPM/revenue ratio or lower *per capita* FPM. In every regression I control for population size in the beginning of the period so the coefficient "Population" is controlling for the convergence effect. The consistent findings when I control for population support the claim that the impact found on housing growth is related to the distribution of grants.

7 Conclusion

This paper provides an empirical investigation of the incentive effects of intergovernmental transfers on housing markets. Using municipality-level data from Brazil, I show that municipalities with lower *per capita* transfers had a higher housing growth during the following decade. The identification approach was to use a quasi-experiment (a Brazilian federal decree that caused exogenous variation in the Fundo de Participação dos Municípios) to verify the impact of intergovernmental transfers on housing markets. Federal Decree 1,881/81 has created discontinuities in the distribution of FPM grants, but there was some non-compliance with respect to the predicted amount of FPM. Therefore, I use a Fuzzy Regression Discontinuity approach to tackle the problem. A positive aspect of the dataset used in this paper is that it was possible to carry out several robustness checks. I used different methods, sample sizes, time spans, instruments, and control variables. The main result of this paper was robust to several robustness checks.

The results of this paper add to the literature on the impacts of intergovernmental transfers in Brazil. Litschig and Morrison (2013) finds positive impacts of FPM transfers when it comes to schooling outcomes and poverty reduction. I show that places with a greater share of intergovernmental transfers present a slower-growing housing market. Both results seems to be compatible: communities with more intergovernmental transfers may spend money only on current residents (generating better educational outcomes), but they might be less willing to stimulate the housing market to avoid changing the composition of the city (i.e., increasing heterogeneity). On the other hand, places with less transfers need a faster-growing housing market because they need more revenue.

Land is one of the main sources of revenue for local governments in different countries. In the United States, property taxation plays an important role. In China, property taxes represent only a small part of local governments' budget, but land is public and local governments sell it so as to collect revenue. In Brazil, where (i) property taxation represents a small part of local government's budget and (ii) intergovernmental transfers (which are a function of the population size) represent a significant part of total revenue, land plays an "indirect role": it acts as an instrument to attract people and receive more intergovernmental transfers.

In Brazil, FPM is an unconditional transfer. According to the FPM distribution rule, the amount each municipality receives is a function of its population size. Therefore, there are incentives to use policies to attract people. While the rule is specific to Brazil, it sheds light on how government respond to fiscal incentives to maximize revenue. This lesson may extend to other countries. Different intergovernmental transfers programs may generate distinct incentives regarding land policy and other local-level policies. I argue that fiscal transfers to local government aim to combat regional inequality, but they can have an unintended impact: they may change the incentives regarding local housing markets.

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A Detailing the FPM fund

This appendix provides more details on the evolution and characteristics of the FPM ("Fundo de Participação dos Municípios") fund. Particular attention is given to changes in the FPM distribution rule as well as to the relationship between revenue sharing and municipalities' detachments.

In 1965, the Constitutional Amendment 18/1965 created FPM. The FPM fund comprises a share of two relevant national-level taxes: the income tax and the industrial-product tax. The income tax is historically the second most important tax in Brazil, after the state-level VAT (i.e., when one considers the sum of VAT tax of all states from the Brazilian federation). As a rule of thumb, the income tax revenue is roughly 10 times larger than the revenue from the industrial-product tax.

The FPM fund has increased in importance over the years. For instance, in 1969, the FPM represented only 5% of the Income tax and the Industrial-Product tax. In 1981, it represented 10% of the two federal taxes, while by 2007 the FPM represented 23.5% of the two aforementioned federal taxes. Table A.1 shows the evolution of the share of FPM as well as the corresponding legislation.

Table A.1: FPM Participation in terms of Federal Taxes

Year(s)	Legal Instrument	Share of Federal Taxes*
1967/68	Constitutional Amend. 18/65	10,0%
1969/75	Decree 40/68	5,0%
1976	Constitutional Amend. 5/75	6,0%
1977	Idem	7,0%
1978	Idem	8,0%
1979/80	Idem	9,0%
1981	Constitutional Amend. 17/80	10,0%
1982/83	Idem	10,5%
1984	Constitutional Amend. 23/83	13,5%
1985	Idem	16,0%
1985/88	Constitutional Amend. 27/85	17,0%
1988	New Federal Constitution	20,0%
1989	Idem	20,5%
1990	Idem	21,0%
1991	Idem	21,5%
1992	Idem	22,0%
1993	Idem	22,5%
2007	Constitutional Amend. 55/2007	23,5%

Source: Ministry of Finance, Brazil
*Income Tax and Industrial-Product Tax.

At the outset of the sharing mechanism, the federal government required the municipalities to spend the FPM money only on specific programs. However, in 1979 the aforementioned requirement changed and municipalities were given the right to spend the FPM money with full autonomy. Only in 1996 the Constitutional Amendment 14/1996 slightly changed the rules: it stipulated that, from 1998 on, 15% of FPM resources had to be allocated to expenditures on education. In this paper, FPM was classified as an unconditional transfer since the main period of analysis is from 1980 to 1991.

The first rule regarding the distribution of the FPM fund was created by the 1967 Constitution. Table A.2 details how the step function created by the 1967 Constitution worked. In 1981, the Federal Decree n. 1,881/81 reformulated the rules regarding the distribution of FPM. Table A.3 shows the population ranges and their respective coefficients of the FPM distribution rule created by the Federal Decree 1,881/81. Notice that Figure

2(c) shows that municipalities with population between 6,000 and 156,216 have a smaller coefficient from the "Federal Decree 1,881/81 rule" than from the "1967 Constitution rule". Therefore, those municipalities would receive a smaller amount of fiscal transfers because of the federal decree. The problem is that two factors can generate an increase in the FPM transfers even after the changing coefficients. Recall that the FPM fund is a share of the total revenue from Federal Income and Industrial-Product Taxes. Therefore, any increase in those federal taxes induces an increase in the FPM transfer. Additionally, during the 1980's, several pieces of legislation increased the share FPM represents out of the two aforementioned federal taxes (as shown by Table A.1). In fact, during the 1980's, 1983 was the only year in which there was a drop in the real value of FPM fund.

Table A.2: FPM Revenue: Distribution Rule before 1981

Population	Coefficient	Number of Municipalities			
		Brazil		São Paulo State	
		1970	1980	1970	1980
Up to 2,000	0.2	57	58	6	9
2,001 to 4,000	0.4	363	383	69	94
4,001 to 6,000	0.6	500	466	112	83
6,001 to 8,000	0.8	440	384	72	56
8,001 to 10,000	1	393	362	43	32
10,001 to 14,000	1.2	584	549	71	69
14,001 to 18,000	1.4	400	407	41	44
18,001 to 22,000	1.6	284	273	32	34
22,001 to 26,000	1.8	198	212	21	14
26,001 to 30,000	2	127	144	15	21
30,001 to 36,000	2.2	160	158	18	14
36,001 to 42,000	2.4	120	114	16	11
42,001 to 48,000	2.6	62	86	5	12
48,001 to 54,000	2.8	47	70	10	12
54,001 to 60,000	3	34	51	5	10
60,001 to 68,000	3.2	37	47	5	7
68,001 to 76,000	3.4	14	39	1	8
76,001 to 84,000	3.6	16	19	2	2
84,001 to 92,000	3.8	11	19	2	3
Above 92,000	4	104	150	25	36
	Total	3,951	3,991	571	571

Source: 1967 Constitution of Brazil.

Revenue sharing has an important association with municipalities detachments over time. While other factors may be important, such as redemocratization during the 1980's, FPM incentives to subdivision are likely to be important as well. According to the "Ato Complementar" 35/1967, every five years (starting from 1970) there would be a revision of the Population Count so that a "detached" municipality would start to receive its "fully deserved" FPM amount. However, between each Population Count, the detached municipalities would have to share the FPM money with its "mother" municipality, proportionally to the population size of each part. In this way, if a new municipality was created in 1971 after a detachment, it would have to share the FPM money with the mother municipality and wait until 1975 to start to receive its full FPM amount. The Supplementary Law 59/1988 changed the incentives to subdivision: from 1989 on a newly created municipality would receive its full resources of FPM in the next fiscal year.

In this paper, I use the municipalities in São Paulo state as the main focus of analysis. Figure A.1 shows the location of São Paulo state in Brazilian territory. The changes stipulated by Federal Decree 1,881/81 were *permanent* for the municipalities in São Paulo state, i.e., if a municipality was in a certain position in the step function in 1982, it would

Table A.3: FPM Revenue: Distribution Rule after 1981

Population	Coefficient	Number of Municipalities					
		Brazil			São Paulo State		
		1980	1991	2000	1980	1991	2000
Up to 10,188	0.6	1,688	1,839	2,668	278	249	297
10,189 to 13,584	0.8	470	552	609	62	60	54
13,585 to 16,980	1	350	395	423	37	27	35
16,981 to 23,772	1.2	470	561	561	52	55	51
23,773 to 30,564	1.4	277	291	338	28	26	38
30,565 to 37,356	1.6	168	174	194	16	29	30
37,357 to 44,148	1.8	120	139	122	9	17	13
44,149 to 50,940	2	88	86	74	16	14	14
50,941 to 61,128	2.2	93	92	88	18	10	13
61,129 to 71,316	2.4	57	70	81	7	14	12
71,317 to 81,504	2.6	36	48	62	9	8	14
81,505 to 91,692	2.8	24	40	34	3	9	3
91,693 to 101,880	3	17	22	29	4	6	9
101,881 to 115,464	3.2	15	22	33	1	8	10
115,465 to 129,048	3.4	18	20	19	5	1	4
129,049 to 142,632	3.6	9	7	19	2	2	5
142,633 to 156,216	3.8	11	14	11	3	4	3
Above 156,216	4	80	119	142	21	33	40
	Total	3,991	4,491	5,507	571	572	645

Source: Federal Decree n. 1,881/81.

stay in the same position in the following years. A municipality could change its position in the step function only because of three factors: (i) an increase in its population; (b) a decrease in its population; and (c) splits and detachments. During 1982-1985, the population of the 1980 Population Census was used to calculate the distribution of resources so no municipality could change its position in the step function. In 1985, a population estimate calculated by IBGE was used to allocate FPM grants. According to the 1985 population estimates, some municipalities have gone up and others down in the step function. The ones that are going up tell that my mechanism is at work; the ones that went down did so mostly because of splits and detachments. I will illustrate this point by presenting a hypothetical example. One could find a municipality with population of 12,000 in the second interval of the step function and, because of a detachment, now one could find two smaller municipalities both in the first step function (e.g., one with population of 8,000 and the other with 4,000). The Official Bureau of Statistics considered the splits and detachments that took place during the mid 1980's to estimate the population in 1985. Table A.4 shows that the population estimate of 1985 virtually did not affect the position in the FPM step function of the municipalities from São Paulo state.

Table A.4: Transition Matrix of FPM Step Function - from 1980 until 1991

Period	São Paulo State			Brazil		
	Downward	Same	Upward	Downward	Same	Upward
1982 to 1985	2	565	1	92	3,774	20
1982 to 1989	11	357	199	277	2,377	1,233
1982 to 1991	7	329	233	342	2,391	1,159

Notes. Data from TCU, various reports. The numbers only include municipalities that existed in 1980, so it excludes new municipalities from detachments and splits.

Fig. A.1: Map of Brazil and São Paulo State

B Housing Stock and Population Growth in Brazil

What is the relationship between population and housing stock in Brazil? In order to provide evidence on this question, I run several OLS regressions in order to get correlations. I start with three regressions associating housing level to population level - for Censuses years 1980, 1991 and 2000 - as follows:

$$\ln(Housing_i) = \alpha + \beta \ln(Population_i) + u_i.$$

Table A.5 shows that the relationship between population and housing stock is very strong. The R-squared of regressions (i), (ii) and (iii) are very high and fluctuate between 0.987 and 0.992. Glaeser, Gyourko, and Saks (2006) point out that similar regressions using U.S. data also show quite tight correlation between housing units and population size (R-squared around 0.99).

I turn now to the association between population growth and housing stock growth. I run the following regression:

$$\Delta Housing_i = \alpha + \beta \Delta Population_i + u_i.$$

Regressions (iv) and (v) of Table A.5 show that the growth-growth association is still strong (R-squared equals to 0.889 and 0.924, respectively). Note that regressions (iv) and (v) have 3,659 observations because I use the Minimum Comparable Area classification to abstract from the detachments of municipalities that took place in Brazil. U.S. figures of the growth-growth regressions are again quite similar (Glaeser, Gyourko, and Saks (2006)). One important difference is that, while the correlation between population growth and housing growth has decreased over time in the US case (Glaeser, Gyourko, and Saks (2006)), the same correlation has increased over time in the Brazilian case. More specifically, in the U.S., regression 6 for the 1990's generated a coefficient of 0.765 and a R-squared of 0.81. The results of the equivalent Brazilian regression are somewhat closer to a perfect line. Indeed, the results of regressions (iv) and (v) of Table A.5 show us that the housing sector responds almost entirely to population growth. One important feature of the

Table A.5: Housing and Population OLS Regressions: Stock vs. Growth

	(i)	(ii)	(iii)	(iv)	(v)
		ln Housing		Δ Housing	
VARIABLES	1980	1991	2000	1980-1991	1980-2000
ln Population 1980	1.007***				
	(0.00152)				
ln Population 1991		0.994***			
		(0.00174)			
ln Population 2000			0.992***		
			(0.00152)		
Δ Population 1980-1991				0.909***	
				(0.0125)	
Δ Population 1980-2000					0.914***
					(0.00553)
Constant	-1.668***	-1.412***	-1.281***	0.0148***	0.0143***
	(0.0144)	(0.0164)	(0.0142)	(0.000169)	(8.77e-05)
Observations	3,991	4,491	5,507	3,659	3,659
R-squared	0.992	0.987	0.987	0.889	0.924

Notes. Robust standard errors in parentheses. Level regressions are for municipalities in 1980, 1991 and 2000. Growth regressions are for 3,659 Minimum Comparable Areas (MCAs) in Brazil. *** p<0.01, ** p<0.05, * p<0.1

Brazilian housing market is the existence of a quite significant informal housing sector. This might explain why the housing sector in Brazil seems to react more to population growth.