The Effects of Better Houses on Infant Health

Cecilia Machado* Laísa Rachter†

December 2020

Abstract

This paper examines the effects of better houses on infant health in the context of Brazil's *Minha Casa Minha Vida* program, which built roughly 900,000 houses to poor households in Brazil during the period 2010-2017. We use a regression discontinuity design and administrative data to estimate the program's effects on health at birth and infant health. We find the program reduced the share of households living in inadequate houses by 18 percentage points. We find this improvement in housing conditions led to increases in birth weight and decreases in infant (before 1 year) mortality caused by conditions originating in children's perinatal period. We find no effect of the program in children with more than one year. Our results point out the importance of better houses in improving health at birth.

Keywords: *Housing Policies, Discontinuity, Health Outcomes*

*FGV EPGE (e-mail: cecilia.machado@fgv.br).
†FGV EPGE (e-mail: laisa.rachter@fgv.br).

1 Introduction

Health at birth is an important determinant of physical and mental health, human capital accumulation, and income (Gluckman et al., 2005; Cunha & Heckman, 2007; Currie, 2009). Nevertheless, while there is a growing body of empirical work documenting the role of shocks during fetal development on health at birth (e.g., (Almond & Currie, 2011; Almond et al., 2018)), there is much less evidence on the role of the environment in which the mothers live on fetal development and health at birth.

In this paper, we examine the effects of housing conditions on health at birth, exploring exogenous changes in housing conditions coming from investments of the *Minha Casa Minha Vida* Program (hereafter, MCMV). The MCMV is a series of initiatives introduced in the late 2000s focused on helping households become homeowners. It is divided into different segments according to the income of the beneficiaries. We focus on segment I of the program. In this segment, the federal government provides funds for the construction of heavily subsidized houses for poor households (monthly income below R$ 1,600 or US$ 320 at the current exchange rates). We obtain causal estimates of the construction of these houses exploring differences in the MCMV rules that facilitated municipalities with a population above 50,000 inhabitants to obtain funds from the program. This enables us to use a Regression Discontinuity (RD) design to estimate the effects of the MCMV program on health outcomes for municipalities close to the 50,000 inhabitants cutoff.

We begin by exploring the MCMV contracts' data to document the program's investments increase at the 50,000 population threshold. We find that the number of houses delivered by the program increases by 300-350 units during the period 2011-2017 at the 50,000 inhabitants threshold. This corresponds to 14-18% of the housing deficit of the typical municipality to the left of the discontinuity.

We then explore data on birth outcomes to document the program's effects on health at birth. We find that the birth weight increases by 12.9-15.6 grams at the 50,000 inhabitants

threshold during 2011-2017. This effect is robust to different bandwidths and weighting procedures and statistically significant at the 5% levels regardless of the specification. Its magnitude corresponds to 0.4-0.5% of the mean birth weight in the sample. This is comparable to the effect of fasting during Ramadan on birth weight (see Almond & Mazumder (2011)) and the effect of job losses through announced notices during pregnancy (see Carlson (2015)). The increase in birth weight is driven by a combination of gestational length changes and birth weight conditional on gestational age (small for gestational age, thereafter SGA).[1] The share of pregnancies of less than 32 weeks decreases 0.2 p.p. (13% of the mean) while the share of SGA births decreases 0.8 p.p. (7.8% of the mean) at the discontinuity.

The effects of the MCMV on birth weight reflect a combination of changes in housing quality, housing costs, and labor market conditions. We use the timing of the effects to disentangle between these mechanisms. The program is expected to temporarily improve labor market conditions during the construction of the houses, improve housing quality, and permanently reduce housing costs after the houses are delivered. Thus, we expect the effects of the construction to be stronger in the program's early periods (when the program's investments are at their peak, but the number of units delivered is modest) and the effects of housing quality and costs to be stronger in the program's final periods (when the program's investments fall but the number of units delivered is considerable). We find the MCMV effects increase weakly through time, going from a statistically insignificant effect of fewer than 10 grams in 2011 to a statistically significant effect of more than 20 grams in 2017. This is suggestive evidence that the effects are driven primarily by housing quality and costs.

We further examine the effects of the MCMV on children's morbidity and mortality from 0-1 and 1-5 years. We test the program's effects on overall hospitalization and mor-

[1] SGA newborns are those who are smaller in size than normal for the gestational age, commonly defined as a weight below the 10th percentile for the gestational age (Villar et al., 2014).

tality rates and hospitalization and mortality rates by causes. We focus on causes most strongly connected to housing conditions and sanitation, and consider infectious, nutritional, and respiratory diseases, and perinatal origin's affections (also the main drivers of infant/child morbidity and deaths (Organization et al., 2019). For children between 0-1 year, we find no effects of the MCMV on morbidity. However, there is a negative and statistically significant effect on mortality due to perinatal conditions of 1.1 deaths per 1,000 births.[2] This is consistent with the findings that the program improves health at birth. For children between 1-5 years, we find no effects either on morbidity or mortality.

There are several studies documenting positive effects of housing programs on different measures of adult health (e.g., Katz et al. (2001), Ludwig et al. (2013), Gale (2018) for the U.S., Barnhardt et al. (2017) for India, and Franklin (2019) for Ethiopia). There are also several studies documenting the positive effects of slum upgrading initiatives on the prevalence of diarrhea and respiratory problems on children (e.g., Cattaneo et al. (2009) and Galiani et al. (2017)). However, there is considerably less evidence linking housing policies and increases in housing quality with health at birth. We contribute to this literature by documenting the meaningful effects of a housing program in Brazil on infant health.

The health externalities our work uncovers have important implications for the debate on the design of housing policies. The UN estimates that close to 900 million people live in these poor housing conditions in cities throughout the developing world. To deal with this issue, governments typically invest heavily in constructing houses for poor households in the cities' peripheries. However, there is concern these programs hurt households as moving to peripheries might increase the distance to job opportunities, thereby reducing employment and earnings and inducing households to return to their original neighborhoods (e.g., Barnhardt et al. (2017) and Picarelli (2019)). We contribute to this literature

[2]Hospitalizations or deaths due to perinatal conditions are hospitalizations or deaths connected to the health at birth. While most of these events occur in the neonatal period (up to 28 days of life), they can happen at all ages.

by documenting that, despite their negligible or negative effect on adults' economic outcomes, the construction of houses for poor households improves the health outcomes of children. Because improvements in infant health generate long-run benefits in terms of human capital and income (e.g., Gould et al. (2011) and Lavy et al. (2016)), this suggests that the long-run return of these programs might differ substantially from their short-run return. This distinction between effects on adults and children has proved important in other settings (e.g., Chetty et al. (2016) and Kumar (2019)), and is suggestive housing programs might have substantially different intra and inter-generational effects.

This discussion of the effectiveness of housing programs in general mirrors the effectiveness of the MCMV program in particular. The literature on the program finds no effects of the MCMV on employment and earnings (Pacheco, 2019; Squarize Chagas et al., 2019; Belchior, 2019). Our work shows that, despite its negligible effect on adults' economic outcomes, the MCMV improves the health outcomes of children. Furthermore, we provide evidence that this effect is important for assessing the program's cost-effectiveness.

The rest of the paper proceeds as follows. Section 2 provides a description of MCMV program. Sections 3 describes the data construction. Section 4 presents the empirical strategy. Section 5 provides a theoretical discussion of how house infrastructure may affect health outcomes. Section 6 present the results and discussion. Section 7 concludes.

2 Context and Background

This section describes the institutional background of the *Minha Casa Minha Vida* (MCMV) program focusing on the features relevant to our empirical investigation.

2.1 The *Minha Casa Minha Vida Program*

The *Minha Casa Minha Vida* (MCMV) program was created in the late 2000s to provide housing for low and middle-income households in Brazil. In the period 2010-2017, the program financed the construction of about 5.5 million houses at a total cost of R$464 billion (US$ 92.8 billion at the current exchange rates).

The MCMV is divided into four segments according to the income of the beneficiaries. Segment 1 covers households with income up to R$ 1,600 per month (US$ 320 at current exchange rates); Segment 1.5 covers households with income up to R$ 2,600 per month (US$ 520); Segment 2 covers households with income up to R$ 4,000 per month (US$ 800); and Segment 3 covers households with income up to R$ 9,000 per month (US$ 1,800). Each segment has access to different types of benefits. For segment 1, the government subsidizes 90% of the cost of the houses and provides financing to the other 10% at zero interest rates. For the other segments, the government provides financing to the households at subsidized rates starting at 5% per year.[3]

Our work focuses on households in segment 1. We observe roughly 900,000 units built with MCMV financing were destined for households in this segment. Different from the other segments, its houses are not sold in the market. Instead, they are allocated by local governments and, to a lesser extent, non-government organizations. Its resources come from the federal government budget and are managed and channeled by *Caixa*, a stated-owned bank specialized in mortgage financing. This bank is responsible for certifying

[3]The interest rate in Brazil on December 2010 was 10.66% per year (see https://www.bcb.gov.br/controleinflacao/historicotaxasjuros.

construction companies, contracting housing projects, and providing funding subsidized for an eligible household.[4].

Three different initiatives focused on building houses for households in segment 1: MCMV-FAR, MCMV-*Sub-50*, and MCMV-Entities. The MCMV-FAR targets poor households living in municipalities with more than 50,000 inhabitants. This is the main MCMV initiative focused on segment 1. Data on MCMV contracts from *Caixa* indicates that a total of 785,286 units were built under this initiative until 2017. This represents more than 86% of the units built for segment 1. Local governments run the MCMV-FAR. They are responsible for contracting construction companies to implement the projects and for selecting beneficiaries. Municipalities must follow guidelines issued by *Caixa*. However, there is no direct interference of neither the federal government nor *Caixa* in this process. Households were required to register for the program either online or at municipal offices. Local officers organized the selection of beneficiaries (ideally using the lotteries) among registered households. The project's construction typically ends one to two years after the selection of beneficiaries occurred. When the units' construction finishes, the beneficiaries are invited to sign their contracts with *Caixa*.

The MCMV-Entities also targeted households living in municipalities with more than 50,000 inhabitants. However, unlike the MCMV-FAR, the projects' execution and the selection of beneficiaries focuses on the active participation of homeless people's movements, such as Homeless Workers' Movement. These social movements engage in the development of the housing project, managed the project's execution and budget, and select beneficiaries. It is a small initiative with 22,035 units being built under it until 2017. This represents 2.4% of the segment's 1 contracts and less than 1% of the total resources invested in the program(Tatagiba & Teixeira, 2016).

The MCMV-*Sub-50* initiative targets poor households living in municipalities with

[4]Houses in the other three segments are built and sold by private construction companies with *Caixa* providing financing to the buyers.

less than 50,000 inhabitants. In this initiative, the federal government subsidizes housing units' construction in these municipalities through contracts with local governments, local companies, or self-construction efforts organized by the communities themselves. The selection of projects to be subsidized occurs through public notices issued by the federal government. It is important to note that the MCMV-*Sub-50* did not exist when the MCMV was created. It emerged later as the result of lobbying efforts of officials from municipalities of less than 50,000 inhabitants. However, from its beginning, this initiative encountered numerous problems for its implementation. Indeed, it missed the target of constructing 200,000 units until 2017, with 101,612 being delivered until this period, 11.5% of the total units built.

The contrast between the rules of the MCMV-FAR and the MCMV-*Sub-50* indicates municipalities with more than 50,000 inhabitants find it much easier to get a house from the MCMV than municipalities with less than 50,000 inhabitants. This reflects in the number of signed contracts under the different initiatives of the MCMV described above and in the amount of government funds on each modality. While the MCMV-*Sub-50* received R$ 1 billion in subsidies, the MCMV-FAR received R$ 16.5 billion in subsidies (Biderman et al., 2019). Our work explores the different intensities of the MCMV investments to obtain causal estimates of the construction of these houses. Specifically, we explore the differences in the MCMV rules that facilitated municipalities with a population above 50,000 inhabitants to obtain funds from this program. This enables us to use a Regression Discontinuity (RD) design to estimate the effects of the MCMV program on health outcomes for municipalities close to the 50,000 inhabitants cutoff.

2.2 The Roll-Out of the *Minha Casa Minha Vida*

To understand the program's roll-out, Figure 1 depicts the number of contracts of segment I of the MCMV by year. The first contracts of the program are signed in 2010. The number of contracts expands rapidly between 2010 and 2012, stabilizes between 2012-2016, and

ends in 2017. A total of 886,898 contracts were signed between poor urban households and *Caixa*[5].

As explained before, the different rule for obtaining investments from the MCMV for municipalities of different sizes implies that the program's roll-out might differ substantially between municipalities of different sizes. Figure 2 shows this is indeed the case. It plots the accumulated number of signed contracts signed in municipalities with 40,000-50,000 and municipalities with 50,000-60,000 inhabitants. Panel A reports the average number of contracts per municipality, while Panel B the number of contracts as a proportion of the housing deficit in 2010. Both panels report large differences in the program's investments in the two groups. About 170 houses were delivered for the typical municipality with a population between 40,000-50,000 between 2011-2017. This contrasts with about 520 houses delivered for the typical municipality with a population between 50,000-60,000 inhabitants. This represents about 20% of the housing deficit in these municipalities.

The differences in the MCMV investments by municipality population are driven mainly by abrupt changes in the program's investments at the 50,000 inhabitants threshold, as reported in Figure 3. This figure plots the mean number of contracts (Panel A) or the number of contracts divided by the housing deficit (Panel B) at fifteen population bins in the 20,000-80,000 inhabitants interval. There is hardly any relationship between the number of contracts or the number of contracts divided by the housing deficit below and above the 50,000 inhabitants threshold. This contrasts with the sharp change in the number of contracts at this threshold. This figure indicates the program's rules generate discontinuous changes in the MCMV investments, thereby implying it is possible to estimate the program's effects using a Regression Discontinuity (RD) design.

[5]This number considers the MCMV-FAR and MCMV-*sub50*.

2.3 The *Minha Casa Minha Vida*, Housing Quality, and Housing Costs

The poor conditions of the houses in which most of Brazil's poor population suggest the MCMV beneficiaries might experience significant improvements in housing quality. The program's units must have at least two bedrooms, a living room, a kitchen, and a bathroom. Its minimum surface area is 37 m^2 (roughly 400 sq^2). Besides, the project's location must follow some minimum requirements in terms of environmental planning, sewage treatment, connection to the water network, etc. [6] These characteristics contrast with the houses' characteristics in which the poor population lives in the country. According to the 2010 Population Census, 43.77% (14,588,592) of the households eligible for MCMV's segment I do not have access to proper sanitation[7] and that 4.12% (1,374,160 households) live in houses poorly built.[8] This suggests that MCMV investments might have increased housing quality markedly.

The MCMV beneficiaries might also have experienced significant decreases in housing costs. The government subsidizes 90% of the cost of the unit ($\approx$ R$ 50,000) and finances the rest in 120 months with no interest rates. This implies that the beneficiaries typically pay less than R$ 50 per month. According to the 2010 Population Census, the mean rent paid by households eligible for MCMV's segment 1 was R$ 252.45, a much larger number. Moreover, 3.8% (2,209,688) of the households in the segment I are considered in deficit due to excessive rent. This suggests that MCMV investments might have generated noticeable reductions in housing costs and, therefore, income increases.

Evidence for the municipality of Rio de Janeiro (RJ) presented in chapter 1 corroborates these hypotheses. Exploring the lotteries used to select the program's beneficiaries, we document that the MCMV reduced housing costs and improved housing quality. It is

[6]These requirements were instituted by the Provisional Measure 459 enacted in March 2009. This provisional measure was later converted into Law #12,424 enacted in June 2011.

[7]with no access to water and sewage network

[8]defined as improvised households or permanent households (houses or apartments) made of material other than masonry or paired wood.

certainly not possible to extrapolate the evidence from Rio de Janeiro to our setting of mid-size municipalities. However, this evidence highlights the potential connection between MCMV investments, housing quality, and housing costs.

3 Data

3.1 Data Sources

We use data from multiple data sources. To obtain information on MCMV housing contracts, we use official data of the program's contracts obtained from *Caixa*.[9] To generate health outcomes on the municipality level, we use health data at birth, hospital admissions, and mortality from the Brazilian Ministry of Health (MS/DATASUS). Furthermore, to generate information on demographic and socio-economic characteristics, we use the 2010 Population Census. We describe each data source in detail below.

Contracts. *Caixa* provides information on the 886,898 mortgages signed by the beneficiaries of the MCMV program from 2010 to 2017. The data is at the individual level. We have information on the date the contract was signed and the municipality of each contract's housing project. Using this data, we construct a municipality-level panel of the number of signed contracts by year. During the period, individuals from 1,671 municipalities signed contracts to purchase subsidized houses from segment 1 of MCMV under MCMV-FAR and MCMV-*sub50*. From these municipalities, 1,174 had population below 50,000 inhabitants and 497 above this threshold.

Health Outcomes. We construct a dataset on health at birth, infant and child morbidity, and mortality outcomes, combining microdata from the Brazilian National System of Information on Birth Records (Datasus/SINASC), the Brazilian National System of Hospital Admissions (Datasus/SIH), and the Brazilian National System of Mortality Records (Datasus/SIM).

The birth records (Datasus/Sinasc) provides information on birth weight, length of gestation, and APGAR score. The database also provides the exact date of birth and the municipality of birth. This information allows us to construct a municipality-by-year of

[9] Information made available using the Access to Information Requirement number 99902.001060/2017-08.

the birth panel over the 2009-2017 period containing information on the number of births, average birth weight, and the average length of the gestational period.

Hospitalization microdata is obtained from the National System of Information on Hospitalizations (Datasus/SIH), which contains administrative information at the hospital admission level and is managed by the Health Care Agency (SAS/Ministry of Health). The system includes all hospital admissions covered by SUS, both in public facilities and private hospitals accredited by the government. It provides information on patients' age, gender, and cause of hospitalization (ICD-10).[10]

We obtain mortality microdata from the Brazilian National System of Mortality Records (Datasus/SIM), which collects every death officially registered in Brazil. It contains data on deaths by cause (also following ICD-10), birth date, municipality of birth, and residence. We select all deaths of individuals up to one year of age born between 2009 and 2017 and deaths of individuals from one to five years old in the same period. We then build a municipality-by-year death panel for the 2009-2017 period containing information on the number of infant and child deaths (total and by cause of death).

Both SIH and SIM microdata sets include patients' municipality of residence and the date of the hospital admission or death. The date of the event and the code of the municipality of residence are used to aggregate the microdata into a municipality-by-year data set and to match it with data from other sources. We follow the literature on the health impacts of houses and access to sanitation and focus specifically on infectious diseases, nutritional diseases, respiratory diseases, and diseases with perinatal origin's (these are also the main drivers of infant/child morbidity and deaths).[11].

To facilitate comparisons across municipalities and time, we compute health outcomes (such as hospitalizations and mortality) in rates per 1,000 municipality births in the last

[10]The diagnostic codes follow the International Classification of Diseases, 10th Revision (ICD-10).

[11]Infections diseases refer to events classified under ICD-10 A00-B99; digestive diseases refer to events organized under ICD-10 E00-E90); respiratory conditions refer to events classified under ICD-10 J00-J99; conditions originated in the perinatal period refers to events classified under ICD-10 P00-P96

year for infants. We approximate that accumulating the previous four years of births for children aged 1-5 years old.

Other data. We use other sources of data to conduct the analysis. We collect municipality level data on the population size in 2007 (before MCMV) from the population count conducted by the Brazilian Census Bureau (IBGE). We construct an indicator of baseline characteristics using the 2010 Brazilian Census. We construct information on socioeconomic indicators such as the shares of females, young (<18), adults (>28), old (>60), the share of households located in rural areas, the total number of households, the share of migrants, the share of workers, the average wage, the share of individuals with less than 9-11 years of education, the share with less than 12-15 years of education, the share of people with 16 or more years of schooling, the share of workers, and the average wage (in R$). We also construct information on infrastructure characteristics such as the percentage of households with access to piped water and households with access to sanitation. We get information on housing deficit at the municipality level using data from the 2010 Population Census using the methodology proposed by Furtado et al. (2013). Finally, we use information on health inputs from CNES/Datasus. We calculate the number hospital beds, the number of hospitals, and the coverage of the Family Health Program in the municipality.

Merge. The information on births and infant/child mortality and hospital admission is merged by municipality and year with the MCMV contract data and the other datasets described above. The average number of contracts per year is 14. Table B1 presents descriptive statistics of our main variables for all municipalities and for the 235 municipalities between the 40,000 and 60,000 inhabitants that are the focus of our empirical analysis. These municipalities have a total of 11,380,994 inhabitants, accounting for 6.2% of the country's population. Their average population is 48,429, higher than the 33,063 average population observed in the country as a whole. The municipalities around the threshold are similar to the country in terms of age structure, labor and schooling charac-

teristics. They are less less rural and have worse sanitation indicators. Birth characteristics and morbidity and mortality characteristics are similar to the country's statistics. The average birth weight is 3.2 kg, and 9% of pregnancies last less than 37 weeks. The infant hospitalization rate is 184 per 1000 births per year. For children, the hospitalization rate is 68 per 1000 births. Mortality under 1 is 14 per 1000 births, while mortaility from 1 to 5 is 0.71 per 1000 births.

4 Empirical Strategy

Estimating the effects of large-scale government investments such as the *Minha Casa Minha Vida* is challenging because the allocation of these investments is typically correlated with factors like political favoritism or economic potential. This implies that comparisons of regions more affected by these programs ("treatment") with regions less affected by them ("control") will be biased. Moreover, because the direction of the correlation between the factors governing the investments and the outcomes of interests mith be positive or negative, the direction of bias is unknown. For instance, it is unclear whether the unobserved factors which influence the investments of the MCMV are positively or negatively related to infant health.

To overcome these issues, we use a Regression Discontinuity (RD) design to obtain causal estimates of the effects of the MCMV program on health outcomes. Our empirical framework explores a program's rule that facilitated access of municipalities with more than 50,000 inhabitants to this program's funds. As detailed in Section 2, municipalities with less than 50,000 inhabitants had to submit proposals to be evaluated by the federal government before obtaining financing to built houses with funds of the MCMV program, while municipalities with more than 50,000 inhabitants could obtain these funds directly with *Caixa*. This enables us to use RD to estimate the effects of the MCMV program on municipalities' health outcomes close to the 50,000 inhabitants cutoff.

We implement our RD design using a local linear regression approach following the guidelines from Imbens & Lemieux (2008), Lee & Lemieux (2010), and Gelman & Imbens (2019). Formally, we use the following model to obtain RD estimates of the effects of the MCMV on infant health:

$$Y_{its} = \beta_0 + \beta_1 T_{is} + f(P) + \beta_2 Y^I_{is} + \gamma X_{is} + \eta_s + \eta_t + \nu_{its}, t \in [2011, 2017] \quad (1)$$

in which $T_{is} = 1[P_{is} > 50,000]$, $f(P)$ is a linear spline ($f(P) = \mu P_{is} + \varphi P_{is} \times T_{is}$), and $P_{is} \in [50,000 - h, 50,000 - h]$. Y_{its} denotes an outcome of interest of municipality i, year t and state s, P_{is} is the population of the municipality measured, T_{is} is a treatment indicator which is one if the municipality population is above 50,000, Y^I_{is} is the baseline value of the outcome of interest, X_{is} is a vector of municipality controls (measured in 2010), η_s is a state-fixed effect, and h is the bandwidth chosen to select the municipalities used in the estimation. The coefficient of interest is β_1 which measures the difference in outcomes of municipalities just below and above the 50,000 inhabitants threshold.

The outcomes of interest Y_{its} are measured in 2011-2017. This is the period for which we observe most of the MCMV contracts being signed.[12] The initial conditions Y^I_{is} and the controls X_{is} are measured in 2009 and 2010, i.e., immediately before MCMV investments began. The controls included are the share of rural households, the baseline access to the water and sewage networks, and health infrastructure indicators. We include initial conditions, controls, and state fixed effects to improve our estimates' precision as it is common in the literature.[13]

We estimate equation (1) using a preferred bandwidth of 10,000 inhabitants. This results in a sample of 1,645 observations (235 municipalities per year). We fix the bandwidth (instead of choosing the bandwidth optimally as proposed by Calonico et al. (2014)) to ensure the set of municipalities choice does not drive our results estimation. However, we provide evidence that the results are robust to using these authors' optimal bandwidth. We further show that the optimal bandwidth is close to 10,000 for most of the outcomes. We use a triangular kernel to put more weight on the observations close to the discontinuity but provide evidence that results are unchanged if we use a rectangular kernel. We cluster standard errors at the municipality-level to allow for arbitrary correlation of municipalities' error term across time.

[12] There is a small number of contracts signed in 2010 but their number is negligible.

[13] See Burlig & Preonas (2016) and Asher & Novosad (2020) for recent examples of papers using eligibility rules to obtain RD estimates of large-scale government programs.

The effects of the MCMV program estimated using equation (1) pool together the effects of houses and their construction on infant health. To separate these effects, we estimate period-specific effects of the MCMV on infant health by estimating the following equation:

$$Y_{its} = \beta_0 + \sum_{k=2011}^{2017} \beta_{1k} T_{is} \times 1[\text{Year} = k] + \beta_2 f(P) + \beta_3 Y_{is}^I + \gamma X_{is} + \eta_s + \eta_t + \nu_{is}, \quad (2)$$

The coefficients β_{1k} measures the difference in municipalities' outcomes just below and above the 50,000 inhabitants threshold. If the program's effects on infant health operate through houses, we expect this coefficient to increase through time. If the effects of the program on infant health operate through house construction, we expect this coefficient to die out as houses' construction diminishes. The next section discusses this in detail.

4.1 Threats to the Validity

Our regression discontinuity estimates have causal interpretations under three assumptions. First, the RD design requires it is not possible to manipulate the running variable at the threshold. This is an important concern in our setting since it is not clear about the municipality population the government uses in the MCMV program. We opt to use the official count of the population from 2007 as our running variable. This was the most recent source of population data when the program was announced. While using the past population might add noise to our estimates, it ensures municipalities could not manipulate the running variable. Figure 4 provides evidence that the running variable's distribution is smooth around the cut-off. In Panel A, we show that the number of municipalities falls smoothly with the municipality size. In panel B, we formally test the difference in the distribution near the cut-off using the McCrary test (McCrary, 2008). This test examines whether there is a discontinuity in the distribution of the running variable around the cut-off. Its test statistic is 0.268 (s.e. = 0.246). Hence, there is no evidence that our assignment

was manipulated.

Second, the RD design requires continuity of the municipality outcomes other than the number of houses built under the MCMV program at the threshold. Table 1 provides support for this hypothesis. It reports that socioeconomic characteristics (measured in 2010) and infant health (measured in 2009 and 2010) are similar for municipalities slightly below and above the 50,000 inhabitants cut-off. Not only the coefficients are insignificant, but their magnitude is typically small.

Third, the RD design required no other policies which change close to the 50,000 inhabitants threshold. We mapped two other policies using population cut-offs near this threshold to determine its investments: the sanitation investments from the PAC (*Programa de Aceleração do Crescimento*) and the transfers from the *Fundo de Participação dos Municipios (FPM)*.

The sanitation investments from the PAC prioritizes municipalities with a population below 50,000. Thus, to the extent the PAC effectively improves the sanitation of these municipalities, it might improve the infant health of the municipalities below 50,000. This implies the PAC might bias downward our estimates of the effects of the MCMV on infant health. However, we believe this effect would be relatively small as larger municipalities are more likely to have sanitation services provided by better-capitalized state companies than small municipalities. (Estache et al., 2016; Kresch, 2017). Moreover, there is a concern that PAC investments were not well executed (Ceri, 2016). [14]

The transfer from the FPM also prioritizes smaller municipalities. In particular, municipalities with a population below 50,940 received more transfers per capita than municipalities with a population above this population. This might increase local income (e.g., Corbi et al. (2019)) and public goods provision, thereby improving infant health and bias-

[14] According to (Ceri, 2016), from 2007 to 2015, the execution of the "Sanitation for All" under the PAC program was slow – for contracts with execution duration between three and five years, the proportion of completed projects was less than 10%. In March 2016, approximately nine years after the start of the Program, 66% of the total projects were not completed.

ing our estimates downwards. However, these effects are likely to be insignificant because the change in per capita transfers at this cut-off is small and because FPM transfers do not improve public goods provision (see Gadenne (2017)). To strengthen this conclusion, we provide evidence that FPM transfers do not change discontinuously around the 50,000 inhabitants threshold (coef. = 4.76, p-value= 0.438) and that controlling for FPM transfers does not influence our results (Table B2).

5 The Expected Effects of the MCMV on Infant Health

Before presenting the results, we briefly discuss the expected effects of the MCMV program on infant health. The MCMV might influence infant health through three different mechanisms: housing quality, housing costs, and labor market conditions. We discuss each of these mechanisms in detail below.

Due to the poor conditions of the houses in which most of the poor population lives in Brazil, the MCMV might influence infant health by improving housing quality. There is a long line of empirical studies that discuss how houses with proper sanitation, materials, ventilation, etc. positively affect individual health (e.g., Kling et al. (2007) and Ludwig et al. (2013)).

Access to water and sewage networks is the first aspect of houses likely to influence health outcomes. There is considerable evidence that access to clean water and appropriate sewerage collection improve infant health substantially by reducing the incidence of communicable diseases due to oral contamination (Cutler & Miller, 2005; Hutton et al., 2004; Lilford et al., 2017). The evidence further indicates that there are complementarities between water and sewage services (e.g., Duflo et al. (2015) and Alsan & Goldin (2019)). Better sanitation might have long run consequences on health and human capital as suggested by the studies of Gould et al. (2011) and Lavy et al. (2016). This implies the MCMV investments might improve health at birth and during the childhood by increasing the share of households with access to sanitation and enabling households to take advantage of complementarities between water and sewage services.

House characteristics like the presence of bathrooms, clean floors, and ventilation are other aspects of the constructions likely to influence health outcomes. Bathrooms with proper latrines and clean floors improve child health by reducing fecal-oral transmission. For instance, Hammer & Spears (2016) finds evidence of substantial benefits in terms of infant mortality and height of a program to induce the use of latrines in India, while

Cattaneo et al. (2009) finds evidence of significant decreases in the incidence of parasitic infections, diarrhea, and the prevalence of anemia of a program that installed cement floors in Mexico. Lack of ventilation might deplete health of its residents by increasing the incidence of respiratory diseases (Cappelletty, 1998). This effect might be strengthened by the prevalence of traditional cooking techniques which are a major source of indoor air pollution (Ezzati et al., 2004). Therefore, the MCMV investments might improve health at birth and during the childhood by increasing the share of households living in houses with proper bathrooms, tile floors, and adequate ventilation.

Changes in housing costs and labor market conditions are other mechanism through which the MCMV program might influence infant health. First, the program might reduce housing costs, thereby the non-labor income of the households. Second, the program might increase labor demand in construction, thereby increasing the labor income of the households. There is strong consensus that increases in income (labor and non-labor) typically improve health outcomes among poor households in developing countries (e.g., Baird et al. (2011), Miller & Urdinola (2010), Rocha & Soares (2015), Adhvaryu et al. (2019)). This is reinforced by evidence from developed countries suggesting that increases in non-labor income unambiguously influence health (Strully et al., 2010; Hoynes et al., 2015). The mechanisms linking income and infant health are numerous. In general, increases in labor income might improve maternal nutrition and reduce maternal stress, thereby improving birth outcomes and increasing survival rates. Increases in non-labor income might also change time use of the mothers towards home production, increasing health at birth and during the childhood.

We expect the total effects of the MCMV program on infant health to reflect the combination of the effects of improvements in housing quality, housing costs, and labor market conditions. The three mechanisms are expected to improve infant health, thereby reducing the incidence of preterm births, increasing birth weight, reducing child hospitalization and death rates. However, the timing of their expected impacts differs. Improvements

in labor market conditions generated by the MCMV are temporary and concentrated in the period of construction of the houses. Therefore, they are expected to influence infant health mostly in the period 2011-2015 which concentrates most of the program's investments but not later. Decreases in housing costs and improvements in housing quality generated by the MCMV are persistent and increase as more households move to the houses built by the program. Therefore, they are expected to influence infant health more as the number of houses delivered increases. [15]

[15] This is true if we consider that the house depreciation nor program exit are nor relevant to our context.

6 Results

We present our results in two parts. We begin exploring MCMV's contract-level data to document the 50,000 population threshold's effects on this program's investments. We then use official birth, hospitalization, and mortality records to document the effects of the MCMV on health at birth and on morbidity and mortality of children under 5 years.

6.1 Housing Investments

Figure 5 graphically presents the regression discontinuity estimates of equation (1). It plots the residuals from a regression of the dependent variable on the controls and state fixed effects on different bins of population size and a linear fit of the relationship between the residuals and population at each side of the 50,000 inhabitants threshold. Panel A depicts the residuals from the total number of units delivered by the MCMV in 2011-2017, and Panel B the residuals from this number divided by the housing deficit. Both panels provide clear evidence that the MCMV investments increase discontinuously at the 50,000 inhabitants threshold. The jump is driven neither by the functional form nor by observations in specific parts of the distribution's support.

Table 2 reports numerical estimates of equation (1) using the number of units delivered by the MCMV in the period 2009-2017 (Panel A) and this number divided by the housing deficit (Panel B) as dependent variables. Columns 1-2 report estimates obtained using a triangular kernel and a bandwidth of 10,000 inhabitants; columns 3-4 estimates obtained using a rectangular kernel and a bandwidth of 10,000 inhabitants, columns 5-6 estimates obtained using a triangular kernel and the optimal bandwidth of Calonico et al. (2014).[16] Odd columns include state fixed effects as controls. In contrast, even columns include state fixed effects and initial municipality characteristics as controls.

We find that the number of units delivered by the MCMV program increases discon-

[16]We use the all municipalities to obtain the optimal bandwidth.

tinuously at the 50,000 inhabitants by about 250-350 units (14-18% of the housing deficit in 2010). The mean number of units below the threshold is close to 170, implying the number of units delivered by the MCMV program effectively triples at the 50,000 inhabitants threshold. This effect is robust and statistically significant at the 5% levels regardless of the specification.

6.2 Health at Birth

Main Results. Figure 6 provides graphical evidence that birth weight jumps discontinuously at the 50,000 inhabitants threshold. It plots the residuals from a regression of the birth weight on the controls and state fixed effects on different bins of population size and a linear fit of the relationship between the residuals and population at each side of the 50,000 inhabitants threshold. The discontinuity is clear and does not seem to be driven by the functional form.

Table 3 provides the corresponding numerical estimates of the relationship shown in the figure. Panel A reports estimates obtained using a triangular kernel and a bandwidth of 10,000 inhabitants, panel B estimates obtained using a uniform kernel and a bandwidth of 10,000 inhabitants, and panel C estimates obtained using a triangular kernel and the optimal bandwidth of Calonico et al. (2014). Columns 1 report estimates obtained controlling only by state and year fixed effects, column 2 adds the birth weight in the initial period as an additional control, and column 3 adds other initial municipality characteristics as controls.

The effects of the discontinuity on birth weight are imprecisely estimated in the specifications without controls (column 1). The coefficients change a lot depending on the kernel and bandwidth chosen and are not statistically significant at the usual levels. This is common in settings in which the dependent variable is measured with error (e.g., Burlig & Preonas (2016)), emphasizing the importance of controlling for initial conditions as

discussed in section 4.

Including controls stabilizes the coefficients and increases their precision (columns 2 and 3). This effect becomes extremely robust and statistically significant at the 5% levels regardless of the specification. Quantitatively, we find that birth weight increases by about 12.8 to 15.6 grams at the threshold. The mean birth weight below the threshold is about 3214 grams, implying the 50,000 inhabitants threshold increases the weight on average in 0.4-0.5%. Our effects on birth weight are slightly below the effects of fasting with Ramadan on birth weight found by Almond & Mazumder (2011) and to the effects of job losses through announced notices during pregnancy found by Carlson (2015).[17]

To further understand the impacts of the MCMV on birth outcomes, Table 4 reports estimates of equation (1) for other measures of health at birth. It uses our preferred specification presented in Panel A, column (2) of Table 3 – triangular kernel, 10,000 inhabitants bandwidth, and the controls discussed in section 4.

In Panel A, we examine the effects of the MCMV on other measures of birth weight. This is important for interpreting the effects discussed before because the literature emphasizes that the long-run effects of low birth weight are typically driven by events in the the lower tail of the weight distribution (Almond et al., 2018). Column 1 estimates the effect of the MCMV on the share of births below 1500 grams. The point estimate is negative but not statistically significant at the usual levels (p-value = 0.24). Column 2 examines the effect of the MCMV on the share of births below 2000 grams. The point estimate is negative and statistically significant at the 10% level (p-value = 0.06). Column 3 estimates the effect of the MCMV on the share of births below 2500 grams. The findings from columns 1-3 indicate that the effect documented in Table 3 is driven by changes in the incidence of low ($<$ 2000 grams) but not very low birth weight events ($<$ 1500 grams). Column 4

[17] Almond & Mazumder (2011) find that birth weight is about 18 grams lower for Arab-pregnancies that overlap with Ramadan (0.6% of the mean). Carlson (2015) find that that the effect of job losses through announced notices ranges from -15 to -20 grams (-0.4% to - 0.6%).

further documents a 1 p.p. reduction in children's share of births relatively small for their gestational age (SGA). This effect is significant at the 1% level. This indicates that the effects of MCMV on birth weight do not operate simply by increasing gestational age but also by increasing weight conditional on age.

In Panel B, we examine effects of the MCMV on other markers of health at birth. Columns 1 documents a significant decrease in the share of pregnancies below 32 weeks. The effect size is 0.2 p.p, which corresponds to 13% of the mean. Column 2 finds no significant effect of the MCMV on the share of pregnancies below 37 weeks. The coefficient is negative but not statistically significant. This is suggestive that reductions in the incidence of very premature births are other mechanisms linking MCMV investments and birth weight. Columns 3-4 examine the effects of the MCMV on the share of births with APGAR scores below 7. Point estimates are negative for APGAR1, and APGAR5 with magnitudes between 13-17% of the outcomes mean in the municipalities below the cutoff. However, the coefficients are not statistically significant (p-values = 0.144 and 0.175, respectively).

Figures 7 and 8 present the corresponding RD figures of the estimates presented in Table 4. The discontinuities are not so apparent for the other outcomes as for birth weight. The exception is the effect on the share of births small for their gestational age for which the discontinuity is visibly apparent.

Dynamics. The effects of the MCMV on birth weight reflect a combination of changes in housing quality, housing costs, and labor market conditions. While it is impossible to disentangle these three mechanisms, it is possible to use the timing of the effects to disentangle between the effects of houses (housing costs and quality) and the effects of the construction of the houses on labor market conditions. As discussed in section 5, the program is expected to temporarily increase labor income during the construction of the houses and permanently improve housing quality and reduce housing costs after the houses are delivered. Thus, we expect the effects of the construction to be stronger

in the program's early periods (when the program's investments are at their peak, but the number of units delivered is modest) and the effects of houses to be stronger in the program's final periods (when the program's investments fall but the number of units delivered is considerable).

We obtain period-specific effects of the MCMV on health at birth and infant health by estimating equation (2). Figure 9, Panel A plots the estimated coefficients β_{1k} for birth weight. It shows that MCMV effects increase weakly through time going from an statistically insignificant effect of 8.12 grams in 2011 (p-value = 0.257) to a statistically significant effect of than 20.9 grams in 2017 (p-value = 0.010). This increase in the effects over time is suggestive that the effects of the MCMV on birth weight operate primarily through decreases in housing costs and increases in housing quality.

To gain further insight on the mechanisms, we decompose the total effect of the MCMV on birth weight on the effects of houses and their construction using a exercise similar to the one proposed by Dix-Carneiro et al. (2018). As detailed in Appendix A, under the hypothesis that the relationship between birth weight, house construction, housing quality, and housing costs is constant over time, it is possible to use the RD coefficients obtained in different periods to determine the role of houses and their construction. This decomposition indicates that the number of houses delivered explains between 60.4-66.5% of the mean effect of the MCMV on birth weight in the period 2011-2017. The contribution of better houses effect increases from 37.2% in the first years of the program to 81.8% in the final years of the program.

Figure 9, panels B-D plots the estimated coefficients β_{1k} of equation (2) for other birth outcomes. Panel B reports results using the share of births below 2000 grams as dependent variable. The effects on the share of births below 2000 grams do not have a clear dynamic. The effect declines between 2011-2016, but reverts in 2017. The effects are significant only in 2015 (0.23 p.p., p-value = 0.03) and 2016 (0.38 p.p., p-value = 0.001). Panel C depicts

results obtained using the share of births below 32 weeks. The dynamics of the effects is similar to the effects on birth weight. The effects on the share of pre-term births increase in absolute value through time until 2016, going from statistically insignificant effects of 0.05 percentage points in 2011 (p-value = 0.62) to a statistically significant effect of 0.30 percentage points in 2016 (p-value = 0.013). Panel D reports results obtained using the share of births of children relatively small for their gestational age. The dynamic of this effect is also consistent with the effects on birth weight with the magnitude of the effect increasing over time. In 2011, this effect is -0.87 percentage points (p-value = 0.187), while in 2017 it is -1.24 percentage points (p-value = 0.009). Taken together, the timing of the effects on birth outcomes suggests the effects of the program are driven primarily by housing quality and housing costs and not by a temporary increase in labor market income that may have occurred during the construction.

6.3 Morbidity and Mortality of Children Under 1 Year

Table 5 reports regression discontinuity estimates of equation (1) using measures of morbidity and mortality of children under 1 year as the outcomes of interest. We report results based on our preferred specification presented in column (2) of Table 3 – triangular kernel, 10,000 inhabitants bandwidth, and the controls discussed in section 4. As discussed in section 5, the MCMV investments might improve health during the childhood by increasing the share of households living in houses with proper bathrooms, tile floors, and adequate ventilation as well as with proper sanitation.

Panel A depicts the results for hospitalization rates. Column 1 uses total hospitalization rates (per 1,000) as the dependent variable. We find no effect of the MCMV on this measure. The point estimate is negative but economically small and statistically insignificant. Column 2-6 reinforces this conclusion by looking at hospitalization rates for specific causes – infectious and parasitic diseases, respiratory diseases, and perinatal conditions.[18]

[18] The theory indicates that housing conditions might be particularly affected by infectious and parasitic

Column 2 focuses on these three leading causes of infant diseases and columns 3-5 focus on each of these causes separately (infectious and parasitic diseases, respiratory diseases, and perinatal conditions, respectively). Column 6 presents the estimates for the residual causes. We find no effect on these measures.

Panel B reports the results for death rates. Column 1 reports negative but statistically insignificant effects of the MCMV on children's mortality under 1 year. Columns 2-6 find this negative effect is entirely driven by a statistically significant reduction in perinatal deaths. Our coefficient indicates that the MCMV reduces perinatal deaths by -1.06 per 1,000 births. This represents 14% the mean and implies the program reduced in 0.8 the number of deaths per year due to perinatal conditions in the typical municipality to the left of the cutoff.

The reduction in perinatal deaths is consistent with the positive effects on health at birth previously documented. Indeed, the literature suggests that exposure to environmental hazards such as inadequate sanitation and nutrition (itself related to poor sanitation) constitute substantial risks to infant health, increasing the mortality rate for low-birth-weight and preterm infants (Prüss-Üstün & Corvalán, 2006; Zhang et al., 1992; Longnecker et al., 2001). Thus, our findings are suggestive that, by improving the environment in which the households live, the MCMV improved the quality of births and decreased the likelihood of deaths due to perinatal conditions.

Figures B1 and B2 from the appendix B report the corresponding RD figures of the estimates presented in Table 5. They reinforce the conclusions of this table. Hospitalizations are continuous at the 50,000 population threshold, while death rates decrease at this threshold, mostly due to the decrease in deaths due to perinatal conditions.

Figures B3 and B4 from the appendix B plot the estimated coefficients β_{1k} from equation 2 using hospitalizations and deaths as dependent variables. As expected by the res-

diseases, respiratory diseases, and perinatal conditions (Organization et al., 2019)

ults on Table 5, Figure B3 shows no statistically significant effect on the hospitalization for infants over time, both overall and for specific diseases. The results of infant mortality also shows no statistical effect on overall infant deaths over time. However, the estimated effect on mortality originated by perinatal origin is statistically different from zero in 2013 and again in 2016 and 2017.

6.4 Morbidity and Mortality of Children Between 1 and 5 Years

Table 6 reports regression discontinuity estimates of equation (1) using measures of morbidity and mortality of children between 1 and 5 years as the outcomes of interest. The Table is identical to Table 5, except that we combine mortality due to perinatal conditions with mortality due to other diseases. We do this because there are too few hospitalization events and deaths due to perinatal conditions in this age group (the mean of deaths by perinatal conditions of 0.003 per thousand births from this cohort.

We find no effects of the MCMV on hospitalization and deaths of children between 1 and 5 years. Point estimates are economically small and statistically insignificant for all measures considered. Figures B5, B6, B7, and B8 from the appendix report the corresponding RD figures and estimates by period of the effects presented in Table 6. They reinforce the conclusions of the table. Hospitalizations and deaths of children are continuous at the 50,000 population threshold.

7 Conclusion

In this paper, we examine the effects of housing conditions on health at birth, exploring exogenous changes induced from investments of the MCMV Program. This program built about 900,000 houses to poor households in Brazil during the period 2010-2017. We obtain causal estimates of the construction of these houses exploring differences in the MCMV rules that facilitated municipalities with a population above 50,000 inhabitants to obtain funds from this program.

Using regression discontinuity design and administrative data, we estimate the program's effects on signed contracts under the program, health at birth and infant health. We find that the number of houses delivered by the program increases by 300-350 units during the period 2011-2017 at the 50,000 inhabitants threshold. This corresponds to 14-18% of the housing deficit of the typical municipality to the left of the discontinuity. We find the increase in MCMV investments led to increases of 12-16 grams in birth weight and decreases of 1 per 1,000 live births in infant (before 1 year) mortality caused by conditions originating in children's perinatal period. We find no effect of the program in children with more than one year. Decomposition exercises indicate that most of this effect is due to improvements in housing quality and decreases in housing costs (as opposed to improvements in labor market conditions coming from the program's investments).

Health at birth is an important determinant of physical and mental health, human capital accumulation, and income (Gluckman et al., 2005; Cunha & Heckman, 2007; Currie, 2009). Thus, understanding its determinants is fundamental to guide public policies. Nevertheless, while there is a growing body of empirical work documenting the role of shocks during fetal development on health at birth (e.g., (Almond & Currie, 2011; Almond et al., 2018)), there is much less evidence on the role of the environment on health at birth.

Our results contribute to this literature by documenting the importance of better houses to improve fetal development and, consequently, health at birth. These results imply

housing policies can have important health externalities. For instance, comparable effects on birth weight increases earnings in the long run by 1.7% (Bharadwaj et al., 2014). Understanding whether these health externalities influence the optimal design of housing policies is an important agenda for future research.

References

Adhvaryu, A., Fenske, J. & Nyshadham, A. (2019). Early life circumstance and adult mental health. *Journal of Political Economy*, *127*(4), 1516-1549. Retrieved from https://doi.org/10.1086/701606 doi: 10.1086/701606

Almond, D. & Currie, J. (2011). Killing me softly: The fetal origins hypothesis. *Journal of economic perspectives*, *25*(3), 153–72.

Almond, D., Currie, J. & Duque, V. (2018). Childhood circumstances and adult outcomes: Act ii. *Journal of Economic Literature*, *56*(4), 1360–1446.

Almond, D. & Mazumder, B. (2011). Health capital and the prenatal environment: the effect of ramadan observance during pregnancy. *American Economic Journal: Applied Economics*, *3*(4), 56–85.

Alsan, M. & Goldin, C. (2019). Watersheds in child mortality: the role of effective water and sewerage infrastructure, 1880–1920. *Journal of Political Economy*, *127*(2), 586–638.

Asher, S. & Novosad, P. (2020). Rural roads and local economic development. *American Economic Review*, *110*(3), 797–823.

Baird, S., Friedman, J. & Schady, N. (2011). Aggregate income shocks and infant mortality in the developing world. *The Review of Economics and Statistics*, *93*(3), 847-856. Retrieved from https://doi.org/10.1162/REST_a_00084 doi: 10.1162/REST_a_00084

Barnhardt, S., Field, E. & Pande, R. (2017). Moving to opportunity or isolation? network effects of a randomized housing lottery in urban india. *American Economic Journal: Applied Economics*, *9*(1), 1–32.

Belchior, C. A. (2019). *Two essays on housing programs and the labor market* (Unpublished doctoral dissertation).

Bharadwaj, P., Johnsen, J. V. & Løken, K. V. (2014). Smoking bans, maternal smoking and birth outcomes. *Journal of Public economics*, *115*, 72–93.

Biderman, C., Acosta, C., Ramos, F., Hiromoto, M., Terentim, G., Caldeira, J. & Pacheco, T. (2019). Morar longe: o programa minha casa minha vida e a expansão das regiões metropolitanas. *São Paulo: Instituto Escolhas. Recuperado em*, *15*.

Burlig, F. & Preonas, L. (2016). Out of the darkness and into the light? development effects of rural electrification. *Energy Institute at Haas WP*, *268*, 26.

Calonico, S., Cattaneo, M. D. & Titiunik, R. (2014). Robust nonparametric confidence intervals for regression-discontinuity designs. *Econometrica*, *82*(6), 2295–2326.

Cappelletty, D. (1998). Microbiology of bacterial respiratory infections. *The Pediatric infectious disease journal*, *17*(8), S55–S61.

Carlson, K. (2015). Fear itself: The effects of distressing economic news on birth outcomes. *Journal of health economics*, *41*, 117–132.

Cattaneo, M. D., Galiani, S., Gertler, P. J., Martinez, S. & Titiunik, R. (2009). Housing, health, and happiness. *American Economic Journal: Economic Policy*, *1*(1), 75–105.

Ceri, F. (2016). Efetividade dos investimentos em saneamento no brasil. *Centro de Estudos em Regulação e Infraestrutura*, 42.

Chetty, R., Hendren, N. & Katz, L. (2016). The effects of exposure to better neighborhoods on children: New evidence from the moving to opportunity experiment. *American Economic Review*, *106*(4), 855–902.

Corbi, R., Papaioannou, E. & Surico, P. (2019). Regional transfer multipliers. *The Review of Economic Studies*, *86*(5), 1901–1934.

Cunha, F. & Heckman, J. (2007). The technology of skill formation. *American Economic Review*, *97*(2), 31–47.

Currie, J. (2009). Healthy, wealthy, and wise: Socioeconomic status, poor health in childhood, and human capital development. *JoUrnal of economIc lIteratUre*, *47*(1), 87–122.

Cutler, D. & Miller, G. (2005). The role of public health improvements in health advances: the twentieth-century united states. *Demography*, *42*(1), 1–22.

Dix-Carneiro, R., Soares, R. R. & Ulyssea, G. (2018). Economic shocks and crime: Evidence from the brazilian trade liberalization. *American Economic Journal: Applied Economics*, *10*(4), 158–95.

Duflo, E., Greenstone, M., Guiteras, R. & Clasen, T. (2015). *Toilets can work: Short and medium run health impacts of addressing complementarities and externalities in water and sanitation* (Tech. Rep.). National Bureau of Economic Research.

Estache, A., Garsous, G. & da Motta, R. S. (2016). Shared mandates, moral hazard, and political (mis) alignment in a decentralized economy. *World Development*, *83*, 98–110.

Ezzati, M., Bailis, R., Kammen, D. M., Holloway, T., Price, L., Cifuentes, L. A., ... Dhanapala, K. N. (2004). Energy management and global health. *Annu. Rev. Environ. Resour.*, *29*, 383–419.

Franklin, S. (2019). The demand for government housing: Evidence from lotteries for 200,000 homes in ethiopia. In *Technical report.* Working Paper.

Furtado, B. A., Lima Neto, V. C. & Krause, C. (2013). Estimativas do déficit habitacional brasiliero (2007-2011) por municípios (2010).

Gadenne, L. (2017). Tax me, but spend wisely? sources of public finance and government accountability. *American Economic Journal: Applied Economics*, 274–314.

Gale, R. (2018). Housing mobility programs and health outcomes. *Health Affairs, Health Policy Brief*.

Galiani, S., Gertler, P. J., Undurraga, R., Cooper, R., Martínez, S. & Ross, A. (2017). Shelter from the storm: Upgrading housing infrastructure in latin american slums. *Journal of urban economics*, *98*, 187–213.

Gelman, A. & Imbens, G. (2019). Why high-order polynomials should not be used in regression discontinuity designs. *Journal of Business & Economic Statistics*, *37*(3), 447–456.

Gluckman, P. D., Hanson, M. A., Spencer, H. G. & Bateson, P. (2005). Environmental influences during development and their later consequences for health and disease: implications for the interpretation of empirical studies. *Proceedings of the Royal Society B: Biological Sciences*, *272*(1564), 671–677.

Gould, E. D., Lavy, V. & Paserman, M. D. (2011). Sixty years after the magic carpet ride: The long-run effect of the early childhood environment on social and economic outcomes. *The Review of Economic Studies*, *78*(3), 938–973.

Hammer, J. & Spears, D. (2016). Village sanitation and child health: Effects and external validity in a randomized field experiment in rural india. *Journal of Health Economics*, *48*, 135 - 148. Retrieved from http://www.sciencedirect.com/science/article/pii/S0167629616300030 doi: https://doi.org/10.1016/j.jhealeco.2016.03.003

Hoynes, H., Miller, D. & Simon, D. (2015, February). Income, the earned income tax credit, and infant health. *American Economic Journal: Economic Policy*, *7*(1), 172-211. Retrieved from https://www.aeaweb.org/articles?id=10.1257/pol.20120179 doi: 10.1257/pol.20120179

Hutton, G., Haller, L., Water, S., Organization, W. H. et al. (2004). *Evaluation of the costs and benefits of water and sanitation improvements at the global level* (Tech. Rep.). World Health Organization.

Imbens, G. W. & Lemieux, T. (2008). Regression discontinuity designs: A guide to practice. *Journal of econometrics*, *142*(2), 615–635.

Katz, L. F., Kling, J. R. & Liebman, J. B. (2001). Moving to opportunity in boston: Early results of a randomized mobility experiment. *The Quarterly Journal of Economics*, *116*(2), 607–654.

Kling, J. R., Liebman, J. B. & Katz, L. F. (2007). Experimental analysis of neighborhood effects. *Econometrica*, *75*(1), 83–119.

Kresch, E. P. (2017). The buck stops where? federalism, uncertainty, and investment in the brazilian water and sanitation sector. *American Economic Journal: Economic Policy*.

Kumar, T. (2019). *The intergenerational effects of subsidizing homeownership: evidence from a program in mumbai* (Tech. Rep.). Working Paper.

Lavy, V., Schlosser, A. & Shany, A. (2016). *Out of africa: Human capital consequences of in utero conditions* (Tech. Rep.). National Bureau of Economic Research.

Lee, D. S. & Lemieux, T. (2010). Regression discontinuity designs in economics. *Journal of economic literature*, *48*(2), 281–355.

Lilford, R. J., Oyebode, O., Satterthwaite, D., Melendez-Torres, G. J., Chen, Y.-F., Mberu, B., ... Ezeh, A. (2017). Improving the health and welfare of people who live in slums. *The Lancet*, *389*(10068), 559 - 570. Retrieved from http://www.sciencedirect.com/science/article/pii/S0140673616318487 doi: https://doi.org/10.1016/S0140-6736(16)31848-7

Longnecker, M. P., Klebanoff, M. A., Zhou, H. & Brock, J. W. (2001). Association between maternal serum concentration of the ddt metabolite dde and preterm and small-for-gestational-age babies at birth. *The Lancet*, *358*(9276), 110–114.

Ludwig, J., Duncan, G. J., Gennetian, L. A., Katz, L. F., Kessler, R. C., Kling, J. R. & Sanbonmatsu, L. (2013). Long-term neighborhood effects on low-income families: Evidence from moving to opportunity. *The American Economic Review*, *103*(3), 226–231.

McCrary, J. (2008). Manipulation of the running variable in the regression discontinuity design: A density test. *Journal of econometrics*, *142*(2), 698–714.

Miller, G. & Urdinola, B. P. (2010). Cyclicality, mortality, and the value of time: The case of coffee price fluctuations and child survival in colombia. *Journal of Political Economy*, *118*(1), 113-155. Retrieved from https://doi.org/10.1086/651673 doi: 10.1086/651673

Organization, W. H. et al. (2019). *Progress on household drinking water, sanitation and hygiene 2000-2017: special focus on inequalities*. World Health Organization.

Pacheco, T. S. (2019). *Moradia, localização e o programa habitacional" minha casa minha vida" no município do rio de janeiro* (Unpublished doctoral dissertation).

Picarelli, N. (2019). There is no free house. *Journal of Urban Economics*, *111*, 35 - 52. Retrieved from http://www.sciencedirect.com/science/article/pii/S0094119019300245 doi: https://doi.org/10.1016/j.jue.2019.04.002

Prüss-Üstün, A. & Corvalán, C. (2006). Preventing disease through healthy environments: towards an estimate of the environmental burden of disease. *World Health Organization*.

Rocha, R. & Soares, R. R. (2015). Water scarcity and birth outcomes in the brazilian semi-arid. *Journal of Development Economics*, *112*, 72–91.

Squarize Chagas, A. L., Malvezzi Rocha, G. et al. (2019). *Housing program and social conditions impact: Evidences from "minha casa minha vida" program lotteries in brazil* (Tech. Rep.). Núcleo de Economia Regional e Urbana da Universidade de São Paulo (NEREUS).

Strully, K. W., Rehkopf, D. H. & Xuan, Z. (2010). Effects of prenatal poverty on infant health: state earned income tax credits and birth weight. *American sociological review*, *75*(4), 534–562.

Tatagiba, L. & Teixeira, A. C. C. (2016). *União nacional por moradia popular and social innovation in housing policies for the poor in brazil.* ImPRovE Case Study.

Villar, J., Ismail, L. C., Victora, C. G., Ohuma, E. O., Bertino, E., Altman, D. G., … others (2014). International standards for newborn weight, length, and head circumference by gestational age and sex: the newborn cross-sectional study of the intergrowth-21st project. *The Lancet*, *384*(9946), 857–868.

Zhang, J., Cai, W.-W. & Lee, D. J. (1992). Occupational hazards and pregnancy outcomes. *American journal of industrial medicine*, *21*(3), 397–408.

Table 1: Summary Statistics and Balance

	Mean	RD	S.E	N
A. Demographics				
Sh. female	0.503	-0.000	(0.003)	235
Sh. youngs	0.355	-0.001	(0.011)	235
Sh. adults	0.539	-0.005	(0.010)	235
Sh. old	0.105	0.005	(0.007)	235
Sh. rural hh	0.237	-0.005	(0.057)	235
Sh. Migrants	0.096	-0.019	(0.013)	235
# holseholds	15038	-474.697	(362.932)	235
# housefolds in deficit	1891	200.105	(159.910)	235
B. Labor and Schooling				
Sh. workers	0.624	-0.022	(0.020)	235
Av. wage	899.6	-15.641	(53.267)	235
less than 9 years	0.652	0.009	(0.021)	235
less than 9-11 years	0.142	-0.006	(0.007)	235
less than 12-15 years	0.159	-0.004	(0.013)	235
16 or more years	0.043	0.002	(0.005)	235
C. Infraestructure				
Sh. hh with water	0.688	0.005	(0.056)	235
Sh. hh with sewage	0.381	-0.033	(0.053)	235
D. Health infraestructure				
# Hospital Beds	99.80	21.246	(30.241)	235
# Hospitals	2.034	0.480	0.480	235
presence of PSF	0.677	-0.065	(0.145)	235
E. Infant Outcomes				
Birth weight	3219	-19.174	(17.819)	235
Low birth (< 2500)	0.0684	0.003	(0.005)	235
Apgar5	9.293	0.068	(0.117)	235
Total infant hosp. (up to 1 age)	205.6	0.139	(27.534)	235
infectious	38.40	7.648	(8.080)	235
respiratory	80.09	-2.725	-15.368	235
perinatal	54.15	-0.313	(9.005)	235
total infant death (up to 1 age)	15.36	-0.845	(1.663)	235
infectious	0.778	-0.104	(0.298)	235
respiratory	0.832	0.210	(0.352)	235
perinatal	9.163	-0.583	(1.285)	235

Notes: The table presents mean values for municipality characteristics, measured in the baseline period. Variables from panels A-C come from the 2010 Population Census, while the final three from panel D come from the CNES/Datasus. Panel E come from SINASC, SIH, and SIM (datasus). Column 1 shows the unconditional means for all municipalities, column 2 shows the regression discontinuity estimate, following equation 1, column 3 is the robust standard errors, and column 4 the number of observations. The bandwidth of $\pm$ 10 around the population thresholds has been used to define the sample of municipalities.

Table 2: Effect of Municipality Prioritization on MCMV Investments

	(1)	(2)	(3)	(4)	(5)	(6)
	Paneal A: Contracts					
1[pop >50,000]	251.89**	296.29**	350.32***	354.29***	266.02**	293.55**
	(126.30)	(128.66)	(122.61)	(126.88)	(131.15)	(128.41)
Mean	171.88	171.88	171.88	171.88	166.06	177.53
Observations	235	235	235	235	255	255
RD bandwidth	±10	±10	±10	±10	±10.77	±10.77
	Paneal B: Contracts/deficit					
1[pop >50,000]	0.14 *	0.16**	0.18 **	0.18 **	0.16**	0.16 **
	(0.07)	(0.08)	(0.07)	(0.07)	(0.07)	(0.08)
Mean	0.10	0.10	0.10	0.10	0.08	0.09
Observations	235	235	235	235	314	314
RD bandwidth	±10	±10	±10	±10	±12.33	±12.33
Controls	No	Yes	No	Yes	No	Yes
Kernel	Triangular	Triangular	Uniform	Uniform	Triangular	Triangular

Notes: The table reports estimates of equation (1) using the number of units delivered by the MCMV in the period 2009-2017 (Panel A) and this number divided by the housing deficit (Panel B) as dependent variables. Columns 1-2 report estimates obtained using a triangular kernel and a bandwidth of 10,000 inhabitants; columns 3-4 estimates obtained using a uniform kernel and a bandwidth of 10,000 inhabitants, columns 5-6 estimates obtained using a triangular kernel and the optimal bandwidth of Calonico et al. (2014). Robust standard errors in parenthesis. *** p<0.01; ** p<0.05; * p<0.10.

Table 3: Effect on Weight at Birth

	(1)	(2)	(3)
		Birth Weight	
Panel A: Triangular, BW ±10			
1[pop >50,000]	-1.53	13.84**	15.58**
	(15.55)	(6.49)	(6.54)
Mean	3214.34	3214.34	3214.34
Observations	1645	1645	1645
RD bandwidth	±10	±10	±10
Kernel	Triangular	Triangular	Triangular
Baseline Control	No	Yes	Yes
Controls	No	No	Yes
Panel B: Uniform, BW ±10			
1[pop >50,000]	15.34	14.63**	15.18**
	(13.37)	(6.39)	(6.17)
Mean	3214.34	3214.34	3214.34
Observations	1645	1645	1645
RD bandwidth	±10	±10	±10
Kernel	Uniform	Uniform	Uniform
Baseline Control	No	Yes	Yes
Controls	No	No	Yes
Panel C: Triangular, BW optimal			
1[pop >50,000]	9.30	12.88**	14.71**
	(10.77)	(5.99)	(5.99)
Mean	3216.52	3216.52	3217.91
Observations	3017	1911	1960
RD bandwidth	±15.90	±15.90	±11.49
Kernel	Triangular	Triangular	Triangular
Baseline Control	No	Yes	Yes
Controls	No	No	Yes

Notes: The table presents estimates of equation (1) using the birth weight as dependent variable. Panel A reports estimates obtained using a triangular kernel and a bandwidth of 10,000 inhabitants, panel B estimates obtained using a uniform kernel and a bandwidth of 10,000 inhabitants, and panel C estimates obtained using a triangular kernel and the optimal bandwidth of Calonico et al. (2014). Columns 1 report estimates obtained controlling only for state and year fixed effects, column 2 adds the birth weight in the initial period as an additional control, and column 3 adds other initial municipality characteristics as controls. Standard errors clustered at the municipality level are reported in parenthesis. *** p<0.01; ** p<0.05; * p<0.10

Table 4: Effects on Birth Outcomes

	(1)	(2)	(3)	(4)
Panel A: Health at Birth	$< 1500g$	$< 2000g$	$< 2500g$	Small
1[pop >50,000]	-0.001	-0.002*	-0.001	-0.010***
	(0.000)	(0.001)	(0.002)	(0.004)
Observations	1645	1645	1645	1635
R-squared	0.120	0.225	0.376	0.268
Dep. Variable Mean	0.010	0.022	0.109	0.110
Panel B: Gestation and Apgar	< 32 weeks	< 37 weeks	Low Apgar1	Low Apgar5
1[pop >50,000]	-0.002**	-0.001	-0.016	-0.004
	(0.001)	(0.004)	(0.011)	(0.003)
Observations	1645	1645	1645	1645
R-squared	0.136	0.254	0.581	0.309
Dep. Variable Mean	0.014	0.106	0.135	0.024

Notes: The table reports estimates of equation (1) for several measures of health at birth. It uses our preferred specification – triangular kernel, 10,000 inhabitants bandwidth, and the controls. Panel A reports estimates for the share of births below 1500 grams (column 1), the share of births below 2000 grams (column 2), the share of births below 2500 grams (column 3) and SGA (column 4). Panel B reports the estimates on the share of pregnancies below 32 weeks (column 1), the share of pregnancies below 37 weeks (column 2), and the share of births with APGAR scores below 7 (columns 3 and 4). Standard errors clustered at the municipality level are reported in parenthesis. *** p<0.01; ** p<0.05; * p<0.10.

Table 5: Effects on Morbidity and Mortality of Children Under 1 Year

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Infant Hospitalization	Total	Main	Infectious	Resp.	Perinatal	Residual
1[pop >50,000]	-1.718	-5.558	0.344	-2.171	-2.246	4.914
	(12.763)	(11.364)	(3.730)	(5.364)	(5.734)	(3.167)
Observations	1645	1645	1645	1645	1645	1645
R-squared	0.479	0.470	0.505	0.518	0.520	0.425
Mean	179.268	147.180	26.288	57.414	63.478	32.087
Panel B: Infant Mortality	Total	Main	Infectious	Resp.	Perinatal	Residual
1[pop >50,000]	-0.534	-0.919	0.044	0.098	-1.062**	0.430
	(0.691)	(0.566)	(0.131)	(0.115)	(0.530)	(0.264)
Observations	1645	1645	1645	1645	1645	1645
R-squared	0.190	0.202	0.124	0.114	0.136	0.033
Mean (per 1000)	13.751	9.470	0.701	0.628	8.141	4.281

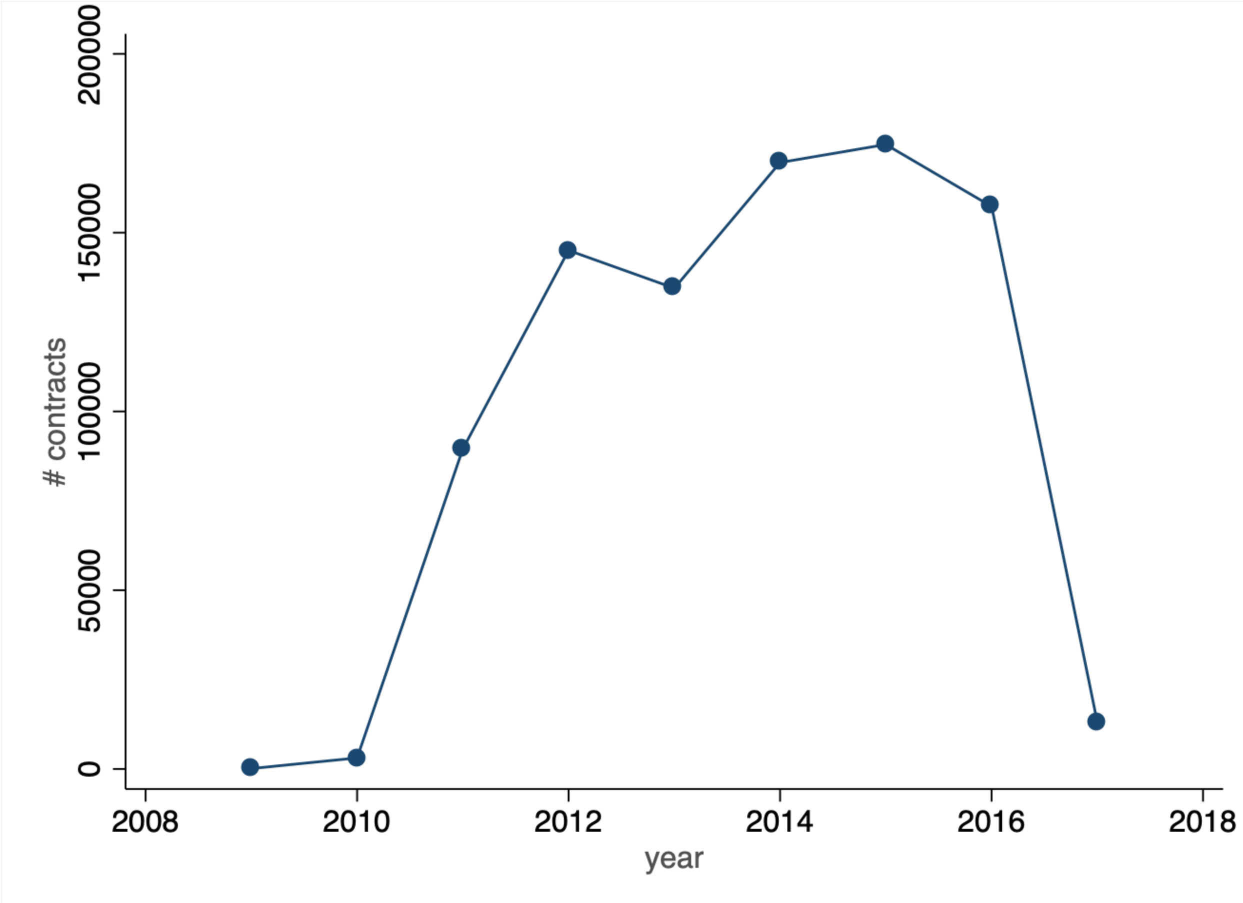
Notes: The table reports regression discontinuity estimates of equation (1) using measures of morbidity and mortality of children under 1 year as the outcomes of interest. We report results based on our preferred specification – triangular kernel, 10,000 inhabitants bandwidth and the controls. Panel A depicts the results for hospitalization rates and panel B reports the results for mortality rates. In Panel A (Panel B), Column 1 uses total hospitalization (mortality) rates per 1,000 births as the dependent variable. Column 2 reports estimates for the combined hospital admission (mortality) due to infectious and parasitic diseases, respiratory diseases, and perinatal conditions. Column 3-6 reports these estimates for hospitalization (mortality) rates for these specific causes, separately. Standard errors clustered at the municipality level are reported in parenthesis. *** p<0.01; ** p<0.05; * p<0.10.

Table 6: Effects Morbidity and Mortality of Children From 1 to 5 Years

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Child Hospitalization	Total	Main	Infectious	Resp	Perinatal	Residual
1[pop >50,000]	-1.708	-2.080	-1.925	0.439	-0.099**	-1.618
	(7.355)	(6.118)	(3.074)	(3.376)	(0.042)	(11.807)
Mean	63.386	42.197	15.653	26.474	0.069	-59.253
Observations	1645	1645	1645	1645	1645	1645
R-squared	0.567	0.604	0.605	0.563	0.251	0.680
Panel B: Child Mortality	Total	Main	Infectious	Resp.	Perinatal	Residual
1[pop >50,000]	-0.011	0.002	0.018	-0.011	-	0.009
	(0.067)	(0.031)	(0.023)	(0.020)	-	(0.084)
Mean (per 1000)	0.653	0.158	0.070	0.088	0.003	0.146
Observations	1645	1645	1645	1645		1645
R-squared	0.149	0.130	0.087	0.044	-	0.157

Notes: Table (6) reports regression discontinuity estimates of equation (1) using measures of morbidity and mortality of children between 1 and 5 years as the outcomes of interest. We report results based on our preferred specification – triangular kernel, 10,000 inhabitants bandwidth and the controls. Panel A depicts the results for hospitalization rates and panel B reports the results for mortality rates. In Panel A (Panel B), Column 1 uses total hospitalization (mortality) rates per 1,000 births as the dependent variable. Column 2 combine mortality due to perinatal conditions with mortality due to other diseases. Column 3-6 reports these estimates for hospitalization (mortality) rates for these specific causes – infectious and parasitic diseases, respiratory diseases, perinatal conditions and residual causes, respectively. Standard errors clustered at the municipality level are reported in parenthesis. *** p<0.01; ** p<0.05; * p<0.10.

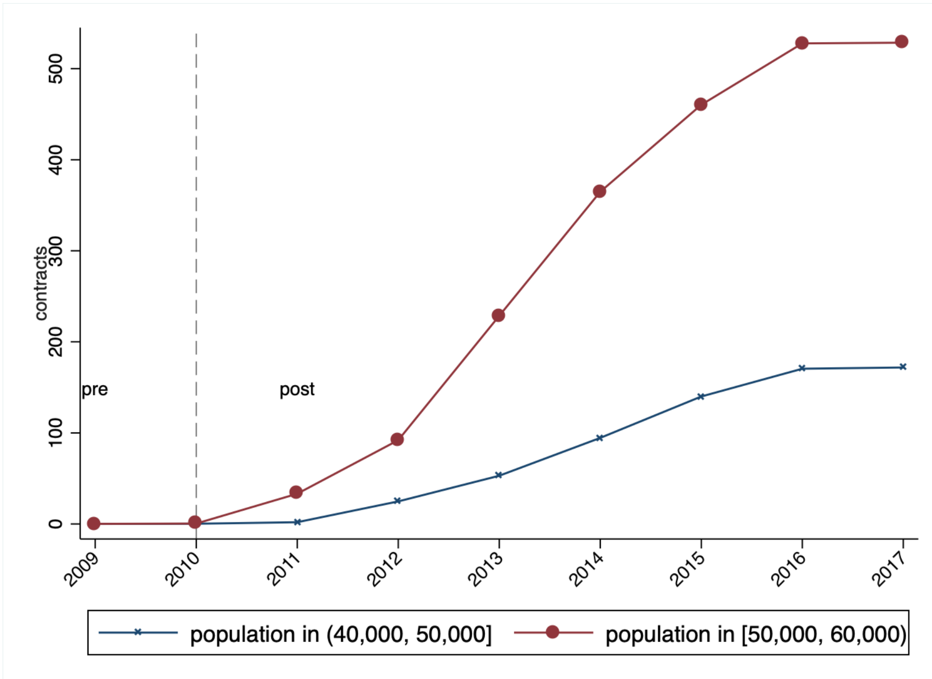
Figure 1: MCMV signed contracts by year (segment 1)



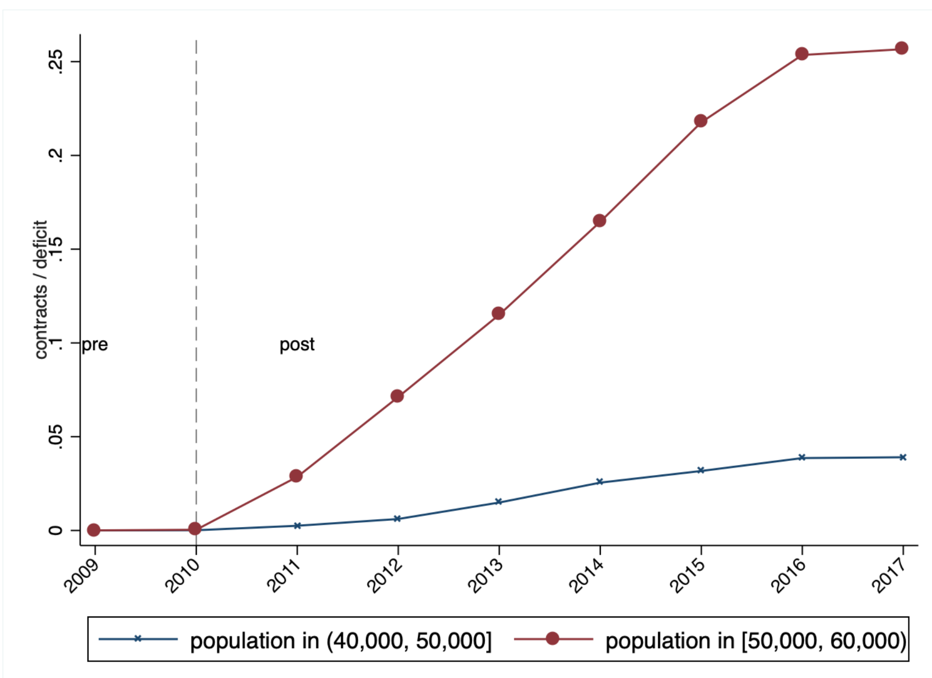
Note: The Figure shows the flow of signed contracts by year in segment 1 of MCMV (MCMV-FAR and MCMV-*Sub50*) for all municipalities in Brazil. The data was obtained from Caixa (2010-2017).

Figure 2: The Roll-Out of the MCMV

(a) Contracts, by year



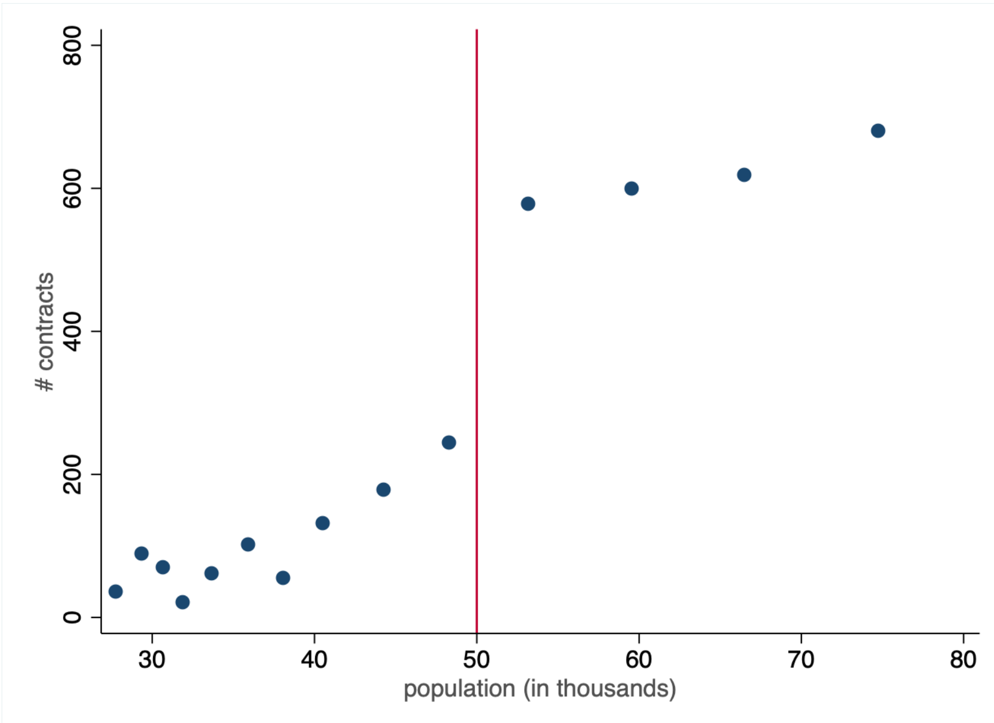
(b) Contracts as a proportion of the households in housing deficit, by year



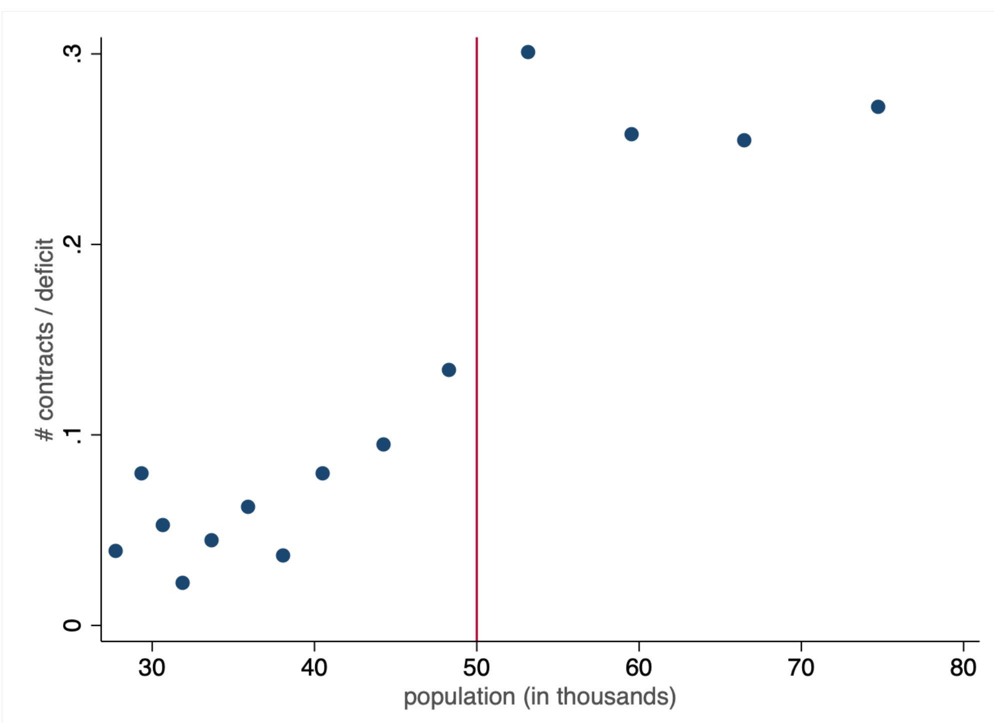
Note: The figure reports the size of the MCMV investments below and above 50,000 inhabitants. Panel A reports the average number of signed contracts by municipality until the year and Panel B reports the share of signed contracts as a proportion of the number of households in housing deficit in 2010. The sample is restricted to observations around the 50,000 population threshold.

Figure 3: Discontinuity on the 50,000 population threshold

(a) Contracts by year



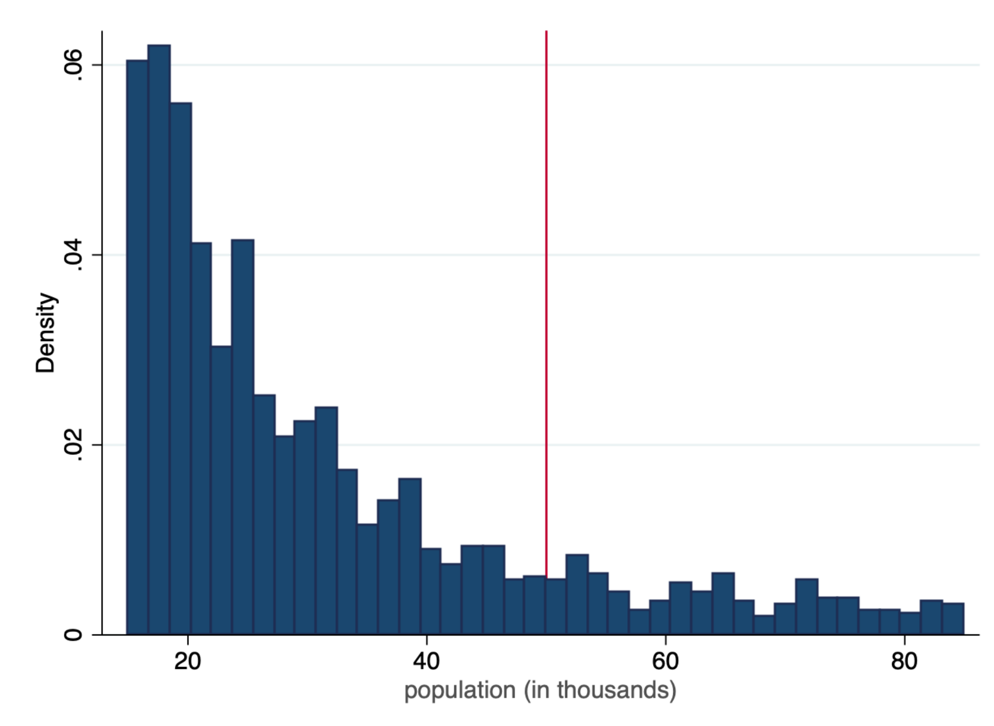
(b) Contracts/HH in deficit



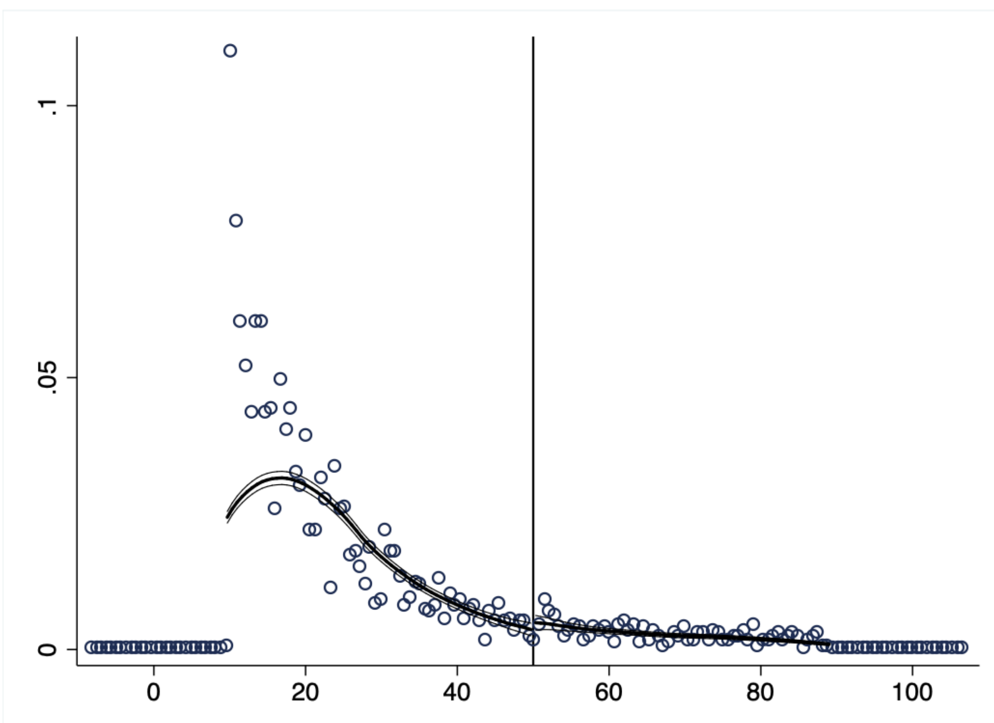
Note: The figure reports bins of the mean number of contracts (Panel A) and contracts as a share of the housing deficit in terms of the population (Panel B).

Figure 4: Histogram and McCrary Test

(a) Running-variable Histogram



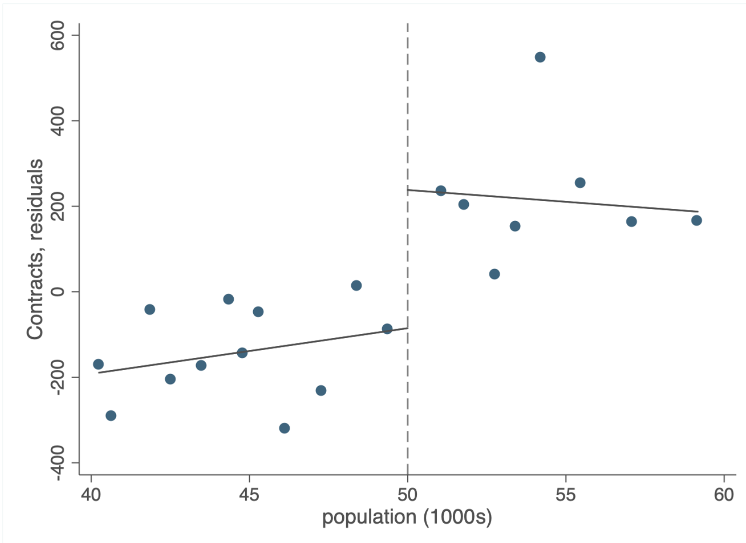
(b) McCrary Test



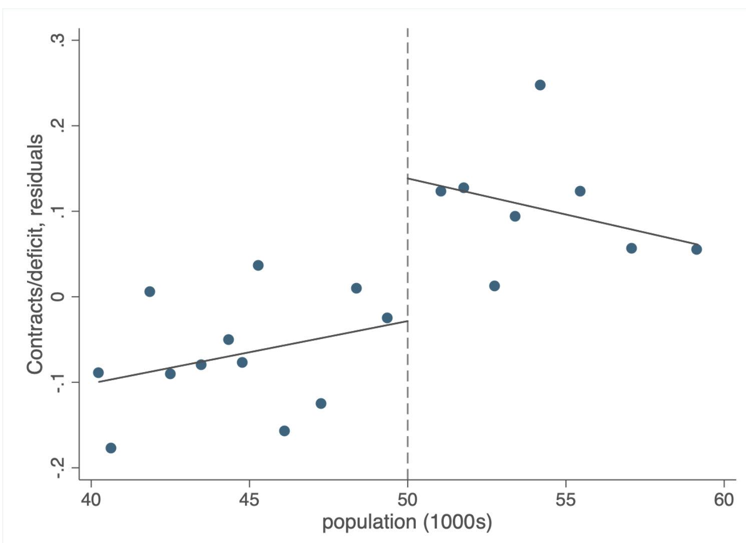
Note: Panel A shows the distribution of Brazilian population (in thousands) of municipalities in 2007. Panel B shows the figure for the McCrary test, which tests whether there is a discontinuity in the data frequency distribution around the cutoff. The McCrary test statistic is 0.268 (s.e. = 0.246).

Figure 5: RD – MCMV Signed Contracts

(a) Contracts

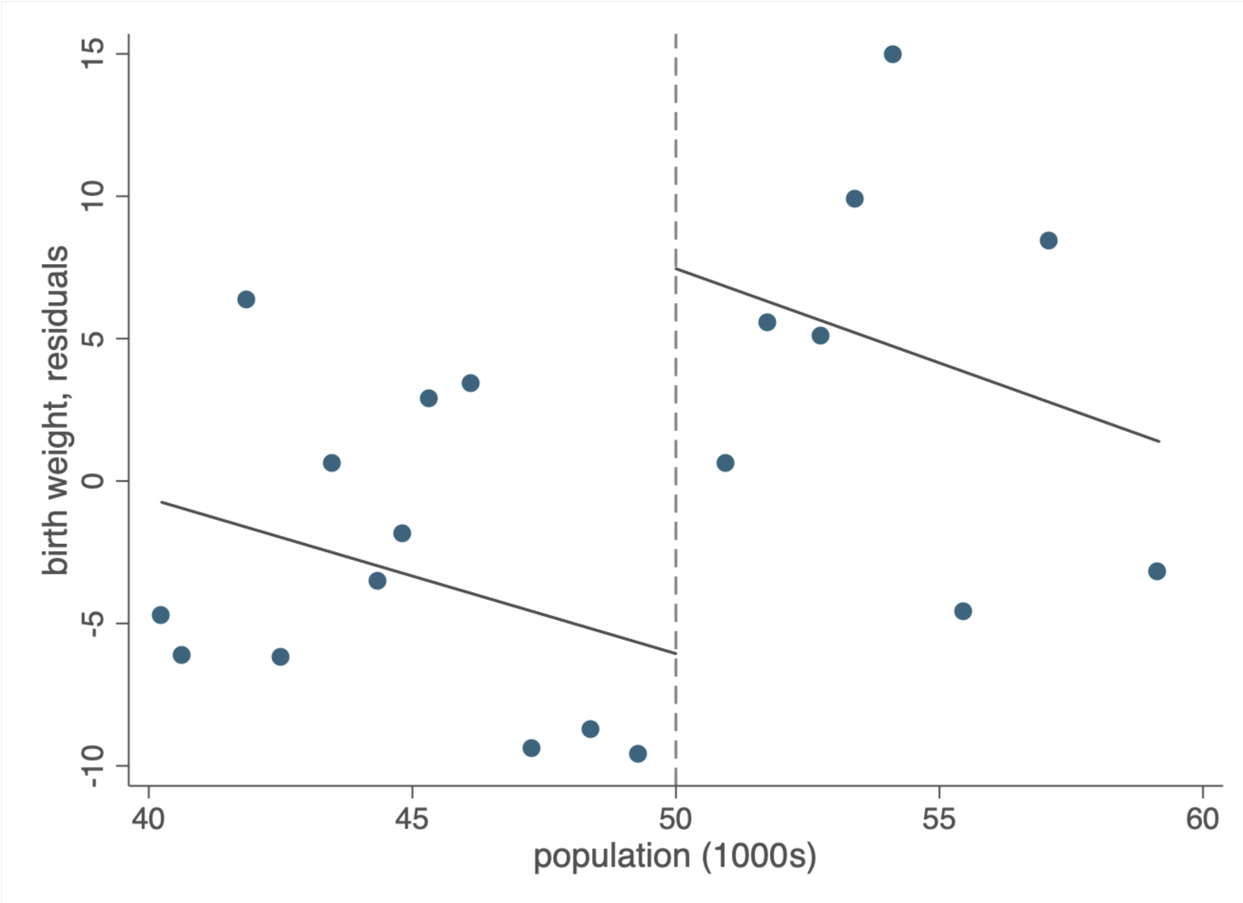


(b) Contracts/Deficit



Note: The figure presents the regression discontinuity estimates of equation (1). It plots the residuals from a regression of the dependent variable on the controls and state fixed effects on different bins of population size and a linear fit of the relationship between the residuals and population at each side of the 50,000 inhabitants threshold. Each dot contains approximately 12 municipalities, averaged in 20 bins. Panel A depicts the residuals from the number of units delivered by the MCMV in 2011-2017, and Panel B, the residuals from this number of units divided by the housing deficit.

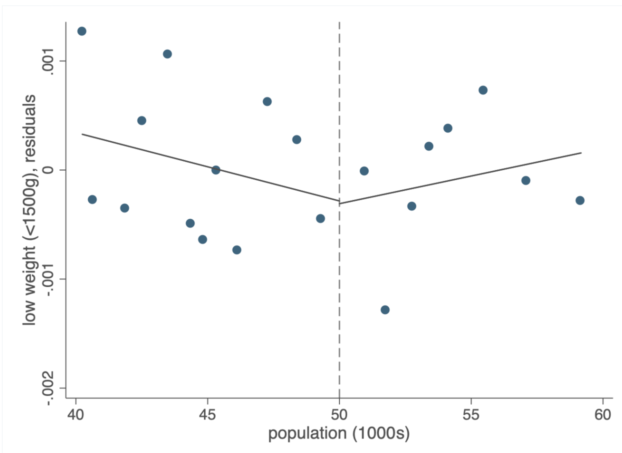
Figure 6: Effects on Birth Weight (g)



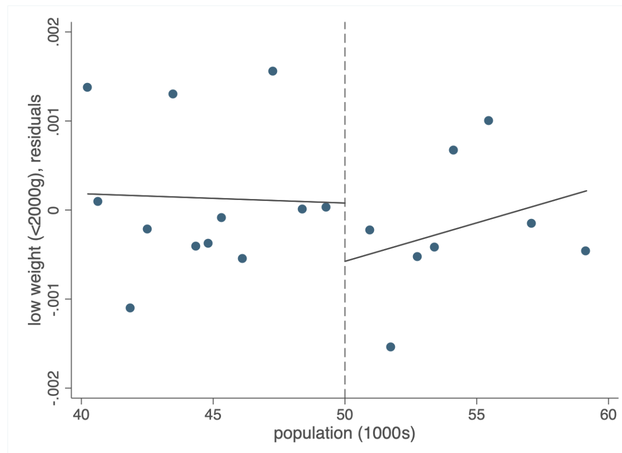
Note: The figure presents the regression discontinuity estimates of equation (1). It plots the residuals from a regression of birth weight on the controls and state and year fixed effects on different bins of population size and a linear fit of the relationship between the residuals and population at each side of the 50,000 inhabitants threshold.

Figure 7: Other Measures on Birth Weight

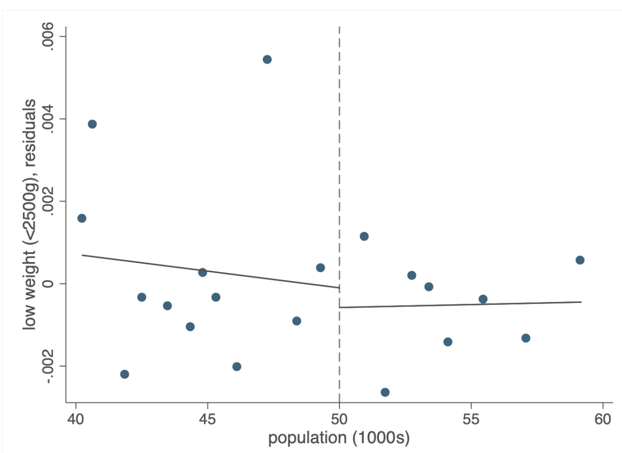
(a) Weight $<$ 1500 (%)



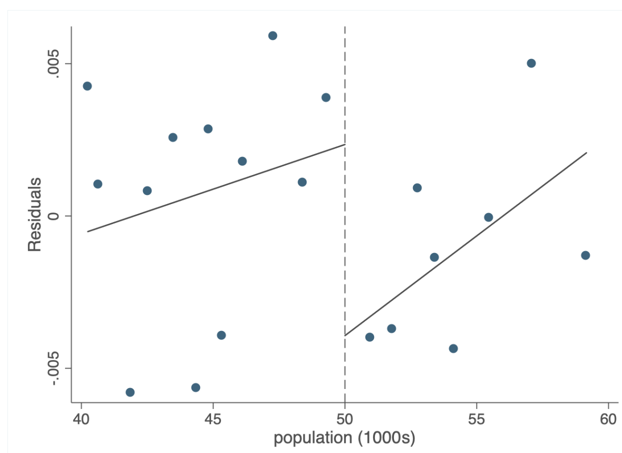
(b) Weight $<$ 2000 (%)



(c) Weight $<$ 2500 (%))



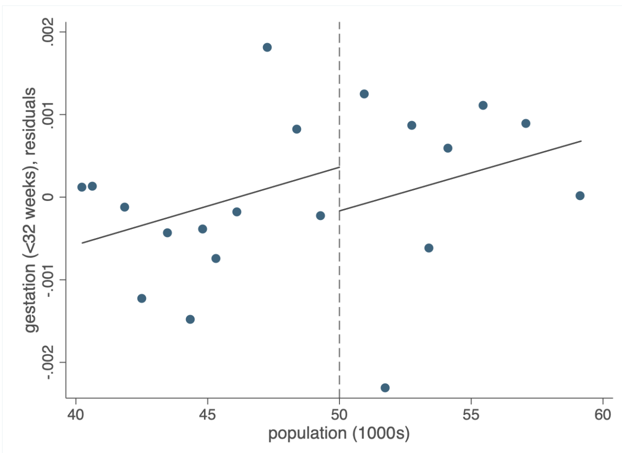
(d) Small for gest. age



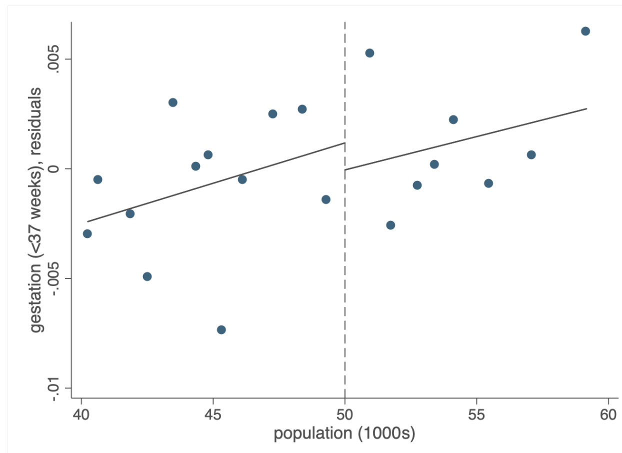
Note: The figure presents the regression discontinuity estimates of equation (1). It plots the residuals from a regression of the dependent variable on the controls and state and year fixed effects on different bins of population size and a linear fit of the relationship between the residuals and population at each side of the 50,000 inhabitants threshold. Each panel reports the results for a different dependent variable as indicated in the text.

Figure 8: Effects on Health at Birth

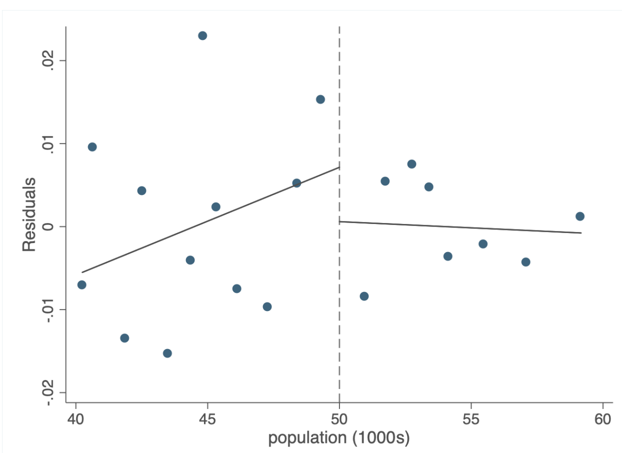
(a) $\leq$ 32 weeks of gestation (%)



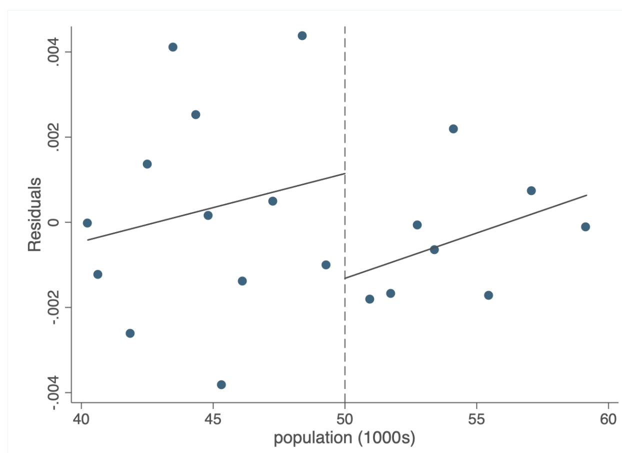
(b) $\leq$ 37 weeks of gestation (%)



(c) Low apgar 1 (%)



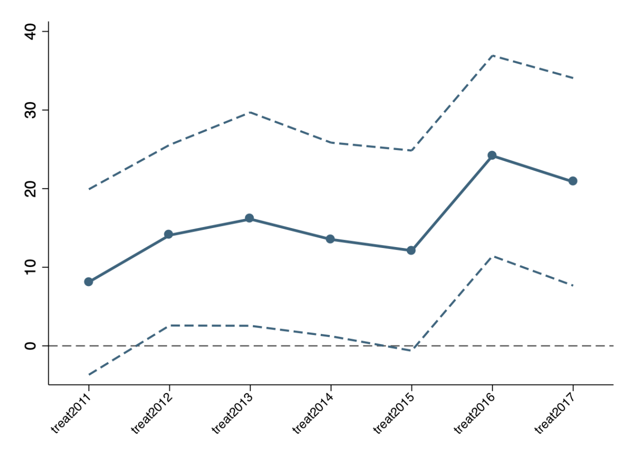
(d) Low apgar 5 (%)



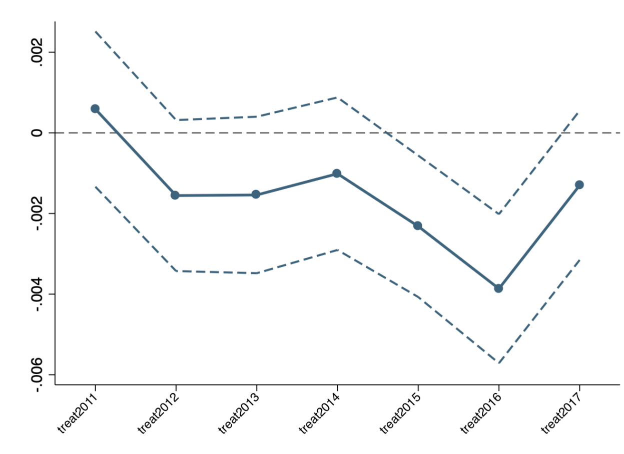
Note: The figure presents the regression discontinuity estimates of equation (1). It plots the residuals from a regression of the dependent variable on the controls and state and year fixed effects on different bins of population size and a linear fit of the relationship between the residuals and population at each side of the 50,000 inhabitants threshold. Each panel reports the results for a different dependent variable as indicated in the text.

Figure 9: Effects Over Time on Health at Birth

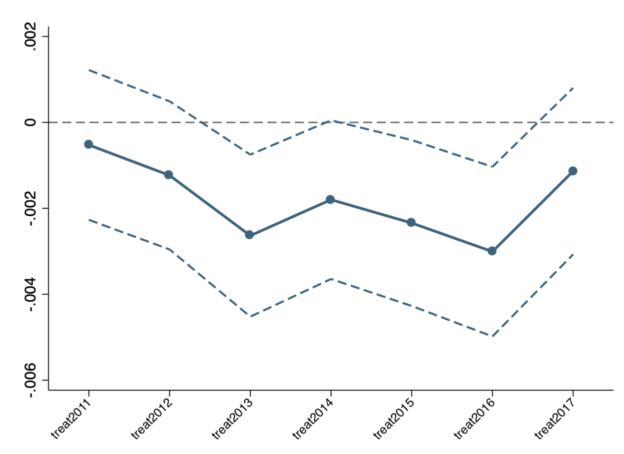
(a) Weight (g)



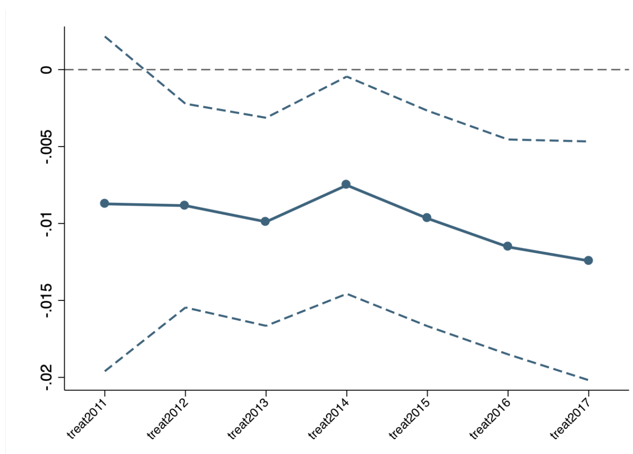
(b) Weight $<$ 2000 (%)



(c) $\leq$ 32 weeks of gestation (%)



(d) Small for gestational age



Note: The figure plots period-specific effects of the MCMV on indicators of health at birth (under 1 year) estimated using equation (2). The solid line reports the coefficients and the dashed line the 90% confidence interval. Panel A reports results for birth weight. Panel B reports the results for the share of births below 2,000 grams. Panel C reports the results for the share of gestations with less than 32 weeks. Panel D reports the results for small for gestational age.

Appendix to "The Effects of Better Houses on Infant Health"

A Decomposition of the Mechanisms

In this appendix, we explain in detail the procedure used to decompose the effects of the MCMV on birth weight on the effects of houses and their construction. Our decomposition exercise is inspired in the work of Dix-Carneiro et al. (2018). We assume the equilibrium relationship between the quality (and cost) of the housing stock, labor market conditions, and birth weight is constant over time and can be approximated using the following expression:

$$Y_{ist} = \beta_H H_{ist} + \beta_C C_{ist} + \gamma_t W_{is} + \eta_s + \epsilon_{ist}, \forall t \tag{A.1}$$

in which H_{is} denotes the quality of the housing stock in municipality i and state s, (proxied by the number of units of the MCMV built in the municipality), C_{is} the demand for labor in the construction sector in municipality i and state s (proxied by the the number of units of the MCMV under construction), $W_{is} = \{1, P_{is}, P_{is} \times T_{is}, Y^I_{is}, X_{is}\}$ is a vector of controls (constant, population, population interacted with dummy indicating whether the population is above the threshold, and initial municipality characteristics), η_s is a state fixed effect, and ε_{ist} an error term.

The quality of the housing stock and the labor market conditions are influenced by the rules of the MCMV. Specifically, we have:

$$H_{ist} = b^H_t T_{ist} + \gamma^H_t W_{is} + \eta_s + \epsilon^H_{ist}, \forall t \tag{A.2}$$

$$C_{ist} = b^C_t T_{ist} + \gamma^C_t W_{is} + \eta_s + \epsilon^C_{ist}, \forall t \tag{A.3}$$

in which $T_{is} = 1[P_{is} > 50,000]$.

Substituting equations (A.2) and (A.3) on equation (A.1), we obtain the following expression:

$$Y_{ist} = (\beta_H b_t^H + \beta_C b_t^C) T_{ist} + (\gamma_t + \beta^H \gamma_t^H + \beta^C \gamma_t^C) W_{is} + \eta_s + (\beta^H \epsilon_{ist}^H + \beta^C \epsilon_{ist}^C + \epsilon_{ist}), \forall t \tag{A.4}$$

Equation (A.4) shows that the RD coefficient of birth weight are the sum of the effects of houses and their construction weighted by the RD coefficients on houses and construction. Because this equation holds for all periods, it is possible to compute the effects of houses and their construction. To see this formally, define $\theta_t = \beta_H b_t^H + \beta_C b_t^C$ and suppose there are two periods (1 and 2). Then,

$$\begin{pmatrix} \theta_1 \\ \theta_2 \end{pmatrix} = \beta_H \begin{pmatrix} b_1^H \\ b_2^H \end{pmatrix} + \beta_C \begin{pmatrix} b_1^C \\ b_2^C \end{pmatrix} \tag{A.5}$$

Equation (A.5) expression demonstrates it is possible to obtain the coefficients β_H and β_C using the RD coefficients θ_1 and θ_2, b_1^H, b_2^H, b_1^C, and b_2^C and solving the system of linear equations it defines. The key hypothesis for this to be possible is that the coefficients β_H and β_C are stable over time. This might not be true, for instance, if the quality of the houses built changes over time.[19]

In our setting, we observe Y_{ist}, H_{ist}, C_{ist}, and T_{ist} for more than two periods. This implies we have an over-identified system with seven equations and two unknowns. However, to improve precision, we opt to perform the decomposition aggregating our data in two periods: initial years (2011-2014) and final years (2015-2017). The first period corresponds to the years in which the construction of houses was more intense but the changes

[19] Dix-Carneiro et al. (2018) have a system of two equations and five unknowns, implying they need to impose further restrictions and are just able to identify bounds on the parameters. They further show these bounds can be obtained using a procedure similar to a 2SLS.

in the housing stock were minor and the second period to the years in which the opposite occurs.

We estimate $b_1^H = 89.62$, $b_2^H = 289.92$, $b_1^C = 56.18$, $b_2^C = 23.86$, $\theta_1 = 12.97$, and $\theta_2 = 19.05$. Using these values to solve equation (A.5), we obtain $\beta_H = 0.054$ and $\beta_C = 0.145$. The parameters imply that improvements in housing quality and decreases in housing costs improve birth weight from 9.77-10.20 grams in the period 2011-2017. This corresponds to 60.4-66.5% of the mean effect of the MCMV on birth weight in this period. Improvements in labor market conditions due to the construction of the houses correspond to the rest 33.5-39.6% of the effect. The effect of houses increases over time as the changes in the housing stock become more important and construction activities end. The effect of houses is 4.81 grams in the first period and 15.58 grams in the second period. This corresponds to 37.2% and 81.8% of the total effects in these periods, respectively.

B Additional Tables and Figures

Table B1: Summary Statistics

	All			[40,000-60,000]		
	Mean	S.E	N	Mean	S.E	N
A. Demographics						
Population (2007)	33063	(197768)	5,565	48429	(5528)	235
Sh. young	0.347	(0.059)	5,565	0.355	(0.011)	235
Sh. old	0.121	(0.033)	5,565	0.105	(0.007)	235
Sh. rural hh	0.362	(0.220)	5,565	0.237	(0.057)	235
Sh. Migrants	0.106	(0.055)	5,565	0.0963	(0.013)	235
# households in deficit	1194	(7295.167)	5,565	1891	(159.910)	235
B. Labor and Schooling						
Sh. workers	0.612	(0.134)	5,565	0.624	(0.020)	235
Av. wage	808.5	(301.220)	5,565	899.6	(53.267)	235
less than 9 years	0.689	(0.090)	5,565	0.652	(0.021)	235
less than 9-11 years	0.132	(0.029)	5,565	0.142	(0.007)	235
less than 12-15 years	0.140	(0.050)	5,565	0.159	(0.013)	235
16 or more years	0.036	(0.0231)	5,565	0.0431	(0.005)	235
C. Infraestructure						
Sh. hh with water	0.645	(0.213)	5,565	0.688	(0.056)	235
Sh. hh with sewage	0.289	(0.312)	5,565	0.381	(0.053)	235
D. Health infraestructure						
# Hospitals	1.389	(6.995)	5,565	2.034	0.480	235
Presence of PSF	0.442	(0.497)	5,565	0.677	(0.145)	235
E. Outcomes						
Birth weight	3219	(90.473)	5,565	3219	(17.819)	235
Low birth (< 2500)	0.067	(0.031)	5,565	0.0684	(0.005)	235
Apgar5	9.332	(0.370)	5,565	9.293	(0.117)	235
Total infant hosp. (up to 1 age)	192.492	(110.107)	5,565	205.6	(27.534)	235
infectious	33.97	(34.293)	5,565	38.40	(8.080)	235
respiratory	76.38	(66.71)	5,565	80.09	-15.368	235
perinatal	50.31	(41.90)	5,565	54.15	(9.005)	235
total infant death (up to 1 age)	(15.39)	14.43	5,565	15.36	(1.663)	235
infectious	0.77	(2.783)	5,565	0.778	(0.298)	235
respiratory	0.84	(3.396)	5,565	0.832	(0.352)	235
perinatal	9.068	(10.813)	5,565	9.163	(1.285)	235

Notes: The table presents mean values for municipality characteristics, measured in the baseline period. Population from 2007 comes from IBGE. The remaining variables from panels A-C come from the 2010 Population Census. The variable from panel D come from CNES/Datasus and the ones from Panel E come from SINASC, SIH, and SIM.

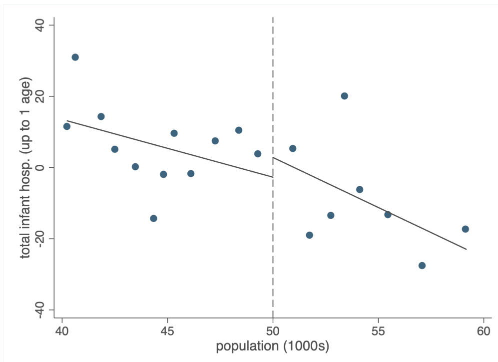
Table B2: **Effect on Weight at Birth controlling for percapita FPM**

	(1)	(2)	(3)	(4)	(5)	(6)
			Birth Weight			
1[pop >50,000]	14.47**	16.17**	14.80**	15.55**	14.29**	15.59**
	(6.52)	(6.40)	(6.11)	(6.55)	(6.20)	(6.08)
Mean	3214.34	3214.34	3214.34	3214.34	3217.34	3217.51
RD bandwidth	±10	±10	±10	±10	±11.10	±11.17
Kernel	Triangular	Triangular	Uniform	Uniform	Triangular	Triangular
Observations	1645	1645	1645	1645	1862	1883
Controls	FPM	All	FPM	All	FPM	All

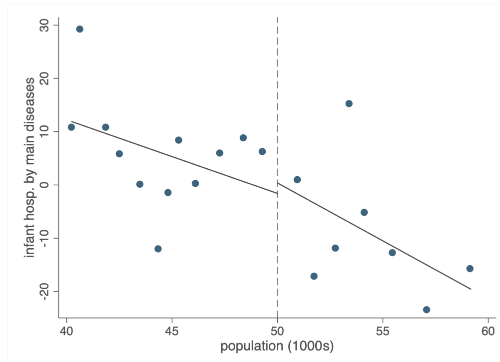
Notes: The table reports regression discontinuity estimates of the effects of the MCMV on measures of birth weight as dependent variable. Column 1 reports estimates obtained using a triangular kernel and a bandwidth of 10,000 inhabitants and including controls for the the weight birth at the baseline and control for per capita FPM. Column 2 adds the other controls for socioeconomic characteristics and health infraestructure. Column 3 reports estimates obtained using an uniform kernel and a bandwidth of 10,000 inhabitants and including controls for the the weight birth at the baseline and control for percapita FPM. Column 4 adds the other controls. Column 5 present the estimates obtained using a triangular kernel and the optimal bandwidth of Calonico et al. (2014) controlling for initial condition and per capita FPM, while column 6 adds all the controls. Standard errors clustered at the municipality level are reported in parenthesis. *** p<0.01; ** p<0.05; * p<0.10

Figure B1: Effects on infant hospitalization

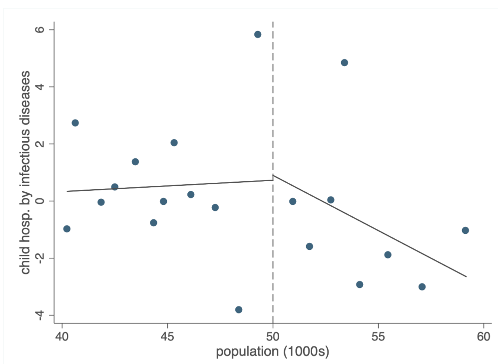
(a) Infant hosp. (overall)



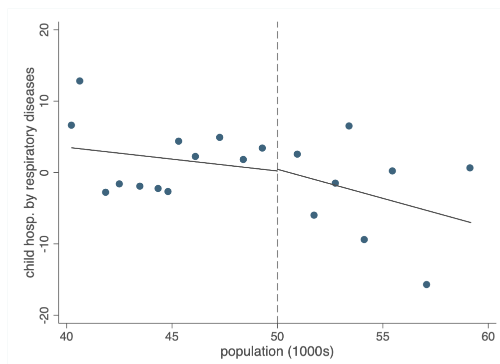
(b) Main causes



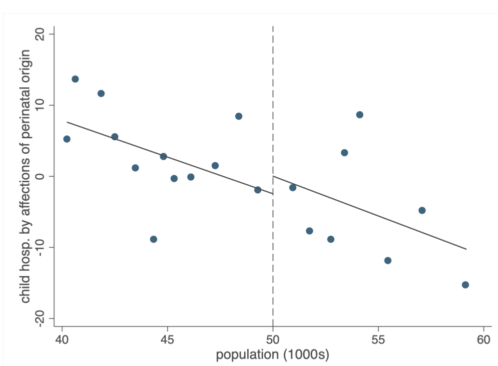
(c) Infectious diseases



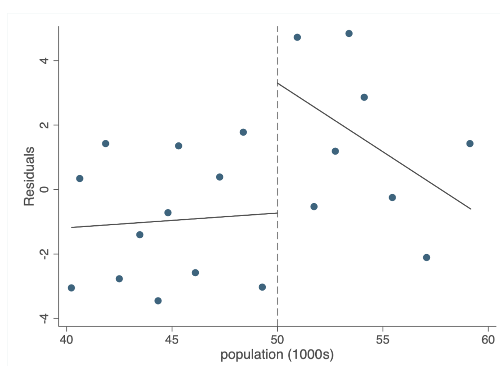
(d) Respiratory diseases



(e) Perinatal origin



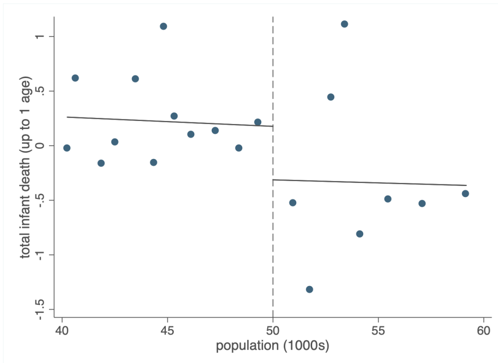
(f) Residual



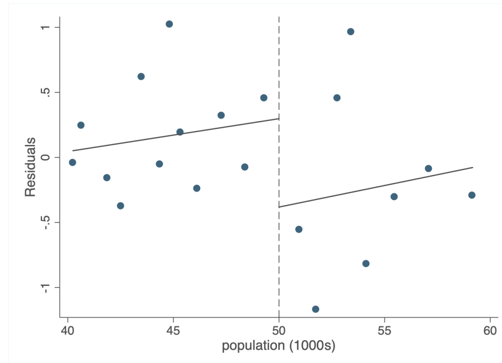
Note: The reports regression discontinuity estimates of equation (1) using measures of morbidity of children under 1 year as the outcomes of interest. We report results based on our preferred specification –triangular kernel, 10,000 inhabitants bandwidth, and the controls. Panel A reports total chil death, panel B aggregates the main causes considered (infectious and parasitic diseases, respiratory diseases, and perinatal conditions) and Panels C-D focus on each of these causes separately (infectious and parasitic diseases, respiratory diseases, and perinatal conditions, respectively). Panel E presents the estimates for the residual causes.

Figure B2: Effects on infant deaths

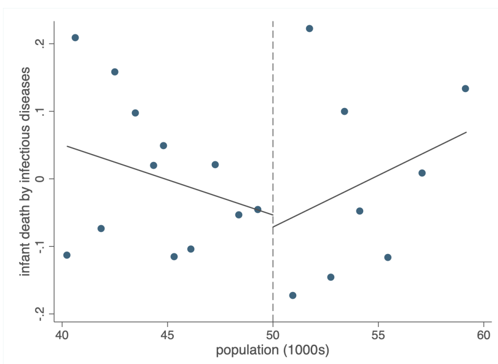
(a) Infant death (overall)



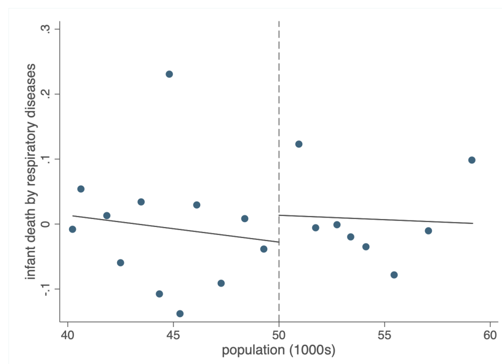
(b) Main causes



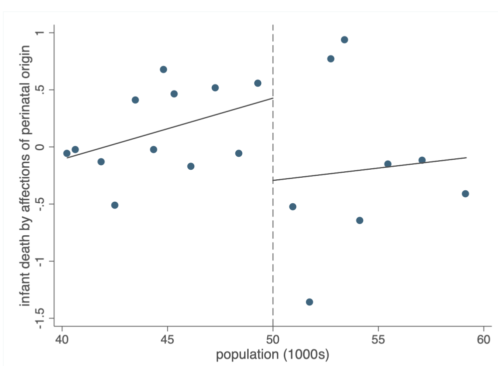
(c) Infectious diseases



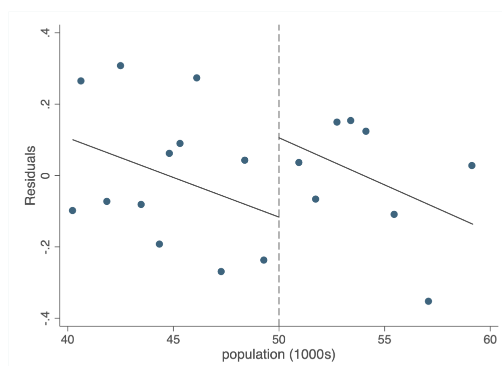
(d) Respiratory diseases



(e) Perinatal origin

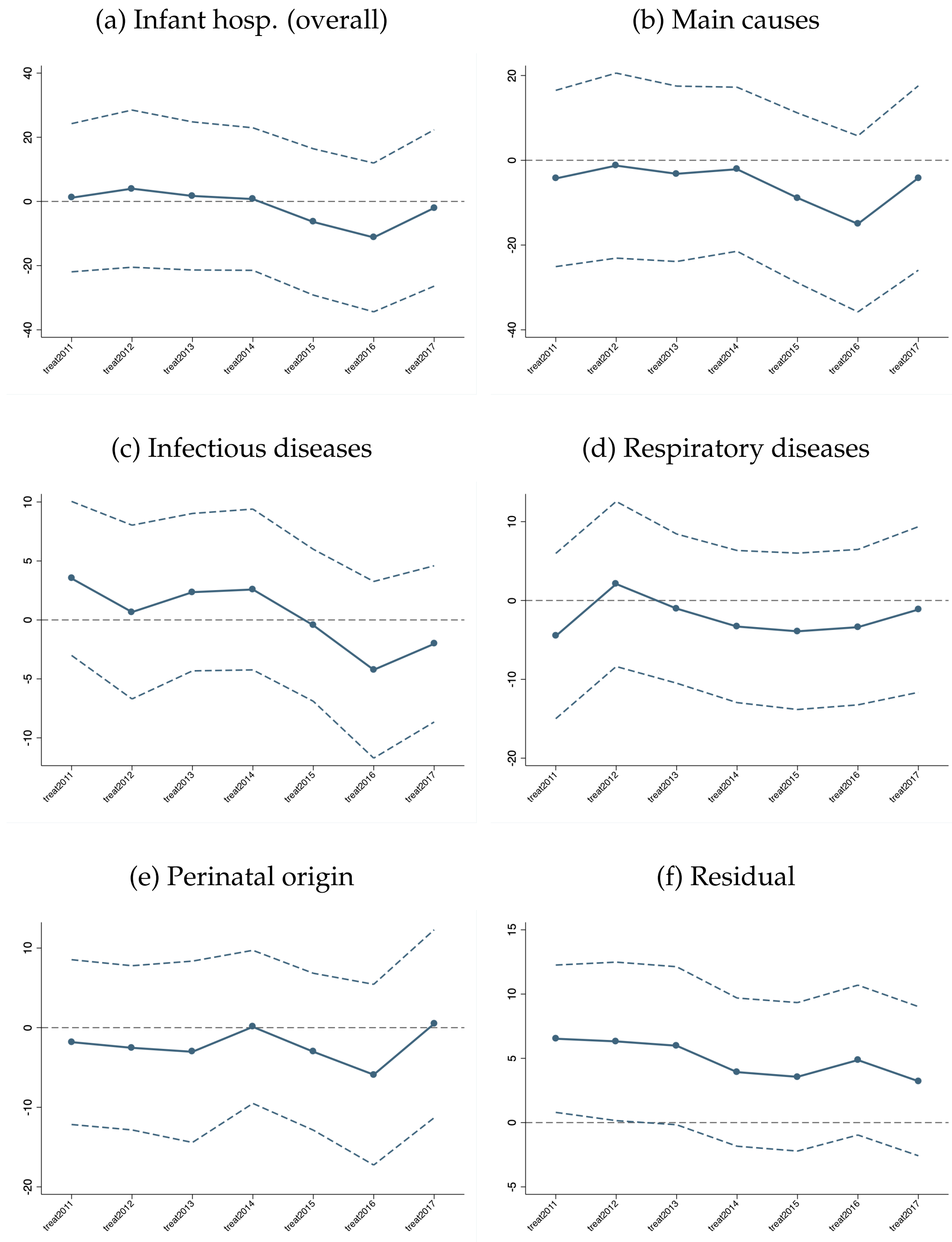


(f) Resisual



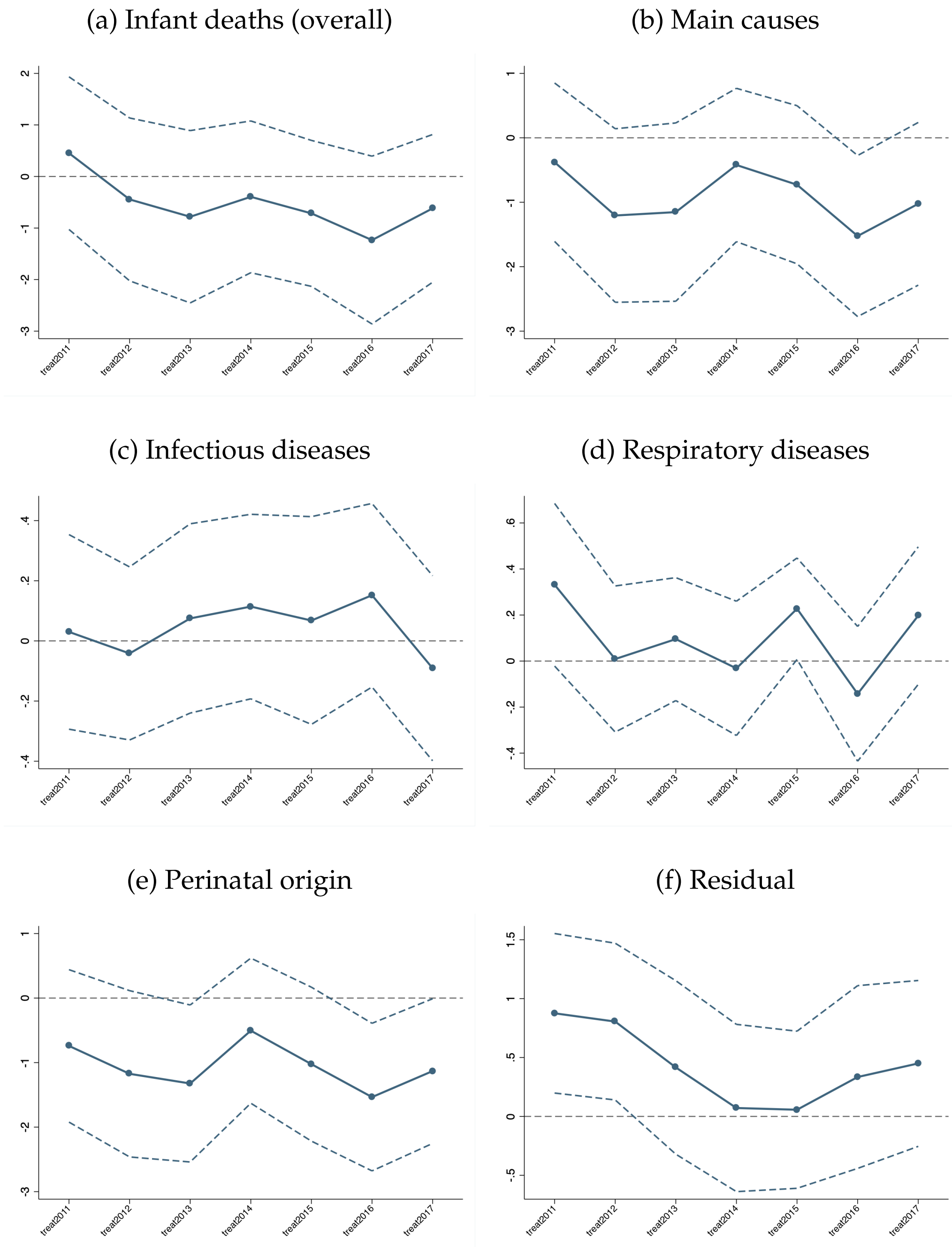
Note: The reports regression discontinuity estimates of equation (1) using measures of mortality of children under 1 year as the outcomes of interest. We report results based on our preferred specification –triangular kernel, 10,000 inhabitants bandwidth, and the controls. Panel A reports total chil death, panel B aggregates the main causes considered (infectious and parasitic diseases, respiratory diseases, and perinatal conditions) and Panels C-D focus on each of these causes separately (infectious and parasitic diseases, respiratory diseases, and perinatal conditions, respectively). Panel E presents the estimates for the residual causes.

Figure B3: Effects Over Time on Infant Hospitalization



Note: The figure plots period-specific effects of the MCMV on infant hospitalization (under 1 year) estimated using equation (2). The solid line reports the coefficients and the dashed line the 90% confidence interval. Panel A reports results for hospitalizations in general. Panel B reports the results aggregating the main causes considered (infectious and parasitic diseases, respiratory diseases, and perinatal conditions). Panels C-E reports the results for each of these causes separately (infectious and parasitic diseases, respiratory diseases, and perinatal conditions, respectively). Panel F presents the estimates for the residual causes.

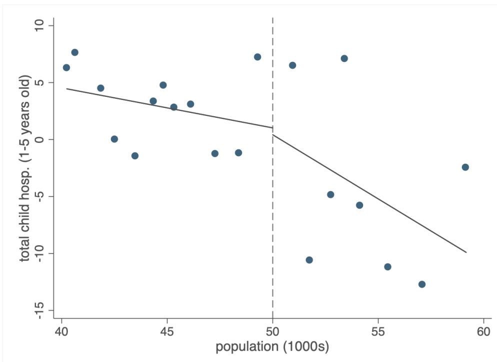
Figure B4: Effects Over Time on Infant Deaths



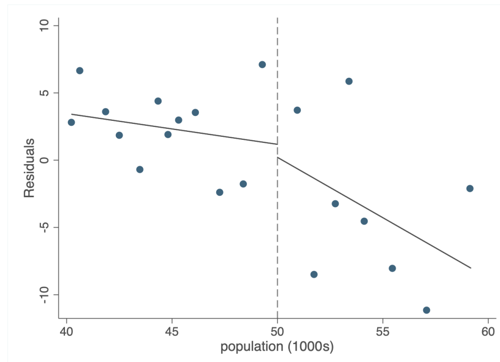
Note: The figure plots period-specific effects of the MCMV on infant mortality (under 1 year) estimated using equation (2). The solid line reports the coefficients and the dashed line the 90% confidence interval. Panel A reports results for hospitalizations in general. Panel B reports the results aggregating the main causes considered (infectious and parasitic diseases, respiratory diseases, and perinatal conditions). Panels C-E reports the results for each of these causes separately (infectious and parasitic diseases, respiratory diseases, and perinatal conditions, respectively). Panel F presents the estimates for the residual causes.

Figure B5: Effects on child hospitalization

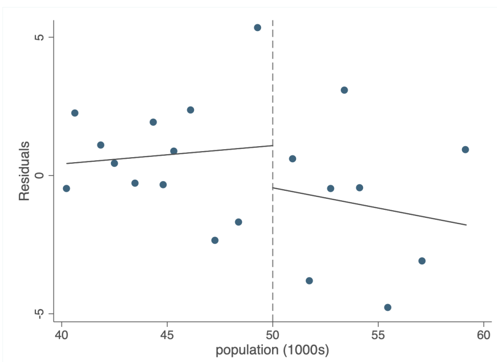
(a) Child hosp. (overall)



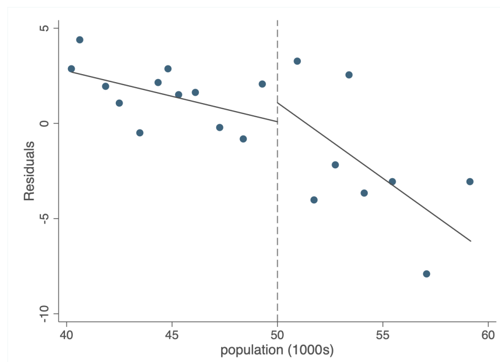
(b) Main causes



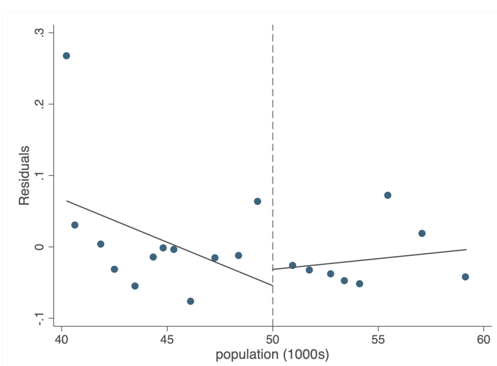
(c) Infectious diseases



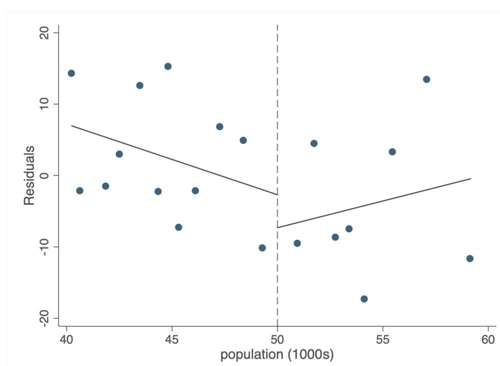
(d) Respiratory diseases



(e) Perinatal origin



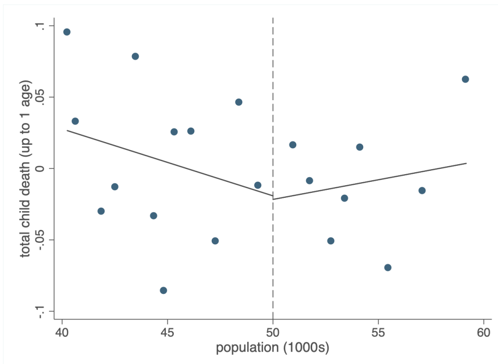
(f) Residual



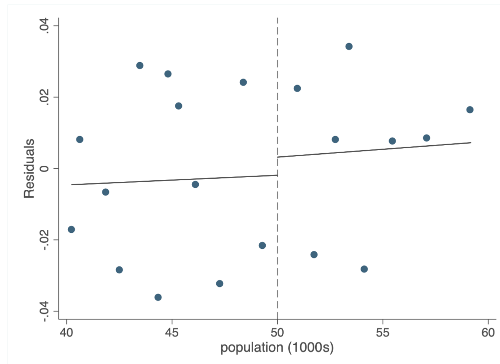
Note: The figure plots period-specific effects of the MCMV on infant hospitalizations (1 to 5 years) estimated using equation (2). Panel A reports results for hospitalizations in general. Panel B reports the results aggregating the main causes considered (infectious and parasitic diseases and respiratory diseases). Panels C-E reports the results for each of these causes separately. Panel F presents the estimates for the residual causes.

Figure B6: Effects on child deaths

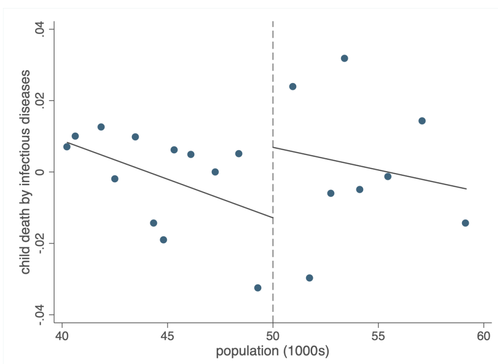
(a) Child death (overall)



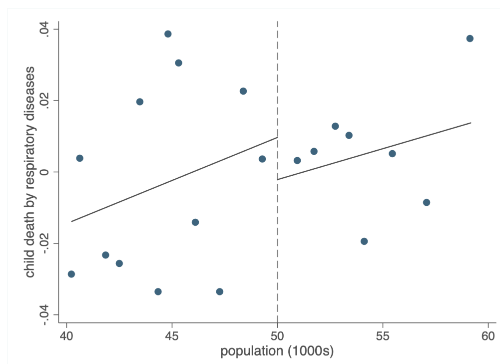
(b) Main causes



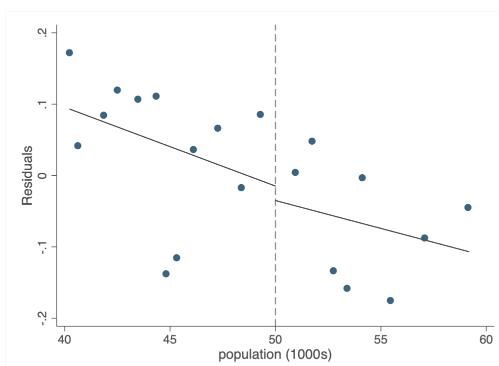
(c) Infectious diseases



(d) Respiratory diseases



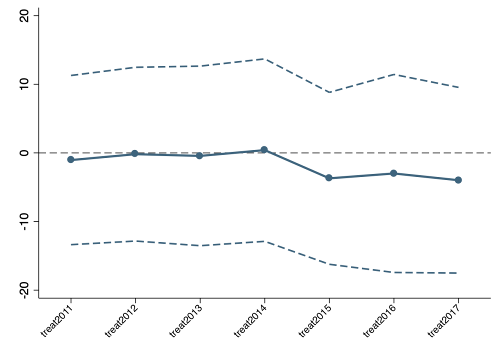
(e) Residual



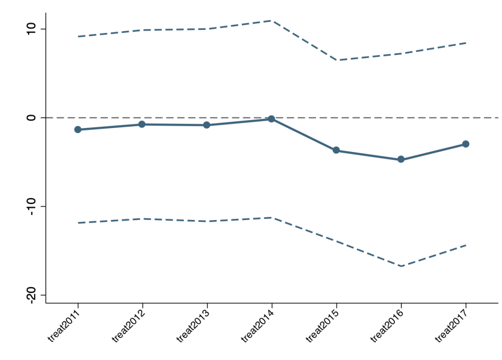
Note: The figure plots period-specific effects of the MCMV on infant mortality (1 to 5 years) estimated using equation (2). Panel A reports results for hospitalizations in general. Panel B reports the results aggregating the main causes considered (infectious and parasitic diseases and respiratory diseases). Panels C-D reports the results for each of these causes separately. Panel E presents the estimates for the residual causes.

Figure B7: Effects Over time on Child Hospitalization

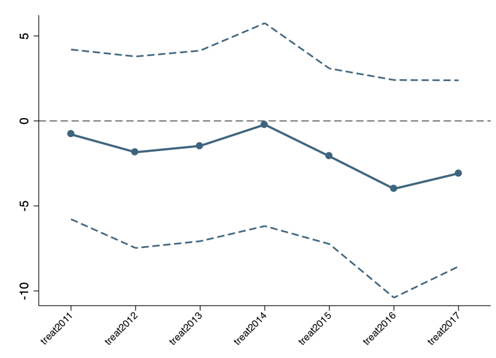
(a) Child hosp. (overall)



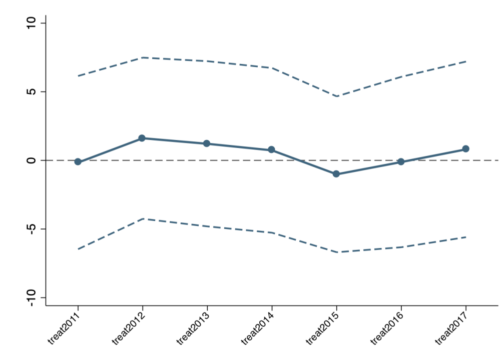
(b) Main causes



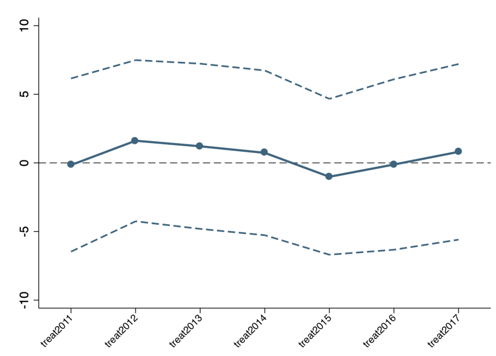
(c) Infectious diseases



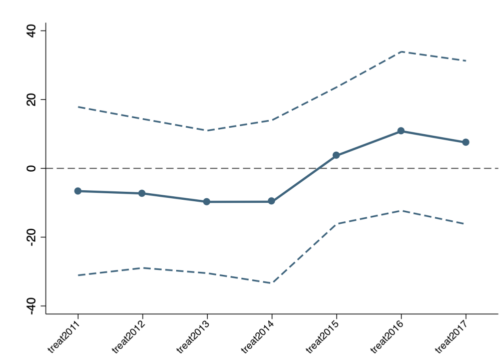
(d) Respiratory diseases



(e) Perinatal origin



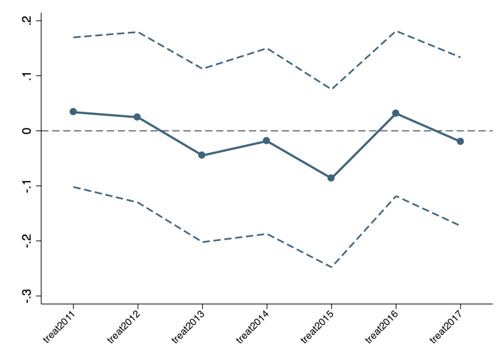
(f) Residual



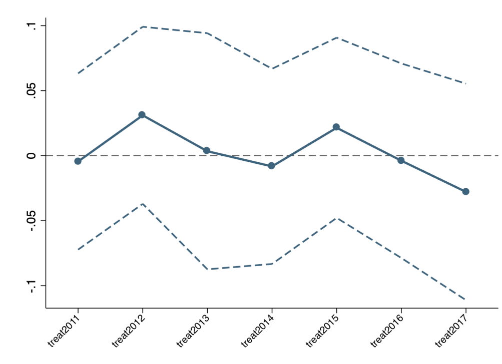
Note: The figure plots the estimated coefficients of equation (2) to obtain period-specific effects of the MCMV on hospital admission for children more than 1 and less than 5 years old. The solid line reports the coefficients and the dashed line the 90% confidence interval. Panel A aggregates the main causes considered (infectious and parasitic diseases, respiratory diseases, and perinatal conditions) and Panels C-E focus on each of these causes separately (infectious and parasitic diseases, respiratory diseases, and perinatal conditions, respectively). Panel F presents the estimates for the residual causes.

Figure B8: Effects Over Time on Child Deaths

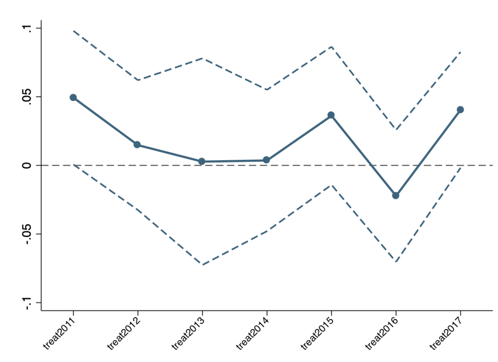
(a) Child death (overall)



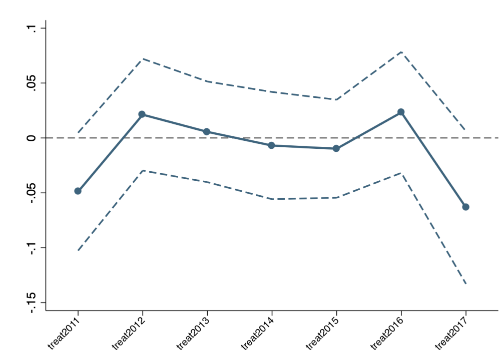
(b) Main causes



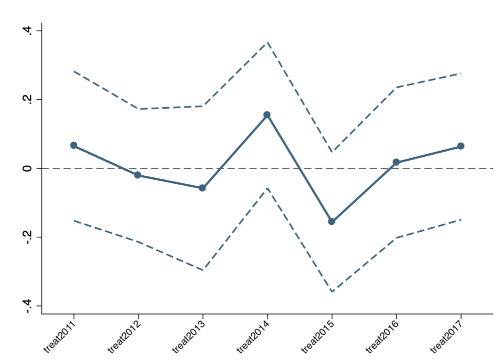
(c) Infectious diseases



(d) Respiratory diseases



(e) Residual



Note: The figure plots the estimated coefficients of equation (2) to obtain period-specific effects of the MCMV on child mortality rate. The solid line reports the coefficients and the dashed line the 90% confidence interval. Panel A aggregates the main causes considered (infectious and parasitic diseases and respiratory diseases) and Panels C-D focus on each of these causes separately. Panel E presents the estimates for the residual causes.