Health Spending and Health Outcomes: Evidence from a Constitutional Reform in Brazil

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Abstract

This paper treats Brazil as a case study to document the causal effects of health spending on infant mortality. By leveraging the variation in health spending prompted by Brazil's 29th Constitutional Amendment of 2000, we are able to document not only the effects of health spending on infant mortality, but also the links in the chain connecting spending to health outcomes. We show that (a) a constitutional amendment mandating minimum health spending effectively changes spending patterns both for municipalities which were previously below spending floors as well as those that were above spending floors; (b) these increases in health spending translate into greater primary care coverage, higher supply of hospitals and low-skilled professionals, and; (c) that spending increases in low-spending municipalities bring about moderate reductions in infant mortality within 24 hours and due to perinatal conditions, as well as long term reductions in total infant mortality and infant mortality amenable to primary care (among other causes). Our results contribute to the literature on the impacts of health spending by providing one of the first well-identified causal parameters of the relationship between spending and health outcomes.

JEL Codes: I1, I3, O5
Keywords: Health spending; health care reform; health care production; infant mortality.

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1 Introduction

Understanding the production function of health care is complicated, given that this production function is multi-faced. It covers labour provision (Custer et al., 1990), infrastructure and drugs (Auster et al., 1969), micro-level health seeking behaviour (Lleras-Muney, 2005), among others. What these factors have in common however, is that at least in theory they are amenable to be modified by greater investments: salaries for medical workers can boost primary care coverage, often at relatively low cost (Banke-Thomas et al., 2020), and information campaigns can shape health-seeking behaviour and health outcomes at low cost (see, eg Hinde et al. (2015)). Nevertheless, for mandated spending reforms to impact final health outcomes in practice, a number of links must be made from initial legislation at the beginning of the chain to measurable health stocks at the end of the chain. Should any individual step from legislative reform to health spending to health inputs to health outputs break down, health spending reform will not necessarily lead to improvements in measured health.

The last decades have been marked by significant increases in public health expenditure around the globe. Data from the World Bank (2019) reveals that per capita public health expenditure more than doubled since the turn of the century. A question that still remains unanswered is how effective this type of expenditure is in reducing mortality, especially among developing countries, where mortality is relatively high, and health systems are often fragile (Mills, 2014). While certain within- or across country studies exist, for example Crémieux et al. (1999a), these are generally based on country or state fixed effect specifications, or simply cross-space and cross-time observational set-ups. Moreover, most of the studies which seek to establish this causal relationship are not able to analyse the links in the chain connecting health spending and health outcomes, and thus offer only a partial picture of the full nature of public spending reform and its impacts.

In this article, we seek to study the question of whether and how spending reform can result in micro-level improvements in health. To do so, we seek to answer several questions along the chain connecting public health spending to health outcomes. Specifically, how do municipalities allocate resources when increasing health spending? How do expenditures translate into health inputs, such as health infrastructure, health services, human resources and ambulatory care? And how do all of these affect the specific measure outcome of infant mortality?

To answer these questions we treat Brazil as case study. Specifically, we leverage the variation in municipal public health spending generated by Brazil's 29th Constitutional Amendment of 2000, which brought about a sudden and sharp increase in spending decentralised at the level of each municipality. We seek to identify the causal chain of effects, culminating in the causal effects of health spending on infant mortality. To do this, we combine many sources of administrative health databases, and a difference-in-difference design, based on a continuous treatment, defined based on baseline spending gaps to a specific minimum spending threshold.

After a decade of public health under-funding, in September of 2000, the Brazilian Congress enacted the 29th Constitutional Amendment. It established the minimum share of resources that the federal, state and municipal governments need to spend on the provision of public health services. This institutional reform was responsible for increasing public health spending and for raising the direct participation of states and municipalities in the financing of health care (Piola et al., 2013). While it is hard to imagine scenarios in which increasing spending would not lead to improvements in outcomes, the overall evidence on the impacts of health spending on health outcomes it is still quite mixed and weak (we discuss this literature at more length in section 2.1 here). The main contributions of this paper lies not only in providing one of the first well identified causal parameters on the relationship between health spending and infant mortality, but also in exploring the pathways through which health spending affects infant mortality. The richness of Brazilian health data allow us to construct a unique panel data set, covering fiscal data, health inputs and health outcomes, to provide an entire picture of the impact and magnitude of the health care spending reform, as it propagates through the health system.

Our results suggest that the constitutional reform has promoted substantial increases in local health spending. These increases took place mainly through administrative, investment and human resource spending, which in turn has been translated into greater primary care coverage, and a greater supply of municipal hospitals and health care human resources. This shift in health inputs had led to important reductions in infant mortality rates within 24 hours of birth and in infant mortality rates caused by perinatal conditions, with estimated elasticities ranging between -0.12 and -0.27 for these mortality rates. Moreover, we find some long term effect on total infant mortality, infant mortality amenable to primary care and infant mortality caused by infectious and respiratory diseases.

The remainder of this article is organized as follows. Section 2 discusses previous evidence on health spending and health outcomes, and outlines the institutional background and the 29th Constitutional Amendment. In Section 3 we detail the data used in this paper. In Section 4 we lay out our empirical strategy and identifying assumptions. Results are presented in Section 5, and finally, we briefly conclude in Section 6.

2 Background and Institutional Context

2.1 Prior Evidence on Health Spending and Healthcare Outcomes

Previous research has documented the relationship between health spending and measures of health stocks (generally mortality), but most such studies focus on aggregate cross-country relationships, rather than seeking to provide well-identified parameters of the causal relationship between health spending and mortality. Most of the previous research relies on single sections of cross-country data and usually cannot account for unobserved heterogeneity and existing trends that could bias estimations. Filmer and Pritchett (1999) use an instrumental variable approach on a global panel data, finding no significant impacts on infant and child mortality. Bokhari et al. (2007), using a similar approach on a cross-section for the year 2000, find small but significant effects of health spending on child and maternal mortality. More recently, Moreno-Serra and Smith (2015) find very similar effects, reinforcing this evidence. Nixon and Ulmann (2006), using a 15 year panel data for 15 European Union members, finds that increases in health spending are associated with large reductions in infant mortality. Gupta et al. (2002) analyse this relationship for 50 developing and transition countries and find effects on infant and child mortality that are sensitive to different specifications. Working with larger and richer data set of developing and transition countries, Gupta et al. (2003) estimates suggests that the effects of health spending on infant and child mortality are twice as large among the poor. Notwithstanding, a recent review of cross-country studies suggests that, in general, these cross-country results are sensitive to robustness checks (Nakamura et al., 2020).

Some of the identification issues faced by the cross-country studies are partially addressed by the use of fixed effects in the micro-level literature. The findings of Crémieux et al. (1999a) suggest that increases in health expenditure are associated with decreases in the infant mortality rate and increases in life expectancy, on a panel of data for Canadian provinces. Bhalotra (2007), working with a rich panel data at the individual level in India, presents micro-level models estimating the impact of health expenditures on the risk of infant mortality that suggest no significant contemporaneous effect, but long term and small effects for rural residents. Research for Brazil suggests that increases in health spending are associated with increases in primary care coverage, the number of mothers attending seven or more prenatal visits, and with decreases in infant mortality rates, especially for the poorer municipalities (Paixão and Ferreira, 2012; Castro et al., 2019).

Recent work from (Castro et al., 2021), also set in Brazil, draws identification from discontinuity in federal spending grants provided by the government. Using a panel of small Brazilian municipalities for the period of 2002-2012 and a regression discontinuity design approach, this study finds large and significant effects of health spending on infant mortality, with elasticities ranging from -0.5 to -0.9. Moreover, they show that health spending presents strong spatial externalities, with the population of neighboring municipalities also benefiting from increases in health spending. However, the issue with this approach is that it leverages exogenous transfers to municipalities from a federal grant that have been shown to also impact education outcomes and poverty reduction (Litschig and Morrison, 2013), which in turn might be correlated with mortality outcomes. Disentangling the drivers of mortality reductions in this setting is rather difficult.

2.2 Constitutional Amendment 29

The promulgation of the 1988 Brazilian Federal Constitution (CF/1998) promoted profound changes in the provision of health care in Brazil as it established universal and egalitarian access to health care as a constitutional right. Under this context, the Unified Health System (*Sistema Único de Saúde* – SUS) was created to provide free and universal health care to all citizens. The CF/1988 also established that the provision of health care would be financed by the Social Security System budget, together with social assistance and the public pension system, with resources coming from the federal, state and municipal budgets, and specific tax instruments. The implementation of new social rights, in a period of hyperinflation and macroeconomic restrictions, led to several budget disputes and crises in the financing of health care (Piola et al., 2013). In order to secure resources for the SUS, the 29th Constitutional Amendment (*Emenda Constitutional 29* – EC/29) was enacted in September of 2000.

In August of 1999 the President of the Brazilian Lower House determined the attachment of two old Constitutional Amendment Proposals (*Proposta de Emenda Constitucional* - PEC) that were not approved – 169 of 1992 and 82 of 1995 – into a new proposal. While the PEC/169 intended to secure 30% of the federal Social Security budget to the provision of public health care and 10% of state and municipalities tax income, the PEC/82 intended to secure all resources from taxes over profits and revenues, that were originally financing the whole Social Security budget, to the provision of health care. The new proposal was approved by the Lower House in November of 1999 and sent to the Upper House, where it was approved in September of 2000 as the EC/29.

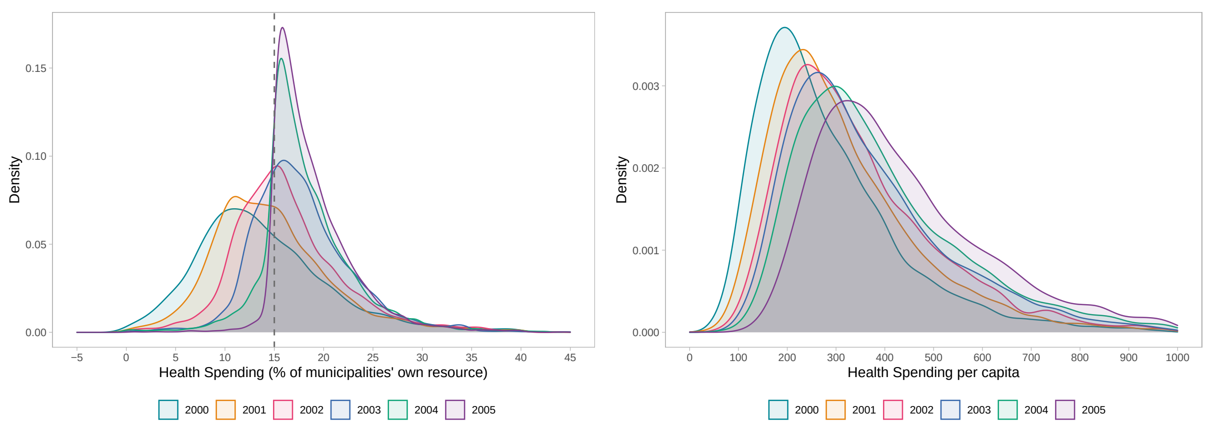
The EC/29 established the minimum amount of resources that each government level[1] needed to spend on the provision of public health services. According to Art. 7 of EC/29, from 2000 to 2004, the federal government should spend in the year of 2000 the amount spent in 1999 increased in 5% and from 2001 to 2004 correct this value by the GDP growth; the state governments should spend 12% of its tax income net of transfers to

[1]Brazil's political system is organized in a federalist structure that encompasses three independent government levels. The federal government, 26 states and the federal district, and 5570 municipalities

municipal governments; and municipalities should spend 15% of its tax income and income from constitutional intergovernmental transfers (own resource spending). The states and municipalities spending less than the amount established when the EC/29 was enacted would have to gradually increase its expenditure, decreasing the distance to the target by at least one fifth a year and spending at least 7% of its tax income [2]. The fiscal structure in Brazil is characterized by high centralization of the tax income and decentralization of expenditure, that occurs via federal transfers to municipalities. Municipalities play a major role in the provision of public services and in the implementation of public policies, with a substantial level of autonomy in the allocation of resources.

Figure 1: Spending Density Plots

(a) Health Spending (% of own resources) (b) Health Spending per capita (2010 R$)



Notes: Density plots calculated using SIOPS data (see Section 3 for more details). Dotted line in Figure 1a marks the EC/29 target (see Section 2 for more details).

2.3 Municipal Health Expenditure after the EC/29

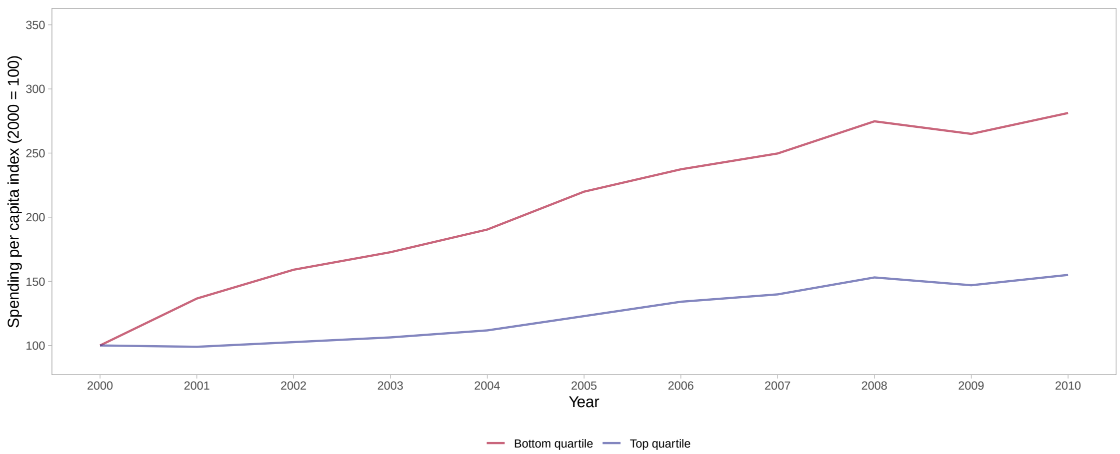
Figure 1a shows the distribution of municipalities according to their share of own resources spent in public health. While in 2000, our baseline year, most of the municipalities spent less than 15%, in 2005 the great majority of municipalities were complying with the target stipulated by the EC/29. Figure 1b presents the distribution of municipalities according to their health spending per capita (in 2010 R$). One could suggest two facts about this

[2]The EC/29 established the shares of resources that governments needed to spend only until 2004. A Complementary Law would have to be approved to regulate the EC/29 from 2005 on. In the a absence of a Complementary Law the share of resources defined by the Art. 7 would apply. The Complementary Law was only approved in 2012, but it made no changes to the Art. 7.

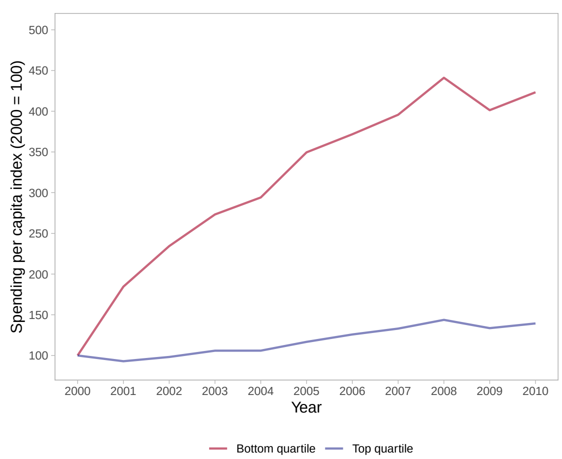
figure. First, there was a significant increase in the average health spending per capita and second, there was also some increase in the inequality of health spending per capita across municipalities.[3]

Figure 2: Health Spending Trends

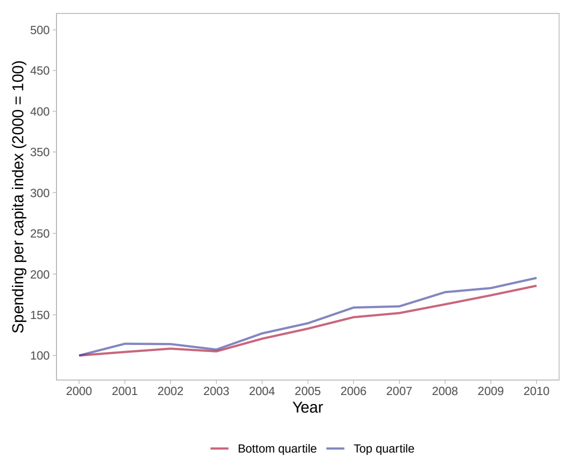
(a) Total Health Spending (2000 = 100)



(b) Health Spending from Own Resources (2000 = 100)



(c) Health Spending from Transfers (2000 = 100)



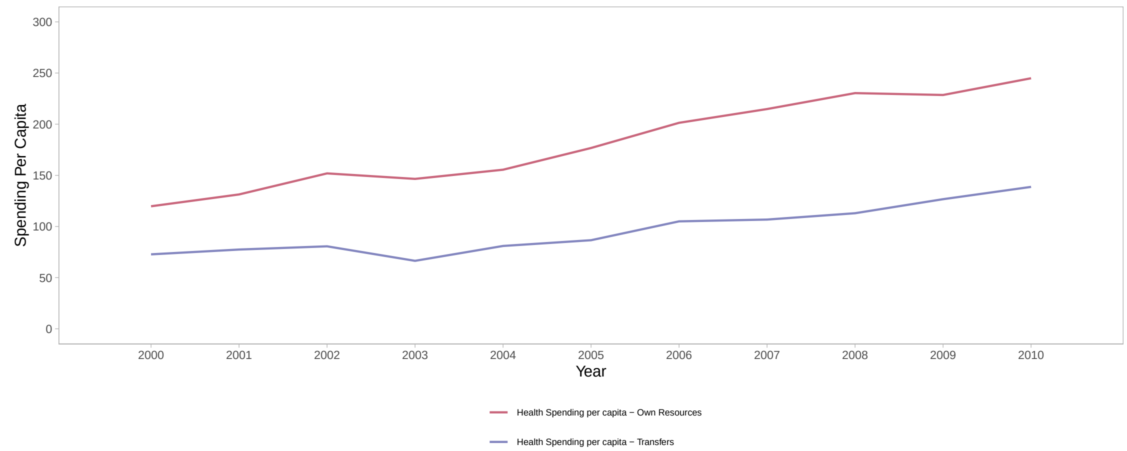
Notes: Trends calculated using SIOPS spending data (see Section 3 for more details).

Figure 2 present trends in health spending at the municipality level converted into indices set at 100 in 2000, for the bottom and top quartile of the distribution of the share of own resources spent in health care. Figure 2a shows that the municipalities in the bottom of the distribution presented much higher increase in health spending relative to the

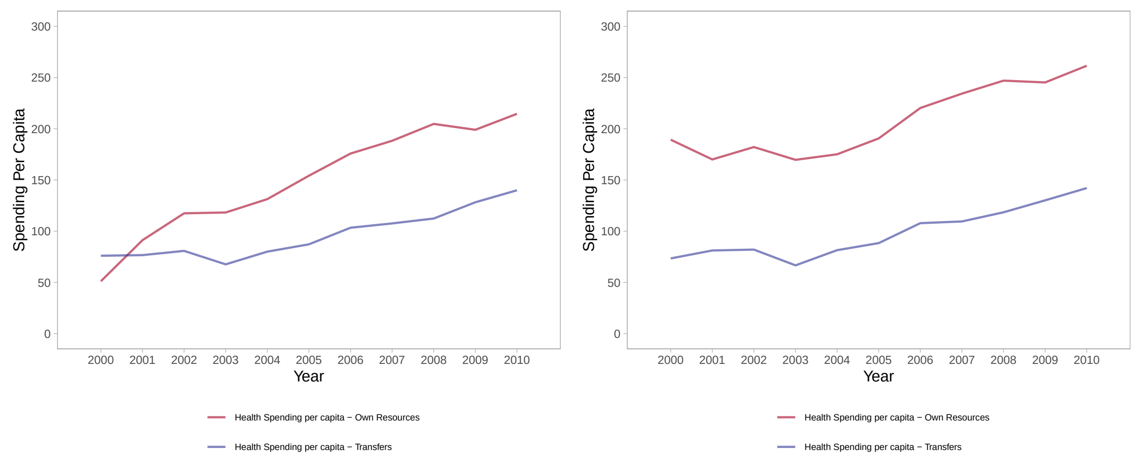
[3] Piola et al. (2013) highlights that the EC/29 provided a broad definition of health care that led some states and municipalities to include in this account expenditures that should not be considered part of expenditures related to the provision of public health services by the SUS.

Figure 3: Health Spending Trends

(a) Health Spending by Source (R$2010) - Full Sample



(b) Health Spending by Source (R$2010) - Bottom Quartile (c) Health Spending by Source (R$2010) - Top Quartile)

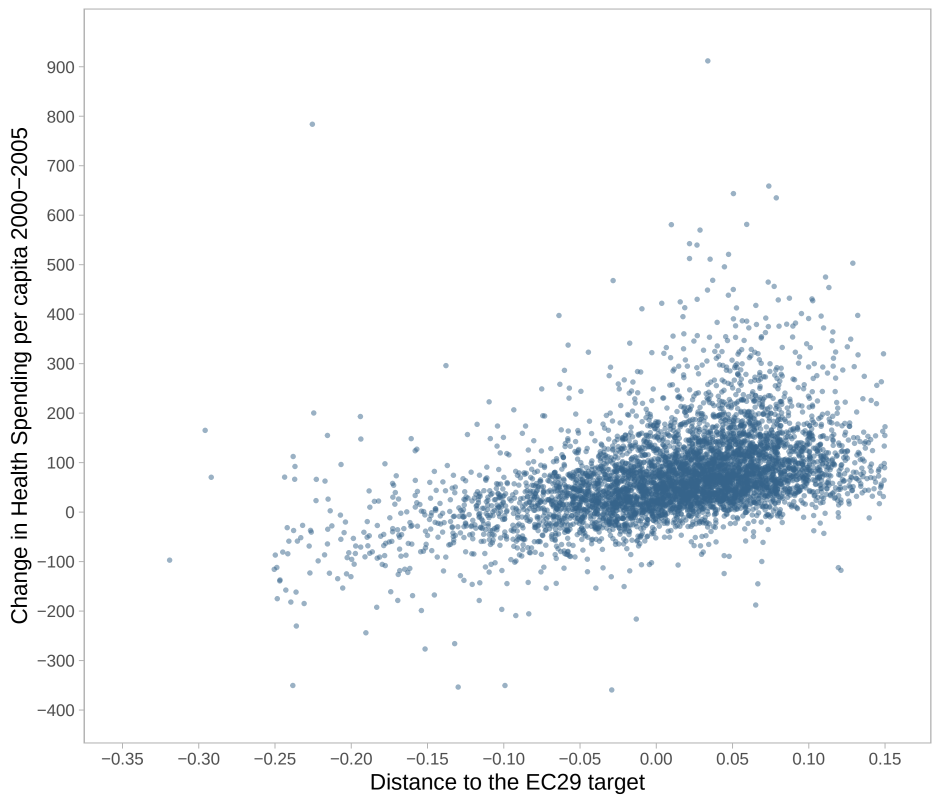


Notes: Trends calculated using SIOPS spending data (see Section 3 for more details).

municipalities on the top of the distribution. Moreover, as shown in Figure 2b and 2c, expenditure coming from own resources explains almost all the difference in the health spending increase between the bottom and top quartile. Figure 3 plots trends for health spending per capita by source. Own resources has always been the main source of public health spending for municipalities, but the trends suggest that it gained even more importance after the EC/29 (Figure 3a). In the baseline year of 2000, health spending per capita in the bottom quartile was half of the top quartile. Figures 3b and 3b suggest that all these difference comes from differential own resource spending. Piola et al. (2013) shows that states and municipalities own resource spending was responsible for about two thirds of the increase in health spending between 2000 and 2011.

Moreover, municipalities' baseline level of own resource spending in health presents ample variation and is somewhat predictive of the change in total health spending per capita, which will be crucial to our identification strategy. Figure 4 plots, for all municipalities, the distance in percentage points to the EC/29 own resource spending target[4] versus the change in total health spending per capita between 2000 and 2005. Consistently with the evidence presented in figure 2 and 3, increases in health spending were larger in places with initially low levels of own resource spending, with a moderate to strong correlation of 0.45.

Figure 4: Changes in Health Spending per capita (2000-2005)



Notes: Distance to the EC/29 target comes from SIOPS data. Changes in Health Spending per capita calculated using Health and Sanitation spending per capita from Finbra (see Seciton 3 for more details). Correlation of 0.45.

In general, the descriptive evidence suggests that the EC/29 was responsible for bringing more resources to the provision of public health services and increasing the direct

[4]We work with the distance the target instead of the share of own resource expenditure in health in order to have easier to interpret estimates, as this measures presents a positive correlation with health spending.

participation of states and municipalities in the financing of health care.

3 Data

We generate a municipality × year level database, covering each of Brazil's 5,570 municipalities over the period of 1999-2010. Table A.1 describes principal data and their sources, and also presents summary statistics at the baseline year for all the variables used in this analysis: variables related to the EC/29, fiscal data, health inputs, infant mortality rates, birth outcomes, and control variables. We provide more details on each of the specific sets of measures below.

3.1 EC/29 and Fiscal Data

To evaluate municipalities' fiscal reactions to the EC/29, we combine public spending data from the Brazilian Finance System (FINBRA)[5], which covers the period of 1998 to 2010, with data from the Brazilian National System of Public Health Budget (Datasus/SIOPS)[6] available from 2000 onward. FINBRA provides data on total public spending, and spending by a few aggregated categories, such as Health and Sanitation, Education and Culture, etc, and data on public revenues. The SIOPS, on the other hand, provides more detailed information on public health spending, which allow us to evaluate how municipalities allocate resources within the public health sector. It gathers data on total health spending, health spending from own resources, health spending from intergovernmental transfers, and health spending by types of spending, including spending in human resources, investments, services from third parties, and others[7]. Moreover, SIOPS calculates for each municipality the share of own resources spent in the provision of health care, that we use to build our independent variable.

Figure 5 displays the spatial variation in the share of own resources spent in health. Munic-

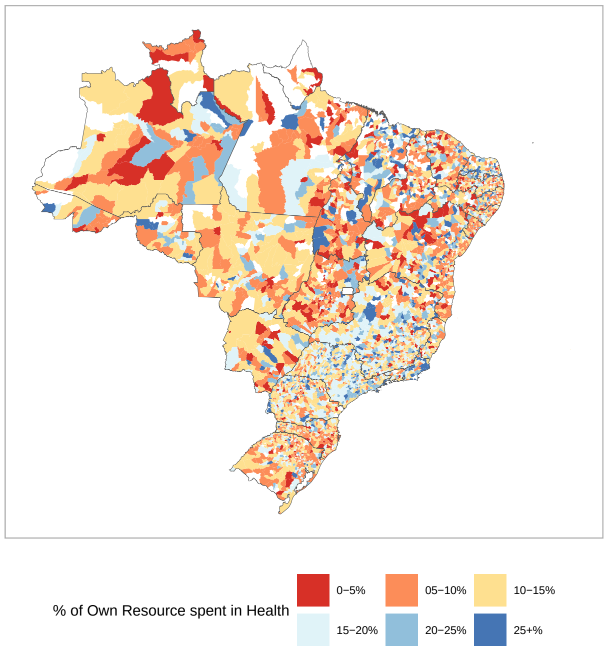
[5]All spending data is presented in 2010 R$. We used the General Price Index (IGP) to correct values

[6]SIOPS was created right after the EC/29 to monitor revenues and expenditure in the provision of health care at the state and municipal levels, and to monitor compliance with the EC/29.

[7]Others expenditures includes mainly administrative spending

ipalities below the EC/29 are represented with colors in the red scale, while municipalities above the target are represented with the blue scale. The map shows significant differences in the share of own resources spent in health within the same state, providing the identifying variation of this study as we include state fixed-effects in our main specification.

Figure 5: EC/29 Compliance Geographic Variation



Notes: Data is plotted at the municipality level. Borders at the state level. Colors in the red scale represent municipalities below the EC/29 target. Colors in the blue scale represent municipalities above the EC/29 target.

3.2 Health Inputs

We combine data from several sources to build our health inputs data base. First we collect data on primary care coverage – at the extensive and intensive margin – from Brazilian National System of Information on Primary Care (Datasus/SIAB) . Data on health human resources and hospital infrastructure comes from the 1999, 2002, 2005 and 2009 Medical-Sanitary Assistance Survey (AMS), a census of the health sector run by Brazilian Institute of Geography and Statistics (IBGE).

The Brazilian National System of Information on Ambulatory Care (Datasus/SIA) every ambulatory procedure funded by SUS, with information on the type and complexity of the procedure, the health professional responsible, and the corresponding health facility register number. This data is used to create variables on ambulatory production, primary care ambulatory production, and ambulatory production by procedures complexity. We also use this data to indirectly create variables that measure the supply of health ambulatory facilities, as well as the supply of ambulatory facilities with health professionals related to primary care services. This is done by evaluating the number of facilities within a municipality that recorded ambulatory procedures of interests or ambulatory procedures executed by specific professionals of interest [8].

To measure access to health services, we used data from the from Brazilian National System of Birth Records (Datasus/SINASC), that records every birth in Brazil and provides detailed information on these births. Using this data we calculated the share of no prenatal visits, 1-6 prenatal visits and more than 7 prenatal visits. Importantly, in the first years of our sample, there is no information on prenatal visits for a considerable amount of births. To account for this under-registration issue, we also calculated the share of prenatal ignored. By estimating the impacts on this variable, we can separate the effects of access increasing from improvements in data registration.

Lastly, we collect data on maternal and infant hospitalization from the National System of Information on Hospitalizations (Datasus/SIH), which provides administrative records of all hospitalizations in Brazil funded by SUS with detailed information on cause of hospitalization. We use the classification from Alfradique et al. (2009) to split infant hospitalizations into causes that are amenable and not amenable to primary care.

3.3 Infant Mortality and Birth Outcomes

We use micro-data from Brazilian National System of Mortality Records (Datasus/SIM) and from SINASC to construct Infant Mortality Rates. These micro-data allow us to construct Infant Mortality Rates by the timing of death, and for the main causes of death. Moreover, following Alfradique et al. (2009)'s classification we are able to construct mortality rates that are amenable and non-amenable to primary care access. The SINASC also provides

[8]We are able to construct these variables only for the period of 1998 to 2007, as changes in the SIA classification of ambulatory procedures changes in 2008.

detailed information on Apgar 1 and 5, birth weight, and premature births. We also use data on population by age and sex from Datasus to calculate fertility rates.

3.4 Controls

Our control variables can be classified into three different categories: baseline socioeconomic controls, time varying socioeconomic controls, and time varying fiscal controls. The first, comes from IBGE's Census of 2000. Our time varying socioeconomic controls includes GDP per capita, from IBGE, and the *Bolsa Família* program transfers per capita, from the Ministry of Social Development. The last set of controls comes from FINBRA dataset. We use as fiscal controls the average health spending per capita in the bordering municipalities[9] and the share of total current public revenue spent with personnel[10].

4 Empirical Approach

We estimate the effects of the EC/29 using a difference-in-difference (DiD) style design with a continuous treatment, exploiting within-municipality variation. Intuitively, we compare the evolution of outcomes in municipalities far from the EC/29 15% target with municipalities that were already complying with the target. The underlying assumption, discussed more precisely in section 4.1 is that the level of changes in outcomes for the latter group provide a good counterfactual for changes that would have been observed in the former group had they been complying with the target.

The identification relies on the cross-municipality variation in the share of own resource spent in the provision of healthcare and on the time-varying adoption of the EC/29 approval.[11] Our approach to estimate the effect of the EC/29 correspond to the following

[9] Castro et al. (2021) show the importance spending of spillover effects in health, which highlights the importance of including this control.

[10] In the year of 2000, the Fiscal Responsibility Law (Brasil, 2000) was enacted. This law defined that municipalities cannot spend more than 60% of its revenue in personnel. We include this control to account for the different incentives municipalities might face according to their compliance with the law.

[11] We note that the passage of EC/29 was fixed in time, and as such, concerns related to heterogeneity in treatment effects and *time-varying* adoption, noted by Goodman-Bacon (2021); de Chaisemartin and D'Haultfoeuille (2020); Callaway and Sant'Anna (2021) are not an issue in this setting. As we lay out below, the fact that treatment is continuous rather than binary in main models does have

equation:

$$Y_{mts} = \beta\, Dist_{m,pre} \times Post_t + \delta_{st} + \delta_j + \theta Z_{m,pre} \times \delta_t + \gamma\, X_{mts} + \varepsilon_{mts} \quad (1)$$

were Y_{mts} is an outcome of interest in municipality m, state s, year t; $Dist_{m,pre}$ is the baseline percentage points distance to EC/29 target in municipality m; $Post_t$ is a dummy that equals one if the year is 2001 or above. Fixed effects δ_{st} and δ_j are included to flexibly capture state-year variation in outcomes and time-invariante municipality level factors. Additionally we estimate specifications including an interaction between socioeconomic baseline controls and time, $\theta Z_{m,pre} \times \delta_t$, and time varying socioeconomic and fiscal controls, X_{mts}. Finally, ε_{mts} is the error component. Standard errors are clustered at the municipality level allowing for arbitrary correlations between unobserved shocks across time within municipalities. Our interest in these specifications is in consistent estimation of the reduced form parameter β, which captures how the funding shock implied by the baseline distance from the minimum spending floor impacts health spending, input or stocks Y_{mts}, once the constitutional reform switches on.

We choose to work with the distance to the EC/29 target instead of the share of own resource spent in health for the ease of interpretation, as the distance positively correlates with changes in health spending. The inclusion of state-year fixed effects are particularly relevant, given that the EC/29 also targeted state health expenditure. Here, our models isolate municipal-specific variation in exposure to the reform, isolating effects which owe to changes in municipal spending brought about by EC/29. These state-year fixed effects have the added benefit of also capturing other state-specific policies that might coincidentally affect outcomes in all municipalities within a state, and for the fact that some health policies and institutions are decentralized to state governments in Brazil. This implies that threats to identification must come specifically from policies or events that differentially affect those municipalities *within* a particular state that are more or less affected by the reform due to their baseline proportion of health spending.

implications for the assumptions and importance of underlying treatment effect heterogeneity.

The time varying fiscal controls include compliance with the Fiscal Responsibility Law (LRF) (Brasil, 2000) and average health spending per capita in the neighboring municipalities. The LRF determines that municipalities must spend less than 60% of its revenue in personnel. Municipalities not complying or close to the 60% cap might have different incentives when increasing spending relative the municipalities complying with the LRF. Castro et al. (2021) shows that health spending presents strong spatial externalities in Brazil, with neighbouring municipalities benefiting from better health outcomes, which highlights the importance of including this control.

4.1 Validity of the Research Design

Recent advances in econometric theory point to several drawbacks in the two way fixed effects regressions frequently used in empirical research based on DiD style designs. Callaway et al. (2021) highlights that DiD models with continuous treatment require stronger parallel trends assumptions, as comparisons between different intensities of treatment can also be confounded by selection bias. Unlike standard (binary) DiD, this bias comes from the heterogeneity in treatment effects. If group of units have different response to a certain dosage of treatment, the DiD will be contaminated by the differences in expected returns for these different dosage groups. Moreover, this bias persists even under traditional parallel trends assumption. For the estimator to be unbiased, we require a "strong parallel trends assumption" which in practice implies that treatment effects across different dosage groups would be homogeneous had they received the same specific treatment dosage.

Like the classic DiD, under randomization of treatment dosage, this stronger parallel trends assumption is satisfied, as groups do not choose dosage levels based on expected returns. But, unlike the classic DiD setup where one can partially test parallel trend assumptions, there is still no clear way to verify whether this assumption is satisfied. In this study, treatment was not randomized, but we argue that is unlikely that municipalities chose their distance to the spending target established by the EC/29 based on expected increases in health spending per capita.

First, the process of approval of the EC/29 involved several political stages and actors and it was arguably quite difficult to predict when the proposals would become an amendment, what exactly this ammendmant would entail, and how it would affect municipalities' public health spending decisions. Lastly, the strong relationship between baseline distance to the target and changes in health spending per capita presented in Figure 4 suggests that the constitutional amendment was binding[12]. Therefore, it seems plausible that changes in spending across different distances to the target groups would probably be very similar for a specific distance.

We are not able to empirically assess homogeneity in counterfactual treatment effects, but we can still check for the presence of pre-trends and evaluate if classic parallel trends assumption holds in our case. For that, we estimate a variation of equation 1, that allows for more flexible coefficient estimates:

$$\begin{aligned} Y_{mts} = & \sum_{i=1}^{I} \beta_{pre,i}\, Dist_{m,pre} \times EC29_{t+i} + \sum_{j=0}^{J} \beta_j\, Dist_{m,pre} \times EC29_{t-j} \\ & + \delta_{st} + \delta_m + \theta\, Z_{m,pre} \times \delta_t + \gamma\, X_{mts} + \varepsilon_{mts} \end{aligned} \tag{2}$$

where $EC29_{t+i}$ are year specific indicators for whether EC/29 would be enacted i years into the future; in like manner, $EC29_{t-j}$ are specific year indicators for whether EC/29 was enacted in year $t-j$. The former, captures pre-trends in the outcome variable, the later allow us to evaluate the dynamics through the years following the EC/29. All the other terms are the same described in Equation 1.

5 Empirical Findings

The goal of this section is to understand the impacts of health spending on health outcomes, and the pathways through which the impact take place. For that, we first present the

[12]According to the Ministry of Health Financial Management Manual (Minitério da Saúde 2003), non-compliance with the minimum amount of resources that should be spent in the provision of healthcare can lead to sanctions similar to those imposed by the Fiscal Responsibility Law, such as retention of resources from the Municipalities' Participation Fund and States' Participation Fund, suspension of a term of office, and even Federal intervention.

estimates of the impact of EC/29 on fiscal and spending outcomes. Later, we analyse how health expenditure increases translate into health inputs. Lastly, we examine the impacts on infant mortality rates and birth outcomes. All outcomes were analyzed as rates and that is how effects are presented in our regression tables and graphs. However, in our discussion of results, we will focus on the percent variation relative to baseline means of a representative municipality with a distance of 10% to the EC/29 target of the share of own resource spent in health. This distance is equivalent to the distance to the target of the municipalities in bottom quartile of the distribution of the share of own resource spent in health, which is the group of municipalities that presented the most pronounced increase in health spending after the EC/29 was enacted.

5.1 Municipalities' Fiscal Response to the EC/29

Table 1 shows the estimates for total public revenue and spending, public spending by category, and public health spending, total, by source and type. In column 1 we present our baseline estimates, a continuous DiD with municipality and state-year fixed effects. Column 2 adds to the baseline specification a set of baseline controls interacted with time. Column 3 adds socioeconomic time varying controls, and column 4 adds time varying fiscal controls. The last specification is the most saturate, still, in the context of our analysis, fiscal controls are quite endogenous. For that reason, our preferred specification is the one presented in Column 3, which is considerably saturated and only includes exogenous controls.

Panel A shows that the EC/29 had no significant impact on total revenues and total spending per capita. Though the points estimates are positive, Finbra data, specially for the pre-reform years, is in general quite noisy[13]. Next, we look at public health spending by category (Panel B). The only category that has been significantly impacted by the amendment is Health and Sanitation spending per capita, and the results are quite robust across different specifications.

In our preferred specification (column 3), the estimate of around 300 suggests a increase

[13] Appendix Figure B.1 plots the dynamic effects for these outcomes estimated with Equation 2.

of R$30 in health spending per capita for our representative municipality, equivalent to a increase of around 14% relative to the baseline health and sanitation spending per capita (see Table A.1). This distance is roughly the distance to the target of the bottom quartile of the distribution of the share of own resources spent in health in the baseline.

As discussed in Section 4, the validation of our research design relies partially on evaluating the presence of pre-trends. Even though SIOPS is a much better data source to study health spending, it is only available after the year 2000. Therefore, we will use Finbra data mainly to evaluate the presence of pre-trends in health spending and the move to analyse health spending and resource allocation within the public health sector using SIOPS data. Figure 6a plots the dynamic effects estimated with Equation 2 for the equivalent of the specifications presented in Column 1 and 4, for Health and Sanitation per capita. We find no pre-trends and a clear and significant pattern of increase in spending, with each of the first years after the EC/29 presenting stronger effects, that stabilize after 2004. Appendix Figure B.2 plots the dynamic effects for all other categories of spending. Estimates are very imprecise for almost all categories and it is hard to extract much information. But in general, there seem to be no pre-trend, nor significant effects on other categories of spending besides Health and Sanitation. These results are extremely relevant because it will allow us to claim that any reductions we find in Infant Mortality rates are most certainly associated with increases in health expenditure and not increases in spending from other categories that could also affect mortality, such as social assistance and education.

Panel C in Table 1 presents the results for total health spending, health spending by source and health spending by type. Our estimations suggests an effect of R$ 530 for total Health Spending per capita, which is equivalent to a 27% increase in spending relative to the baseline for our representative municipality, almost twice the effect on Health and Sanitation per capita. Additionally, this effect comes almost entirely from increases in spending from own resources, a 50% increase relative to own resource spending in the baseline. We also find some substitution effects, with municipalities reducing some of its spending from intergovernmental transfers in health. All types of health spending were responsible for this increase in total health spending, but the increase in investment is the

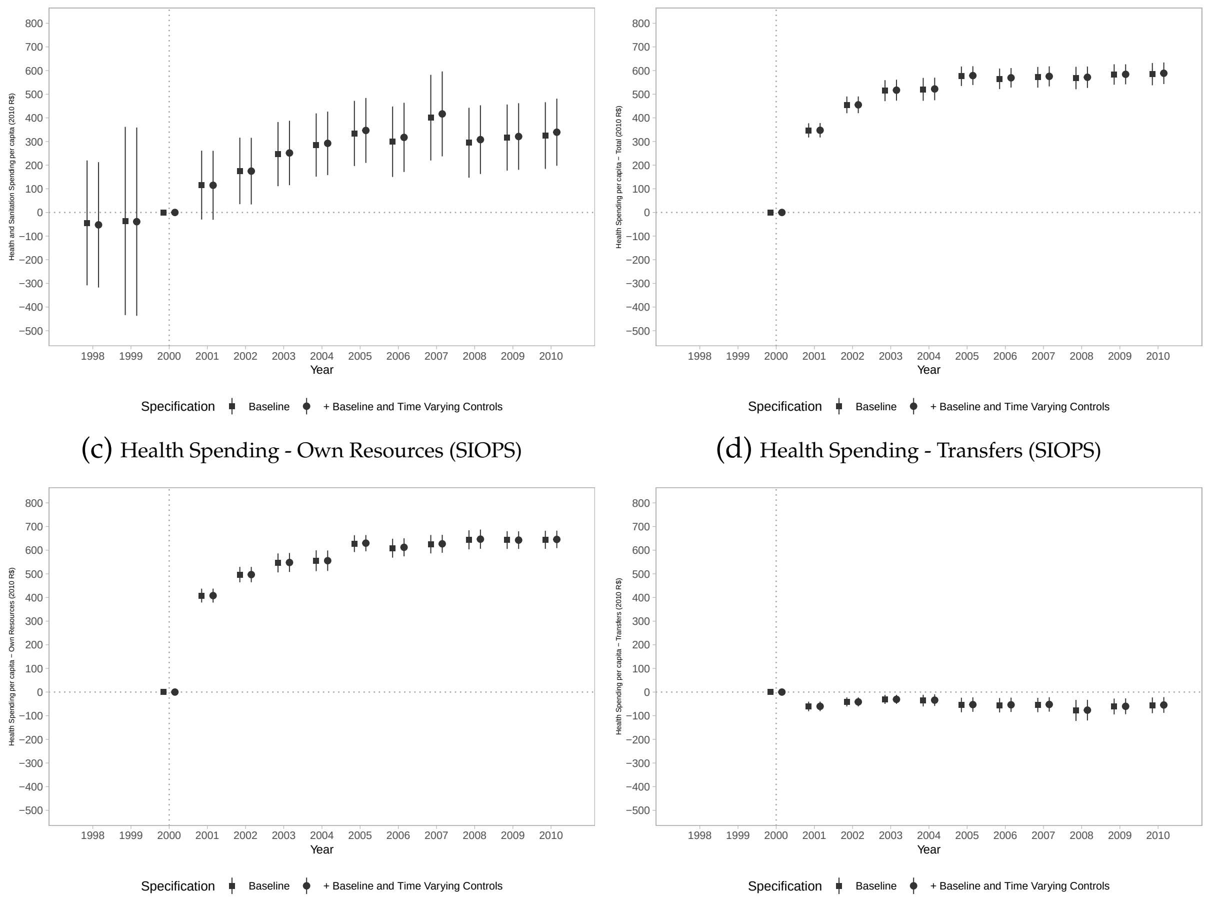
Table 1: Fiscal Reactions

	(1)	(2)	(3)	(4)
A. Public Revenue and Spending per capita (Finbra)				
Total Revenue	841.224	868.151	911.342	929.681
	(1248.728)	(1264.873)	(1262.793)	(1264.449)
Total Spending	1089.977	1116.507	1153.877	1120.384
	(1450.455)	(1468.068)	(1466.367)	(1467.661)
B. Public Spending By Category (Finbra)				
Health and Sanitation Spending	302.751***	307.022***	314.312***	308.104***
	(94.499)	(95.853)	(94.851)	(94.901)
Transport Spending	53.404	55.428	57.487	58.332
	(64.588)	(65.717)	(65.673)	(65.738)
Education and Culture Spending	181.786	193.281	203.347	195.657
	(391.088)	(396.875)	(396.579)	(396.904)
Housing and Urban Spending	106.441	103.719	107.997	105.891
	(151.807)	(153.609)	(153.292)	(153.428)
Social Assistance Spending per capita	189.327	197.649	200.966	200.701
	(251.479)	(254.819)	(254.729)	(254.927)
Spending in Other Categories per capita	362.594	365.701	381.213	365.486
	(668.655)	(676.98)	(676.072)	(676.672)
C. Public Health Spending (SIOPS)				
Total	529.375***	530.301***	530.936***	530.317***
	(18.16)	(17.876)	(17.507)	(17.485)
By Source				
Own Resources	580.644***	581.011***	581.215***	580.792***
	(13.943)	(13.725)	(13.421)	(13.431)
Transfers	-53.096***	-52.482***	-51.826***	-52.036***
	(11.269)	(11.157)	(11.123)	(11.107)
By Type				
Human Resources	96.997***	94.917***	95.188***	93.164***
	(11.202)	(11.12)	(11)	(10.914)
Investiment	132.947***	133.38***	133.42***	133.64***
	(9.654)	(9.683)	(9.667)	(9.672)
3rd parties services	55.911***	54.863***	54.756***	55.165***
	(11.687)	(11.545)	(11.471)	(11.49)
Other Expenditures	247.246***	250.325***	250.742***	251.5***
	(11.365)	(11.417)	(11.403)	(11.37)

Notes: The number of observations is 64470 for Finbra variables and 55810 for SIOPS variables. DiD Estimates from Equation 1. Independent variable is the distance to the EC/29 target in p.p. Column 1 presents the baseline model with municipality and state-year fixed effects. Column 2 adds baseline socioeconomic controls from the Census interacted with time. Column 3 adds controls for GDP per capita and *Bolsa Familia* transfers per capita. Column 4 adds fiscal controls. Covariates omitted. Standard errors in brackets are clustered in the municipality level. $p < 0.10$, $p < 0.05$, $p < 0.01$

noteworthy, specially in relative terms. This estimate is associated with a 90% increase in health investments. Baseline statistics show very little resources allocated in investments within total public health spending, the great majority of resources were allocated in human resources and in other administrative expenses. Considering the importance of capital investments to the supply of medical resources and the quality of medical services, and the little amount of investments in the baseline, an effect of this size is really relevant. Other expenditures, that includes mainly administrative spending, presents the strongest

Figure 6: Effects on Public Health Spending per capita



(a) Health and Sanitation (Finbra)

(b) Total Health Spending (SIOPS)

(c) Health Spending - Own Resources (SIOPS)

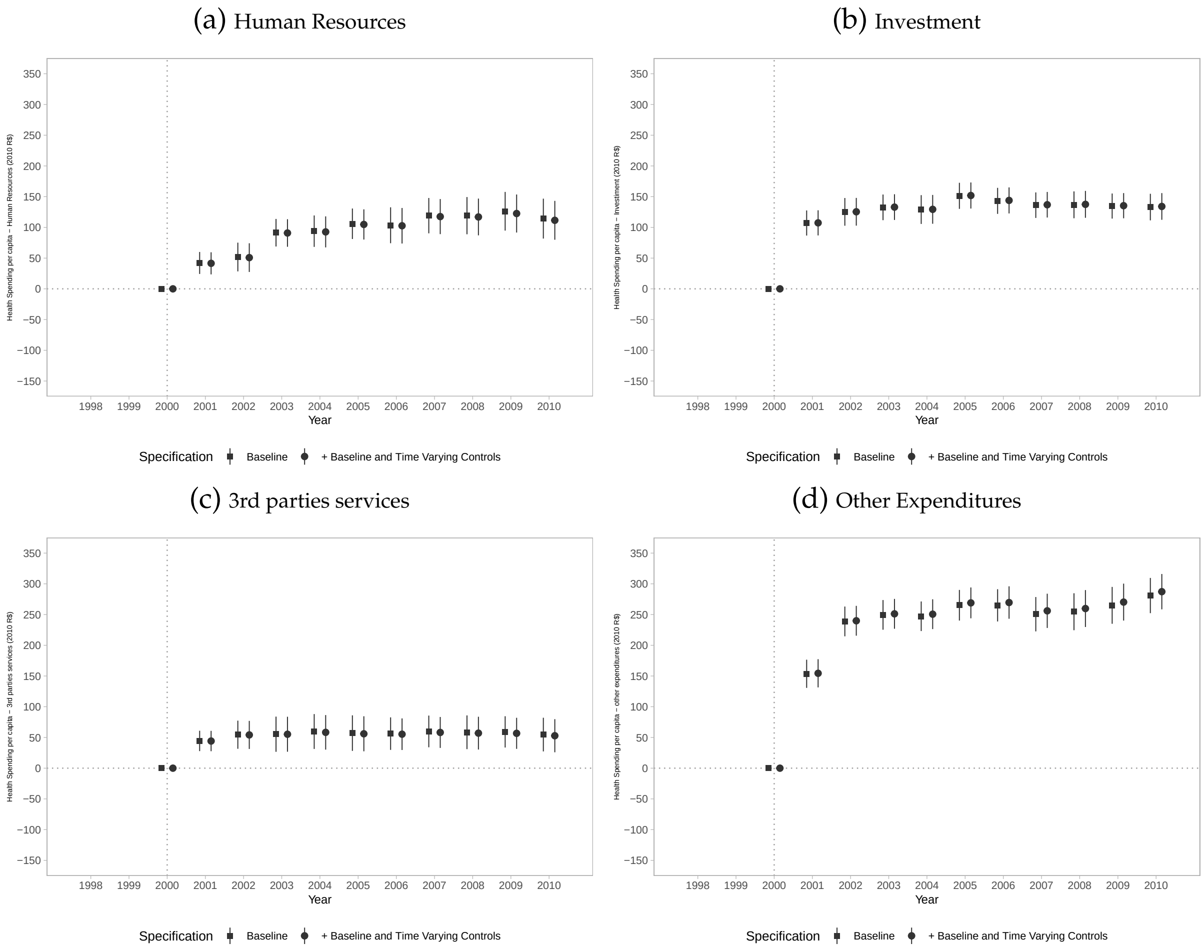
(d) Health Spending - Transfers (SIOPS)

Notes: The number of observations is 63758 for Figure 6a and 55810 for the remaining. DiD Estimates from Equation 2. Independent variable is the distance to the EC/29 target in p.p. Square dots represent the baseline model with municipality and state-year fixed effects. Round dots represent our preferred specification (Column 3 in regression Tables). Lines represent 95% confidence intervals. Arrows, when present, indicate confidence intervals out of the plot bounds. Standard errors are clustered in the municipality level.

effect in per capita terms, almost half of the total increase in health spending per capita, equivalent to a 34% increase relative to the baseline for the representative municipality. In opposition to the relevance investment in a health production function, administrative expenditure plays a much minor role in affecting health outcomes.

The clear pattern of increases in health and sanitation spending depicted in Figure 6a can also be seen for SIOPS total health spending in Figure 6b, but at different levels. Figure 7 suggests that this pattern is mostly influenced by dynamic of the effects on human resources spending (Figure 7a). Investments, 3rd parties and other expenditures present a sharp increase in spending in the first one or two years after the EC/29 an than stabilize.

Figure 7: Effects on Public Health Spending per capita - By Type



(a) Human Resources (b) Investment (c) 3rd parties services (d) Other Expenditures

Notes: The number of observations is 55810. DiD Estimates from Equation 2. Independent variable is the distance to the EC/29 target in p.p. Square dots represent the baseline model with municipality and state-year fixed effects. Round dots represent our preferred specification (Column 3 in regression Tables). Lines represent 95% confidence intervals. Arrows, when present, indicate confidence intervals out of the plot bounds. Standard errors are clustered in the municipality level.

5.2 Effects on Health Inputs

In this subsection we aim to explore the pathways that mediate the relationship between health spending and health outcomes. For that, we explore the impacts of the EC/29 on several health inputs: primary care coverage, human resources, hospital infrastructure, primary care related infrastructure, ambulatorial production, and access to health services.

First we analyse the effects on primary care coverage at the extensive and intensive margin (Table 2, Panel A and B). We find significant effects on the share of population covered by the Community Health program and by Family Health Program. Though significant and positive, these effects are quite small. The representative municipality only increased by 2

Table 2: Primary Care Coverage, Health Infrastructure and Human Resources

	(1)	(2)	(3)	(4)
A. Primary Care Coverage - Extensive Margin				
Population covered (share) by Community Health Agents	0.248***	0.242***	0.242***	0.242***
	(0.056)	(0.055)	(0.055)	(0.055)
Population covered (share) by Family Health Agents	0.187***	0.196***	0.2***	0.2***
	(0.059)	(0.058)	(0.058)	(0.058)
B. Primary Care Coverage - Intensive Margin				
N. of People Visited by Primary Care Agents (per capita)	0.296***	0.289***	0.3***	0.299***
	(0.101)	(0.097)	(0.097)	(0.097)
N. of People Visited by Community Health Agents (per capita)	-0.029	-0.026	-0.026	-0.026
	(0.053)	(0.053)	(0.053)	(0.053)
N. of People Visited by Family Health Agents (per capita)	0.324***	0.314***	0.326***	0.325***
	(0.098)	(0.093)	(0.093)	(0.093)
N. of Household Visits & Appointments (per capita)	1.249***	1.247***	1.281***	1.282***
	(0.349)	(0.346)	(0.345)	(0.345)
N. of Household Visits & Appointments by Community Health Agents (per capita)	0.382	0.362	0.356	0.357
	(0.281)	(0.283)	(0.283)	(0.283)
N. of Household Visits & Appointments by Family Health Agents (per capita)	0.855***	0.874***	0.916***	0.916***
	(0.303)	(0.292)	(0.291)	(0.291)
C. Human Resources				
N. of Doctors (per capita*1000)	1.56	1.176	1.215	1.217
	(1.297)	(1.253)	(1.25)	(1.246)
N. of Nurses (per capita*1000)	1.281*	1.075	1.131	1.115
	(0.746)	(0.696)	(0.695)	(0.695)
N. of Nursing Assistants (per capita*1000)	1.146***	1.159***	1.17***	1.166***
	(0.352)	(0.346)	(0.347)	(0.347)
N. of Administrative Professionals (per capita*1000)	1.84***	1.733***	1.758***	1.746***
	(0.389)	(0.365)	(0.364)	(0.363)
D. Infrastructure				
N. of Municipal Hospitals (per capita*1000)	0.162***	0.16***	0.161***	0.16***
	(0.028)	(0.028)	(0.028)	(0.028)
N. of Federal and State Hospitals (per capita*1000)	-0.014	-0.01	-0.01	-0.01
	(0.012)	(0.011)	(0.011)	(0.011)
N. of Private Hospitals (per capita*1000)	-0.006	-0.007	-0.007	-0.006
	(0.01)	(0.01)	(0.01)	(0.01)
N. of Health Facilities (per capita*1000) with Ambulatory Service	-0.094**	-0.085**	-0.08*	-0.08*
	(0.042)	(0.043)	(0.042)	(0.042)
E. Primary Care Related Infrastructure and Human Resources				
Number of Health Facilities (per capita * 1000) with				
Ambulatory Service and ACS Teams	0.063**	0.061**	0.064**	0.064**
	(0.029)	(0.028)	(0.028)	(0.028)
Ambulatory Service and Community Doctors	0.056*	0.058*	0.063**	0.063**
	(0.032)	(0.031)	(0.031)	(0.031)
Ambulatory Service and ACS Nurses	0.033*	0.032	0.034*	0.034*
	(0.02)	(0.02)	(0.02)	(0.02)
Ambulatory Service and PSF Teams	0.048	0.054*	0.058*	0.059*
	(0.033)	(0.032)	(0.032)	(0.032)
Ambulatory Service and PSF Doctors	0.049	0.053*	0.058*	0.058*
	(0.032)	(0.03)	(0.03)	(0.03)
Ambulatory Service and PSF Nurses	0.063**	0.067**	0.072**	0.072**
	(0.031)	(0.03)	(0.029)	(0.029)
Ambulatory Service and PSF Nursing Assistants	0.022	0.025	0.03	0.03
	(0.03)	(0.029)	(0.029)	(0.029)

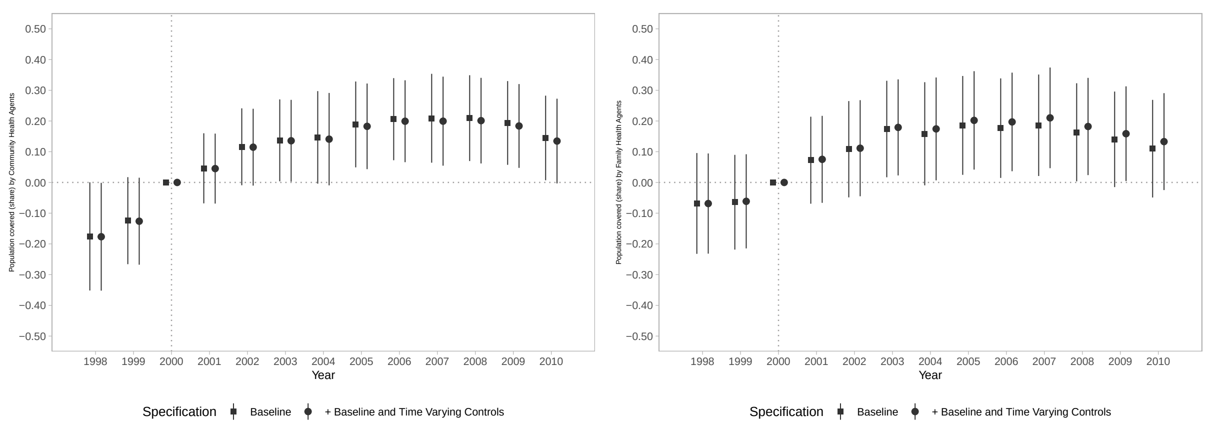
Notes: The number of observations is 64482 for Panels A and B, 1936 for Panel C and the first 3 variables from Panel D, and 48916 for Panel E. DiD Estimates from Equation 1. Independent variable is the distance to the EC/29 target in p.p. Column 1 presents the baseline model with municipality and state-year fixed effects. Column 2 adds baseline socioeconomic controls from the Census interacted with time. Column 3 adds controls for GDP per capita and *Bolsa Familia* transfers per capita. Column 4 adds fiscal controls. Covariates omitted. Standard errors in brackets are clustered in the municipality level. p < 0.10, p < 0.05, p < 0.011

percentage points the share of the population covered by these primary care programs. On the other hand, the effects on the intensive margin are much more pronounced and our estimates suggests that they come mainly from the Family Health Program. We find significant increases in the number of people visited and in the number of household visits and appointments by Family Health Agents. They are equivalent to a 21% and 11% increase relative to the baseline, respectively, for our representative municipality. Figure 8 shows the dynamic effects for the extensive margin and Figure 9 the dynamic effects for the intensive margin of primary care coverage. The temporal patterns of this effects resemble the pattern in health spending increase, where the effect is increasing in the first years after the EC/29 and becomes steady after 2004.

Figure 8: Effects on Primary Care Coverage - Extensive Margin

(a) Population Covered by Community Health Agents

(b) Population Covered by Family Health Agents

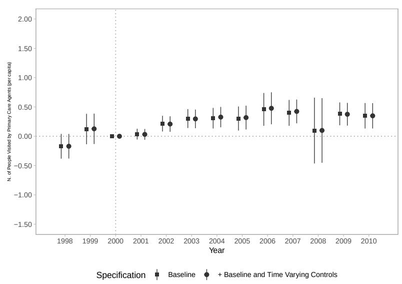


Notes: The number of observations is 64482. DiD Estimates from Equation 2. Independent variable is the distance to the EC/29 target in p.p. Square dots represent the baseline model with municipality and state-year fixed effects. Round dots represent our preferred specification (Column 3 in regression Tables). Lines represent 95% confidence intervals. Arrows, when present, indicate confidence intervals out of the plot bounds. Standard errors are clustered in the municipality level.

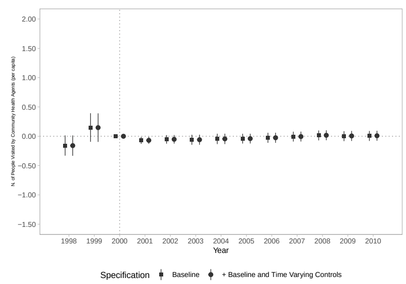
Panel C presents our results on the public health sector human resources. We find no significant effect for the number of doctors and nurses, but Figures 10a and 10b suggests some effect taking place after 2005. On the other hand, we find significant effects in the number of nursing assistants and administrative professionals, a 13% and 15% increase, respectively, relative to the baseline. While Figure 10c indicates a gradual effect trend after the EC/29, Figure 10d suggests a sharp increase in the number of administrative personnel right after the EC/29. Not coincidentally, this pattern resembles the pattern found in other expenditures within health spending (Figure 7d), that, as mentioned before,

Figure 9: Effects on Primary Care Coverage - Intensive Margin

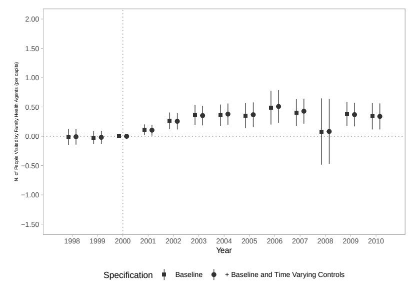
(a) N. of People Visited



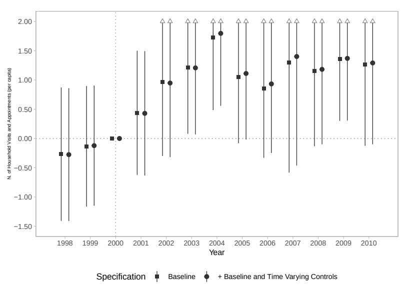
(b) People Visited by CH Agents



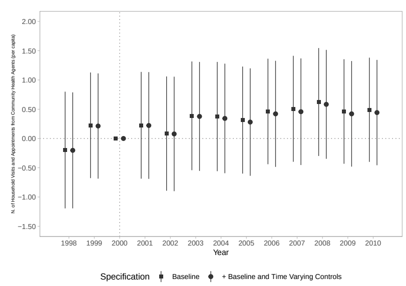
(c) People Visited by FH Agents



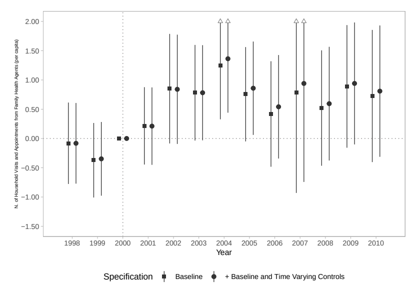
(d) N. of Household Visits and Appointments



(e) N. of Household Visits and Appointments by CH Agents



(f) N. of Household Visits and Appointments by FH Agents



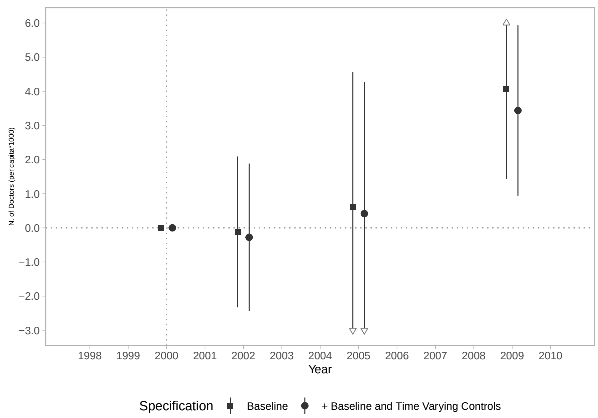
Notes: The number of observations is 64482. DiD Estimates from Equation 2. Independent variable is the distance to the EC/29 target in p.p. Square dots represent the baseline model with municipality and state-year fixed effects. Round dots represent our preferred specification (Column 3 in regression Tables). Lines represent 95% confidence intervals. Arrows, when present, indicate confidence intervals out of the plot bounds. Standard errors are clustered in the municipality level.

includes mainly administrative spending.

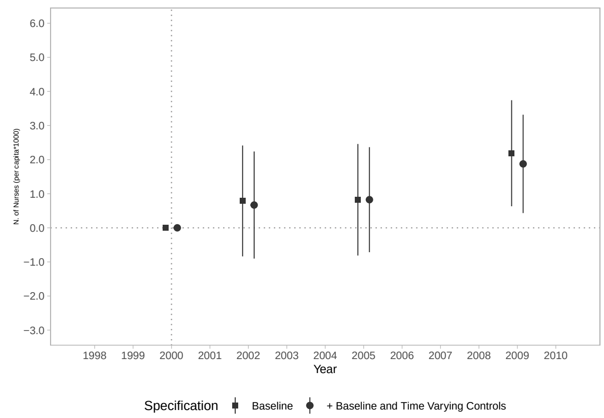
Next, panel D shows the results for health infrastructure. The number of municipal hospital per 1000 inhabitants presented a significant increase of 0.16. This effect represents a sizable variation of 27% relative to the baseline number of hospitals for the representative municipality. Moreover, Figure 11a suggests that the effect follows a similar dynamic pattern as the increase in investment spending within health (Figure 7b). In this analysis we leverage the variation in municipal health spending induced by the EC/29 within state governments, so one would not expect to see increases in the number of hospital from other governmental spheres or from the private sector. Our results validates that. Yet, the point estimates for the number of Federal, State and Private hospitals are negative, which could suggest some substitution effects in the supply of hospitals. These results would be worrisome if the effects were large, as mortality outcomes can be affected by the supply of hospitals, but that is not what the point estimates and Figure 11b suggests. Our results also indicate some marginally significant reduction in the number of health facilities with

Figure 10: Effects on Health Human Resources

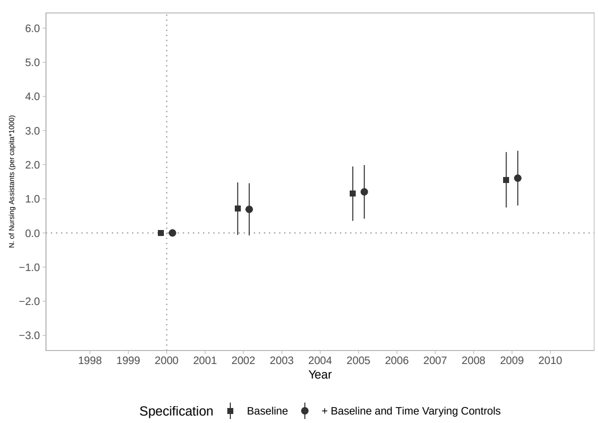
(a) Number of Doctors (per capita*1000)



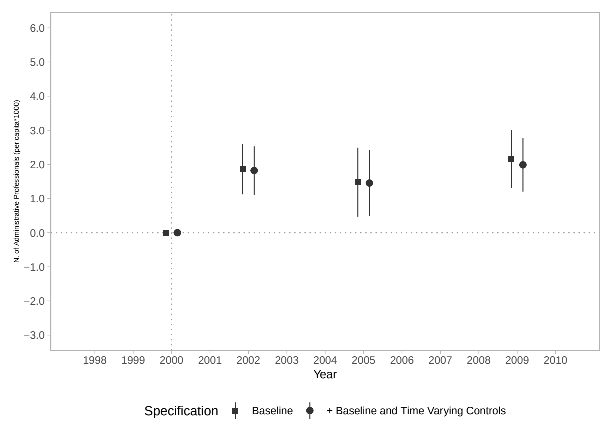
(b) Number of Nurses (per capita*1000)



(c) Number of Nursing Assistants (per capita*1000)



(d) Number of Administrative Professionals (per capita*1000)



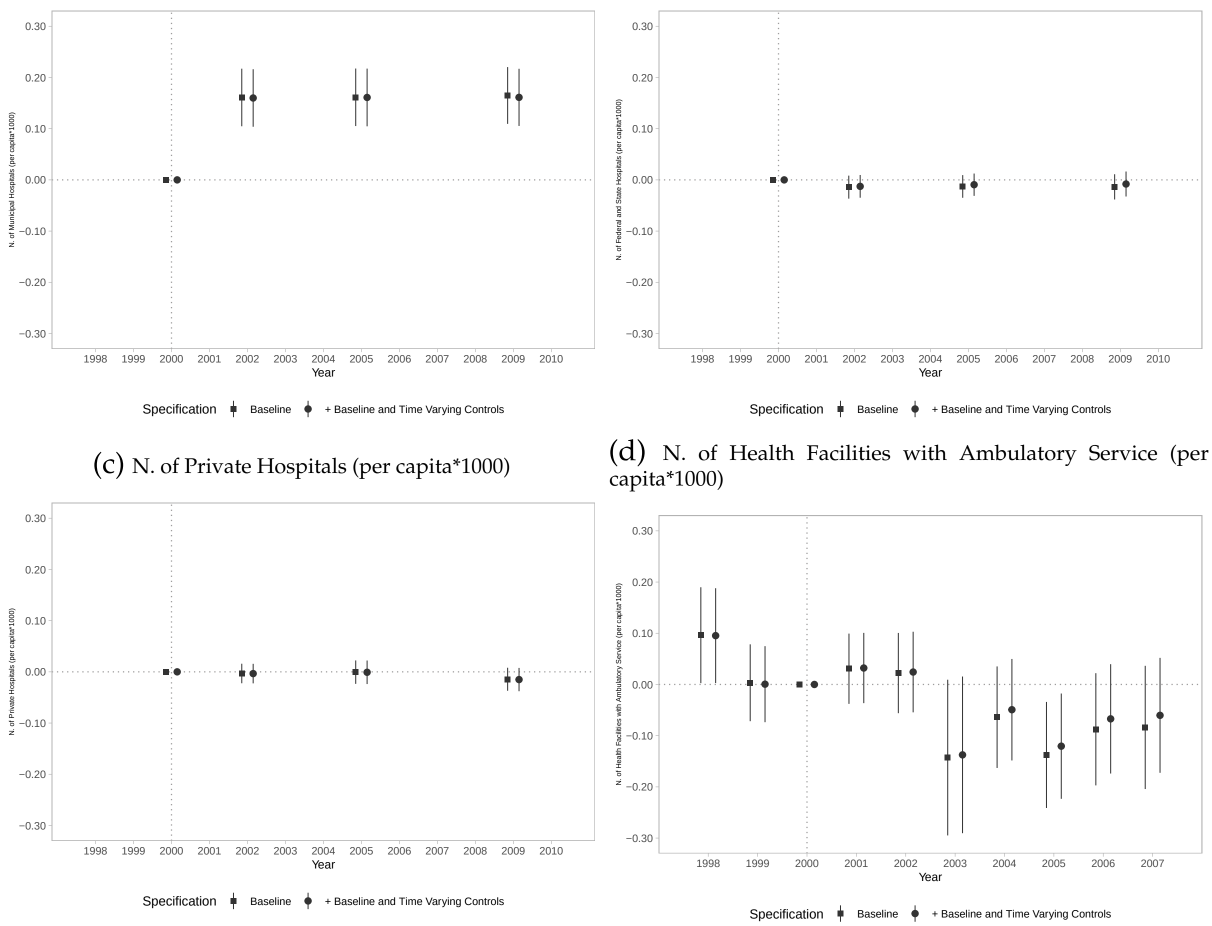
Notes: The number of observations is 19364. DiD Estimates from Equation 2. Independent variable is the distance to the EC/29 target in p.p. Square dots represent the baseline model with municipality and state-year fixed effects. Round dots represent our preferred specification (Column 3 in regression Tables). Lines represent 95% confidence intervals. Arrows, when present, indicate confidence intervals out of the plot bounds. Standard errors are clustered in the municipality level.

ambulatory service, but this effect is rather small, representing a reduction of 1.5% relative to the baseline for the representative municipality.

We also find significant effects on the number of health facilities with ambulatorial services and professionals related to primary care (Panel E of Table 2 and Figure 12), with effects ranging from 5% to 10% relative to the baseline.

In Table 3 we assess the impacts on ambulatory production and on the access to health services. Panel A show significant effects on the number of outpatient procedures, primary care outpatient procedures and outpatient procedures of low and mid complexity. These point estimates represent a considerably small increase in production, between 2-3%. We

Figure 11: Effects on Health Infrastructure



(a) N. of Municipal Hospitals (per capita*1000)

(b) N. of Federal and State Hospitals (per capita*1000)

(c) N. of Private Hospitals (per capita*1000)

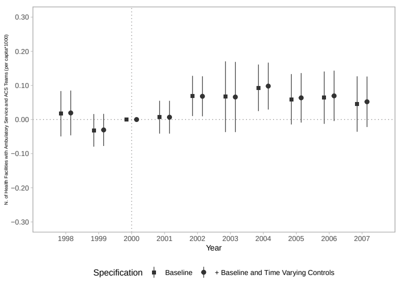
(d) N. of Health Facilities with Ambulatory Service (per capita*1000)

Notes: The number of observations is 19364 for Figure 11a, 11b, 11c and 48916 for the remaining. DiD Estimates from Equation 2. Independent variable is the distance to the EC/29 target in p.p. Square dots represent the baseline model with municipality and state-year fixed effects. Round dots represent our preferred specification (Column 3 in regression Tables). Lines represent 95% confidence intervals. Arrows, when present, indicate confidence intervals out of the plot bounds. Standard errors are clustered in the municipality level.

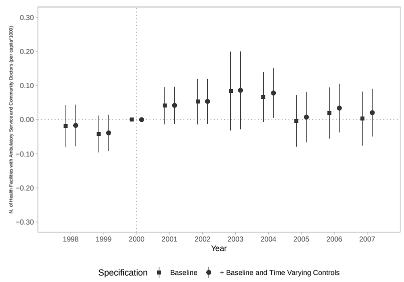
find no significant impact on outpatient procedures of high complexity. The dynamic effects for these outcomes are presented in Figure 13. In Panel B we present our estimates for the access to health services, measured by prenatal visits. The results show a significant decrease of 0.093 in prenatal visits ignored, that measures under-registration of information on birth records, and a increase of 0.116 in 1 to 6 prenatal visits. These results suggests an improvement in data registration, and considerably small effect on prenatal 1-6. If we consider only the effect beyond the reduction in under-registration, the effect will be equivalent to only 0.4% increase relative to the baseline for the representative municipality. Figure 14 present the dynamic effects for prenatal visits. Figure 14b suggests that the

Figure 12: Effects on Primary Care Related Infrastructure and Human Resources: N. of Health Facilities with:

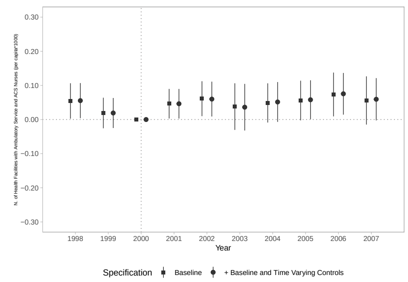
(a) Ambulatory Service and ACS Teams



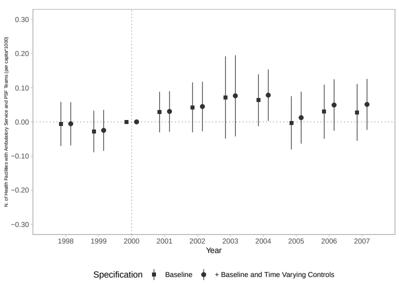
(b) Ambulatory Service and Community Doctors



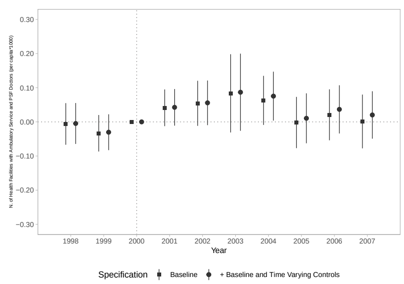
(c) Ambulatory Service and ACS Nurses



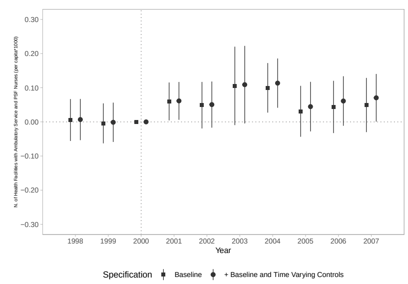
(d) Ambulatory Service and PSF Teams



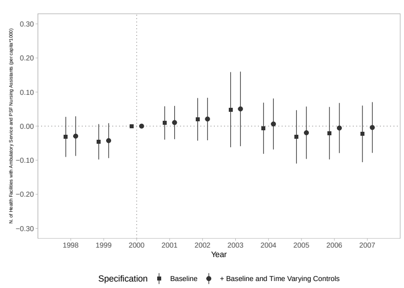
(e) Ambulatory Service and PSF Doctors



(f) Ambulatory Service and PSF Nurses



(g) Ambulatory Service and PSF Nursing Assistants



Notes: The number of observations is 48916. DiD Estimates from Equation 2. Independent variable is the distance to the EC/29 target in p.p. Square dots represent the baseline model with municipality and state-year fixed effects. Round dots represent our preferred specification (Column 3 in regression Tables). Lines represent 95% confidence intervals. Arrows, when present, indicate confidence intervals out of the plot bounds. Standard errors are clustered in the municipality level.

EC/29 might have had some effect in reducing the share of births with mothers having no prenatal visits, which could explain this increase in prenatal 1-6 above the reduction in under-registration.

Finally, Table 4 present the estimates for maternal hospitalization and infant hospitalization rates. While we find a increase of 9.253 in maternal hospitalization rates, which is equivalent to a 1.8% increase for our representative municipality, total infant hospitalization rate presents significant decreases, equivalent to 5.75%. Moreover, the reduction in infant

Table 3: Ambulatory Production and Access to Health Services

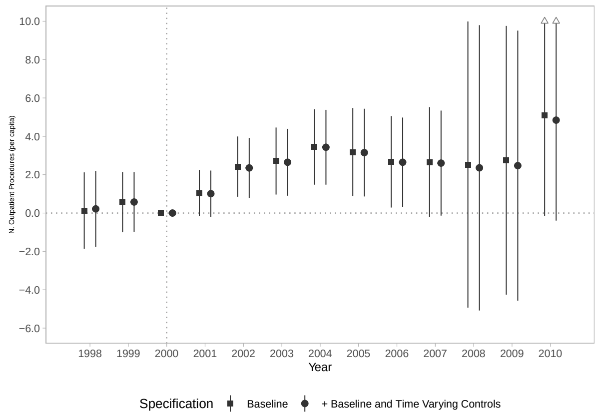
	(1)	(2)	(3)	(4)
A. Ambulatory Production				
Outpatient procedures per capita	2.64**	2.437**	2.509**	2.493**
	(1.027)	(1.026)	(1.022)	(1.02)
Primary Care Outpatient procedures per capita	2.201**	2.196**	2.249**	2.233**
	(0.945)	(0.935)	(0.931)	(0.93)
N. of Low & Mid Complexity Outpatient Procedures (per capita)	2.303**	2.18**	2.286**	2.292**
	(0.908)	(0.898)	(0.892)	(0.891)
N. of High Complexity Outpatient Procedures (per capita)	-0.136	-0.194	-0.177	-0.18
	(0.134)	(0.133)	(0.133)	(0.133)
B. Access to Health Services				
Prenatal Visits Ignored	-0.104	-0.093*	-0.094**	-0.093**
	(0.066)	(0.048)	(0.047)	(0.047)
Prenatal Visits None	0.025*	0.006	0.006	0.006
	(0.015)	(0.011)	(0.011)	(0.011)
Prenatal Visits 1-6	0.129**	0.12**	0.117*	0.116*
	(0.059)	(0.061)	(0.061)	(0.06)
Prenatal Visits 7+	-0.05	-0.033	-0.029	-0.028
	(0.074)	(0.062)	(0.061)	(0.061)

Notes: The number of observations is 64482 for Outpatients procedures and Primary Care Outpatient procedures per capita, 48916 for the remaining variables of Panel A, and 64481 for Panel B and C. DiD Estimates from Equation 1. Independent variable is the distance to the EC/29 target in p.p. Column 1 presents the baseline model with municipality and state-year fixed effects. Column 2 adds baseline socioeconomic controls from the Census interacted with time. Column 3 adds controls for GDP per capita and *Bolsa Familia* transfers per capita. Column 4 adds fiscal controls. Covariates omitted. Standard errors in brackets are clustered in the municipality level. $p < 0.10$, $p < 0.05$, $p < 0.01$1

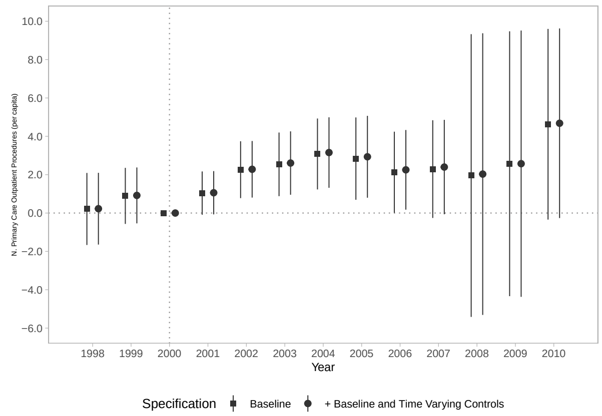
hospitalization rate is mainly driven by the reduction in hospitalizations for causes that are amenable to primary care. We have shown that part of the health expenditure increase has been translated into improving the access to primary care. As highlighted by Bhalotra et al. (2019), expanding primary care coverage allows for early identification and treatment of health problems, and should lead to demand-driven declines in hospitalizations for causes that are amenable to primary care. On the other hand, an increase in the supply of hospitals, like the one we documented, should lead to a increase in hospitalization due to causes that are not amenable to primary care. Our results corroborate this hypothesis as our maternal hospitalization variable captures hospitalization due to conditions other than delivery, which are generally not amenable to primary care (Alfradique et al., 2009). The dynamic effects for hospitalization outcomes are presented in Figure 15. Infant hospitalization rates dynamic effects are quite noisy, but present a clear trend of decrease, that, as we will show

Figure 13: Effects on Ambulatorial Production

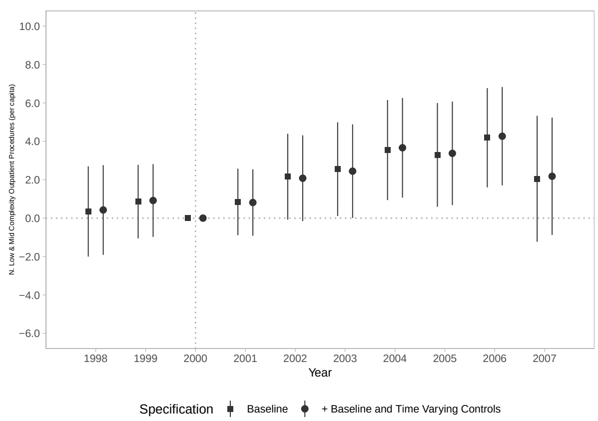
(a) Total



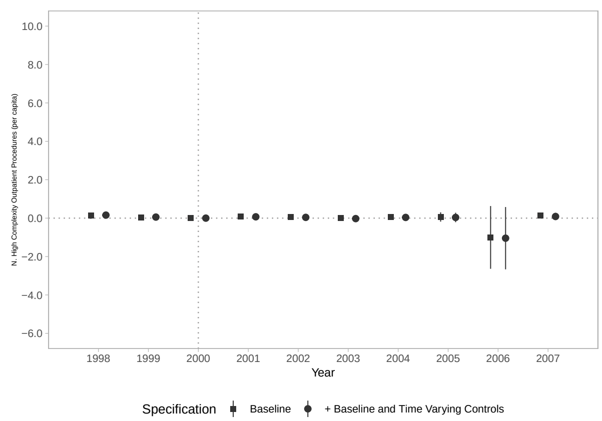
(b) Primary Care



(c) Low and Mid Complexity



(d) High Complexity

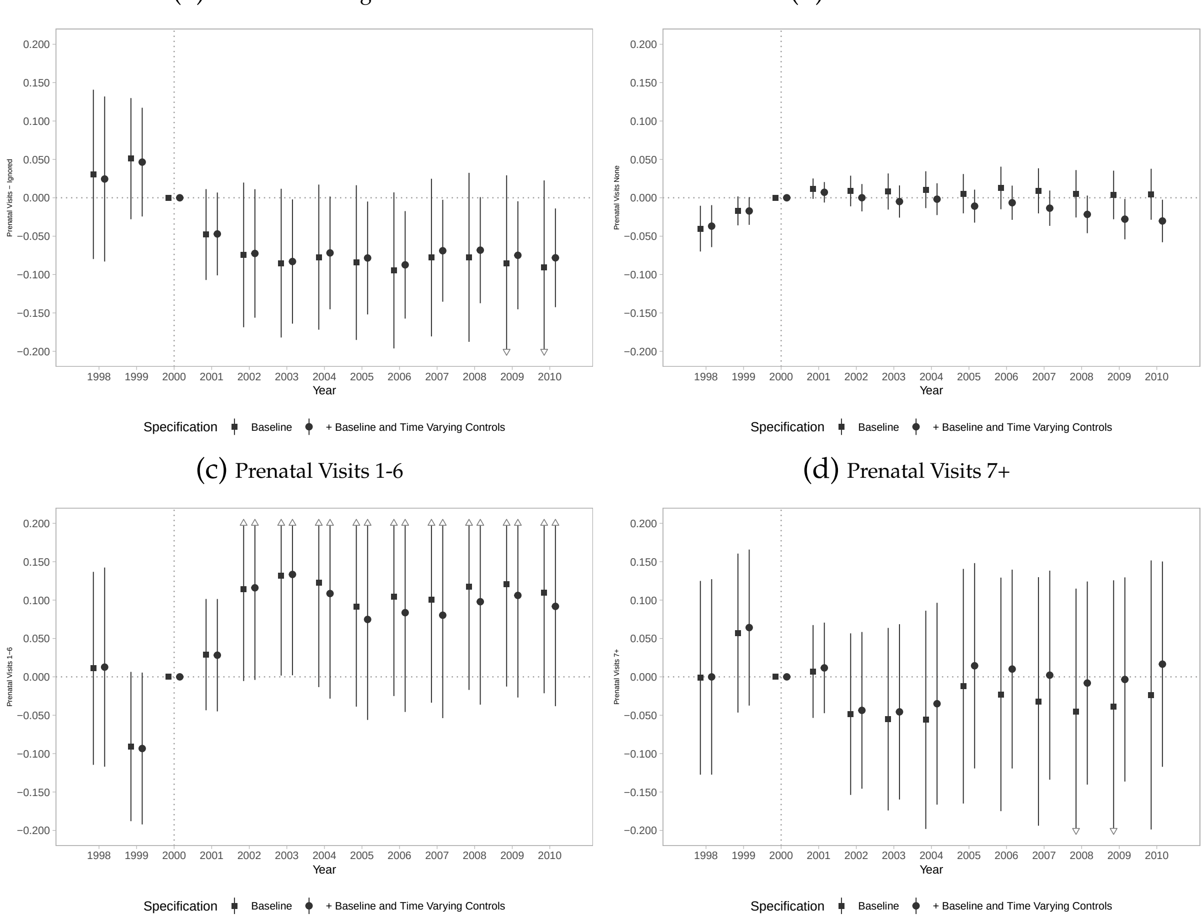


Notes: The number of observations is 64482 for 14a and 14b, 48916 for the remaining. DiD Estimates from Equation 2. Independent variable is the distance to the EC/29 target in p.p. Square dots represent the baseline model with municipality and state-year fixed effects. Round dots represent our preferred specification (Column 3 in regression Tables). Lines represent 95% confidence intervals. Arrows, when present, indicate confidence intervals out of the plot bounds. Standard errors are clustered in the municipality level.

latter, follows a similar pattern of the declines in infant mortality.

With the data available we are not able to directly connect the increase in health spending with the increase in health inputs presented in this section. However, the evidence presented so far suggests that: (i) increases in human resource spending have been translated into greater primary care coverage at the intensive margin, a higher number of facilities with primary care personnel, and into a increase in the number of nursing assistants; (ii) increases in investment spending has been translated into a greater supply of municipal hospitals and a marginal increase ambulatory production; and (iii) increases in other expenditures, which consist mainly of administrative spending, might be associated with

Figure 14: Effects on Access to Health Services



(a) Prenatal Visits Ignored

(b) Prenatal Visits None

(c) Prenatal Visits 1-6

(d) Prenatal Visits 7+

Notes: The number of observations is 64481. DiD Estimates from Equation 2. Independent variable is the distance to the EC/29 target in p.p. Square dots represent the baseline model with municipality and state-year fixed effects. Round dots represent our preferred specification (Column 3 in regression Tables). Lines represent 95% confidence intervals. Arrows, when present, indicate confidence intervals out of the plot bounds. Standard errors are clustered in the municipality level.

the increase in the number of administrative professionals.

5.3 Effects on Infant Mortality

Having provided meaningful evidence of the effects of EC/29 on health spending and how these effects translated into health inputs, we now present estimates of the effects on infant mortality. Differently from most of the literature linking health spending with infant mortality (Filmer and Pritchett, 1999; Bokhari et al., 2007; Moreno-Serra and Smith, 2015; Nixon and Ulmann, 2006; Gupta et al., 2002; Crémieux et al., 1999b; Bokhari et al., 2007), we are able to assess the effects not only for total infant mortality rates, but also for

Table 4: Hospitalization Rates

	(1)	(2)	(3)	(4)
A. Maternal Hospitalization Rate (women 10-49y * 1000)				
Total	13.299**	9.304*	9.252*	9.244*
	(6.653)	(4.976)	(4.96)	(4.958)
B. Infant Hospitalization Rate (pop 0-1y * 1000)				
Total	-78.693	-159.757*	-161.065*	-161.601*
	(87.036)	(83.691)	(83.57)	(83.62)
Amenable to Primary Care	-70.087	-131.795*	-132.98*	-133.34*
	(75.409)	(75.844)	(75.751)	(75.818)
Non-Amenable to Primary Care	-8.606	-27.962*	-28.085*	-28.261*
	(17.682)	(14.927)	(14.911)	(14.886)

Notes: The number of observations is 64482. DiD Estimates from Equation 1. Independent variable is the distance to the EC/29 target in p.p. Column 1 presents the baseline model with municipality and state-year fixed effects. Column 2 adds baseline socioeconomic controls from the Census interacted with time. Column 3 adds controls for GDP per capita and *Bolsa Familia* transfers per capita. Column 4 adds fiscal controls. Covariates omitted. Standard errors in brackets are clustered in the municipality level. p < 0.10, p < 0.05, p < 0.011

infant mortality rates by timing of death and by cause of death. We are also able to analyse infant mortality rates by classifying them between amenable and non-amenable to primary care. These results are presented in Table 5. In all specifications presented for this section, we added a trend of baseline ill-defined infant mortality with the goal of accounting for mortality under-reporting[14]. During the period of analysis, the completeness of death counts improved considerably and it is strongly associated with the reduction in ill-defined causes of death (Lima and Queiroz, 2014).

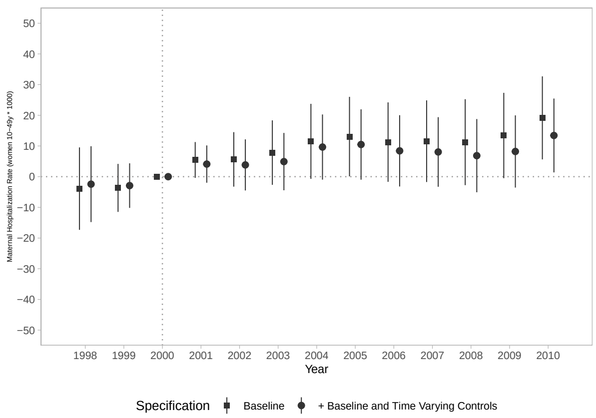
Panel A present the estimates for total infant mortality rates (IMR) and IMR amenable and non-amenable to primary care. Though not significant, the estimates present the expected sign. Yet, the more flexible coefficients estimated with equation 2 provide useful information on the dynamics of the effects and suggest the presence of some significant reduction in IMR. Figure 16 plots the dynamic effects for the IMR presented in Panel A. IMR (Figure 16a) and IMR amenable to primary care (Figure 16b) present a clear trend of reduction, with estimates for 2007 onward being all statistically significant in our preferred specification.

Next, we present the estimates for IMR by timing of death (Panel B). IMR withing 24 hours

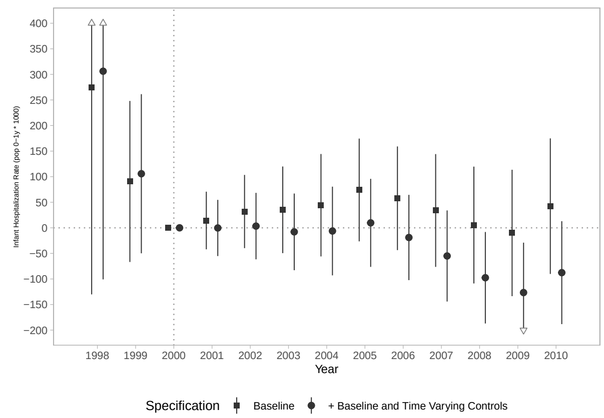
[14]Appendix Table C presents estimates with and without the baseline ill-defined infant mortality trend.

Figure 15: Effects Hospitalization

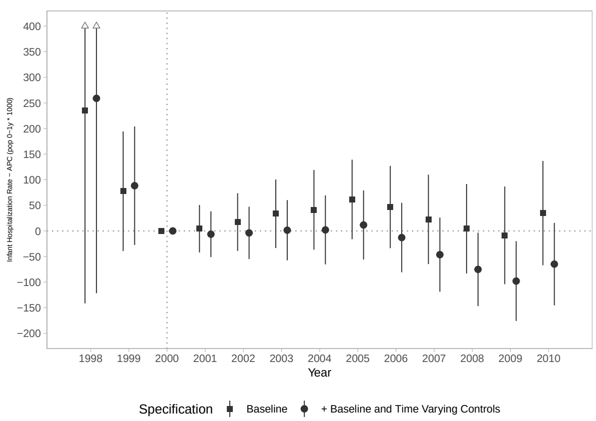
(a) Maternal Hospitalization Rate (women 10-49y * 1000)



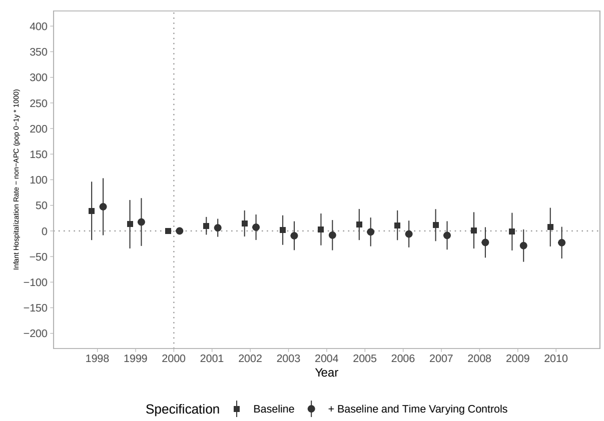
(b) Infant Hospitalization Rate (pop 0-1y * 1000)



(c) Infant Hospitalization Rate - APC (pop 0-1y * 1000)



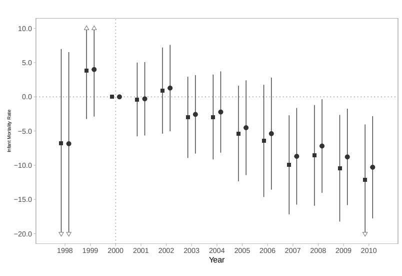
(d) Infant Hospitalization Rate - non-APC (pop 0-1y * 1000)



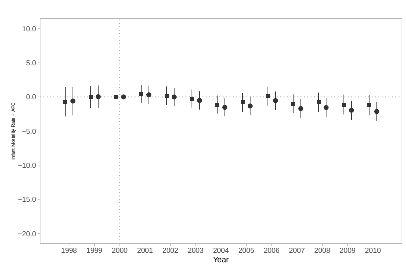
Notes: The number of observations is 64482. DiD Estimates from Equation 2. Independent variable is the distance to the EC/29 target in p.p. Square dots represent the baseline model with municipality and state-year fixed effects. Round dots represent our preferred specification (Column 3 in regression Tables). Lines represent 95% confidence intervals. Arrows, when present, indicate confidence intervals out of the plot bounds. Standard errors are clustered in the municipality level.

Figure 16: Effects on Infant Mortality Rates

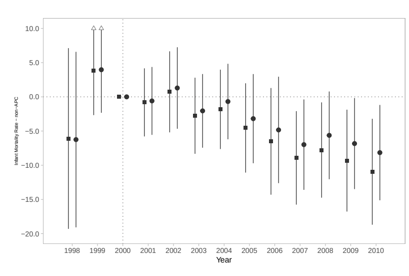
(a) Total



(b) Amenable to Primary Care



(c) Non-Amenable to Primary Care



Notes: The number of observations is 64482. DiD Estimates from Equation 2. Independent variable is the distance to the EC/29 target in p.p. Square dots represent the baseline model with municipality and state-year fixed effects. Round dots represent our preferred specification (Column 3 in regression Tables). Lines represent 95% confidence intervals. Arrows, when present, indicate confidence intervals out of the plot bounds. Standard errors are clustered in the municipality level.

Table 5: Infant Mortality Rates

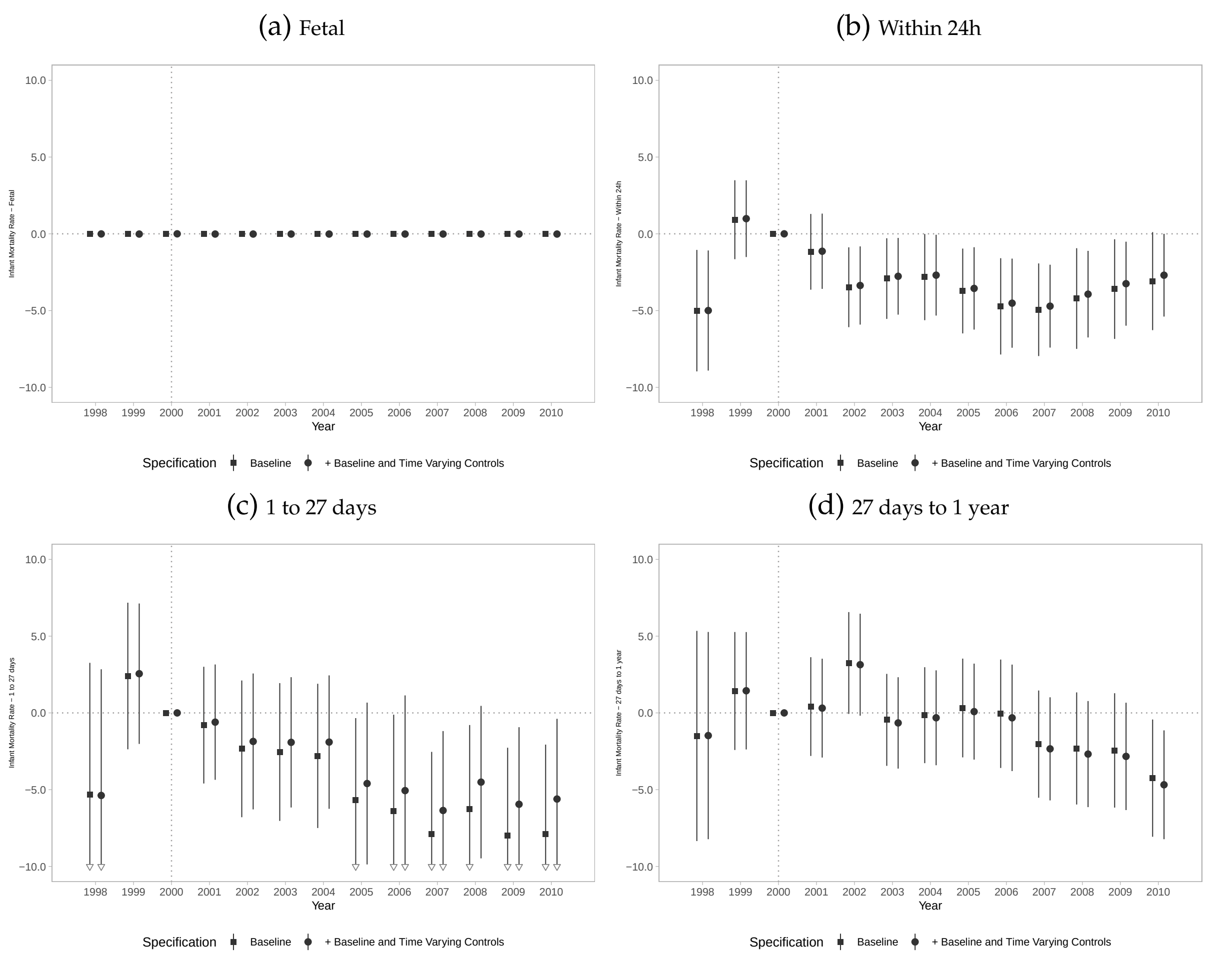
	(1)	(2)	(3)	(4)
A. Infant Mortality Rate				
Total	-5.015	-3.772	-3.831	-3.889
	(3.435)	(2.853)	(2.836)	(2.828)
Amenable to Primary Care	-0.361	-0.866	-0.893	-0.905
	(0.603)	(0.553)	(0.553)	(0.554)
Non-Amenable to Primary Care	-4.653	-2.907	-2.939	-2.984
	(3.245)	(2.645)	(2.632)	(2.624)
B. By timing				
Fetal	-0.008	-0.007	-0.008	-0.008
	(0.008)	(0.008)	(0.008)	(0.008)
Within 24h	-2.275*	-2.083**	-2.07**	-2.071**
	(1.225)	(0.98)	(0.979)	(0.976)
1 to 27 days	-4.228*	-2.883	-2.911	-2.922
	(2.555)	(2.064)	(2.052)	(2.046)
27 days to 1 year	-0.787	-0.89	-0.92	-0.967
	(1.435)	(1.248)	(1.246)	(1.243)
C. By Cause of Death				
Infectious	-0.374	-0.811	-0.82	-0.831
	(0.567)	(0.535)	(0.535)	(0.534)
Respiratory	-0.494	-0.507	-0.511	-0.517
	(0.474)	(0.411)	(0.409)	(0.409)
Perinatal	-5.349**	-3.648*	-3.69*	-3.707*
	(2.571)	(2.015)	(2.007)	(2.002)
Congenital	-0.235	-0.169	-0.16	-0.157
	(0.463)	(0.436)	(0.434)	(0.434)
External	0.024	-0.049	-0.037	-0.034
	(0.183)	(0.165)	(0.165)	(0.166)
Nutritional	-0.204	-0.328	-0.33	-0.343
	(0.246)	(0.231)	(0.232)	(0.232)
Other	-0.183	-0.123	-0.132	-0.139
	(0.201)	(0.199)	(0.198)	(0.198)
Ill-Defined	1.8**	1.862**	1.849**	1.84**
	(0.849)	(0.776)	(0.779)	(0.779)

Notes: The number of observations is 64482. DiD Estimates from Equation 1. Independent variable is the distance to the EC/29 target in p.p. Column 1 presents the baseline model with municipality and state-year fixed effects. Column 2 adds baseline socioeconomic controls from the Census interacted with time. Column 3 adds controls for GDP per capita and *Bolsa Familia* transfers per capita. Column 4 adds fiscal controls. To all columns specifications we added a trend of baseline ill-defined infant mortality with the goal of accounting for mortality under-reporting. Covariates omitted. Standard errors in brackets are clustered in the municipality level. $p < 0.10$, $p < 0.05$, $p < 0.01$

shows a significant reduction of 2.07, which is equivalent to a 3.7% decreased in baseline mortality for the representative municipality. The estimates for the remaining IMR of Panel B are not significant, but the dynamic effects suggests the presence of reduction trend in later years for IMR from 1 to 27 days (Figure 17c) and IMR from 27 days to 1 year old

(Figure 17d).

Figure 17: Effects on Infant Mortality Rates - By Timing

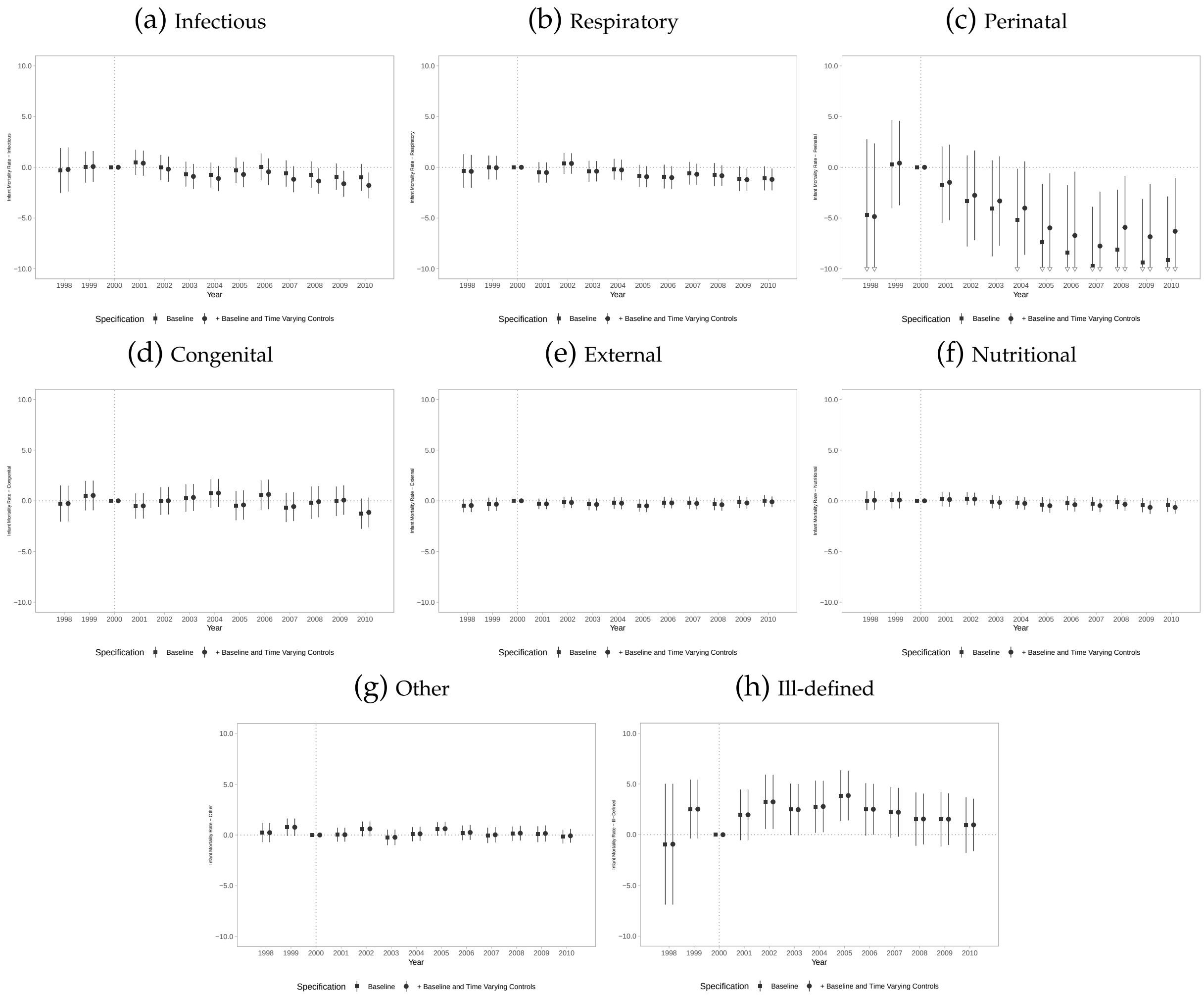


Notes: The number of observations is 64482. DiD Estimates from Equation 2. Independent variable is the distance to the EC/29 target in p.p. Square dots represent the baseline model with municipality and state-year fixed effects. Round dots represent our preferred specification (Column 3 in regression Tables). Lines represent 95% confidence intervals. Arrows, when present, indicate confidence intervals out of the plot bounds. Standard errors are clustered in the municipality level.

The last part of Table 5 present the estimates for IMR by causes of death. We only find marginally significant reductions for IMR from Perinatal causes. This estimated represents a 3.4% decrease relative to baseline mortality. We also find the unexpected effect of increases in IMR from ill-defined causes. Moreover, the dynamic effects presented in Figure 18 suggest the presence of some reduction in IMR by infectious and in IMR by respiratory causes.

In general, articles estimating the causal relationship between health spending and mortality run log-log regressions and present estimates for the elasticity of mortality with

Figure 18: Effects on Infant Mortality Rates - By Cause



Notes: The number of observations is 64482. DiD Estimates from Equation 2. Independent variable is the distance to the EC/29 target in p.p. Square dots represent the baseline model with municipality and state-year fixed effects. Round dots represent our preferred specification (Column 3 in regression Tables). Lines represent 95% confidence intervals. Arrows, when present, indicate confidence intervals out of the plot bounds. Standard errors are clustered in the municipality level.

respect to health spending. We explicitly choose not to apply transformations to our health outcomes variables due to the amount of observations with values equal to 0, notably the ones related to birth and mortality. Our data comprises all the Brazilian municipalities with available data for the period of analyses, some with population size as little as 700 inhabitants, and it is common to find infant mortality rates of 0. Running log transformation would throw away some relevant information for several outcomes. Nonetheless, to relate our results to the literature on this topic we estimate "back of the envelope" elasticities for all IMR using the estimates of our regressions. Table D.1 presents these elasticities.

The elasticities presented in the literature vary greatly. Within cross-country studies, while Filmer and Pritchett (1999) finds a very small elasticity of -0.08, Gupta et al. (2002) finds an elasticity of -0.31 and Bokhari et al. (2007) elasticities ranging between -0.4 and -0.5. In the micro studies Crémieux et al. (1999b) finds large elasticities between -0.8 and -1.1, Bhalotra (2007) finds an elasticity of -0.24 for rural regions, and Castro et al. (2021) elasticities ranging between -0.5 and -0.9. Though not significant, our study finds much smaller elasticities for total infant mortality rates. Using SIOPS as the measure of health spending, we find IMR elasticities ranging between -0.06 and -0.14. When it comes to within 24 hours IMR and Perinatal IMR, the rates for which we found significant decreases, the back of the envelope calculations suggest an elasticity of -0.136 and -0.124, respectively.

Table 6: Fertility and Birth Outcomes

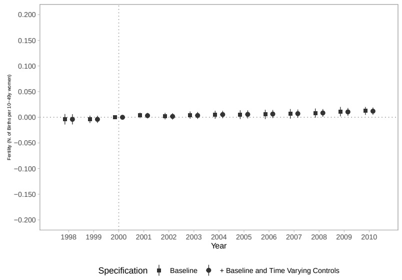
	(1)	(2)	(3)	(4)
A. Fertility				
Rates of Birth per Woman (10-49y)	0.009**	0.008**	0.009**	0.009**
	(0.004)	(0.003)	(0.003)	(0.003)
B. Birth Outcomes				
Apgar 1	-0.056	0.063	0.053	0.051
	(0.206)	(0.198)	(0.198)	(0.198)
Apgar 5	0.009	0.107	0.104	0.101
	(0.183)	(0.179)	(0.18)	(0.179)
Low Birth Weight (<2.5k)	-0.003	-0.002	-0.001	-0.002
	(0.003)	(0.003)	(0.003)	(0.003)
Premature Birth	-0.005	-0.016	-0.017	-0.017
	(0.026)	(0.023)	(0.023)	(0.023)
Sex Ratio at Birth	0.014	0.016	0.017	0.017
	(0.016)	(0.016)	(0.016)	(0.016)

Notes: The number of observations is 64482 for Panel A, 63705 for Apgar 1, 59524 for Apgar 5, 64481 for Low Birth Weight and Premature Birth, and 64470 for Sex Ratio at Birth. DiD Estimates from Equation 1. Independent variable is the distance to the EC/29 target in p.p. Column 1 presents the baseline model with municipality and state-year fixed effects. Column 2 adds baseline socioeconomic controls from the Census interacted with time. Column 3 adds controls for GDP per capita and *Bolsa Familia* transfers per capita. Column 4 adds fiscal controls. Covariates omitted. Standard errors in brackets are clustered in the municipality level. p < 0.10, p < 0.05, p < 0.011

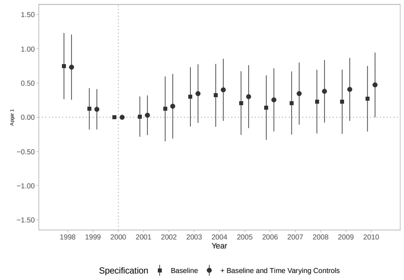
Lastly, table 6 presents the estimates for fertility and birth outcomes. In general, the point estimates are in the expected direction, substantially small,but and statistically insignificant. An exception is our measure of fertility that presents small but significant estimates. A 0.009 increase in the fertility rate, correspond to a 1.6% variation relative to the baseline for the representative municipality. Figure 19 plots the dynamic effects for fertility and birth outcomes. Figure 19a suggests the presence of some trend in our fertility measure, that seems to show a constant increase from the pre-treatment period until the last year of analysis.

Figure 19: Effects on Fertility and Birth Outcomes

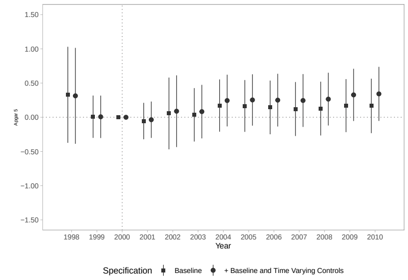
(a) Rates of Birth per Woman (10-49y)



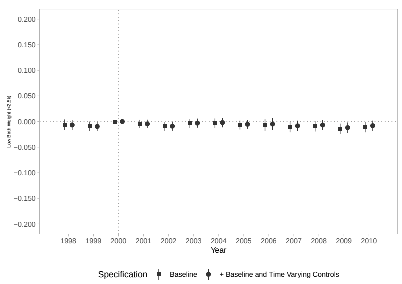
(b) Apgar 1



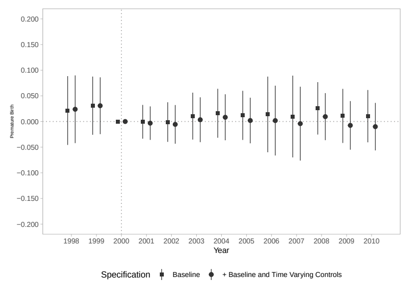
(c) Apgar 5



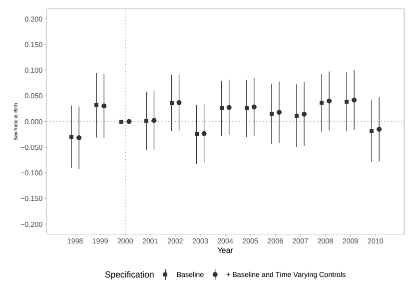
(d) Low Birth Weight (<2.5k)



(e) Premature Birth



(f) Sex Ratio at Birth



Notes: The number of observations is 64482 for 19a, 63705 for 19b, 59524 for 19c, 64481 for 19d and 19e, and 64470 for 19f. DiD Estimates from Equation 2. Independent variable is the distance to the EC/29 target in p.p. Square dots represent the baseline model with municipality and state-year fixed effects. Round dots represent our preferred specification (Column 3 in regression Tables). Lines represent 95% confidence intervals. Arrows, when present, indicate confidence intervals out of the plot bounds. Standard errors are clustered in the municipality level.

Overall, we found significant effects for infant moralities rates that are mainly associated with increases in access to primary care and community-based health interventions (Rocha and Soares, 2010; Bhalotra et al., 2019), suggesting that the effects found for health inputs related to primary care might be the channel through which spending affected infant mortality.

5.4 Robustness

In Section 4.1 we stressed that the validity of our research design relies on having parallel trends and homogeneity in treatment effect. However, we can only empirically test the first identification hypothesis. For all outcomes discussed in this article, we presented figures plotting the estimates of Equation 2 that captures pre-trends in the outcome variable. With only few exceptions, our estimates show no pre-trends in our outcomes.

Another concern may arise from unobserved events coinciding the approval of the EC/29. The inclusion of state-year fixed effects in all specification helps address this concern, as well as the concern on pre-trends. Moreover, we presented in all regression tables estimates for four specifications that gradually included different set of controls, with figures plotting estimates only for the baseline specification and the more complete specification. Our analysis shows that estimates for health spending and health inputs are highly robust to different specifications. The estimates for outcomes related to birth and mortality are a bit more sensible to the inclusion of baseline controls, but still very robust to different specifications.

6 Conclusions

Our empirical analysis has demonstrated that when municipalities are induced to increase public health spending they do so by increasing mainly spending relative to the administrative structure of public health - roughly half of the increase - followed by spending with investments and human resources. We also demonstrate that this increase is associated with a higher number of administrative professionals, greater supply of municipal hospitals, and greater primary care coverage at the intensive margin, with also a higher number of health facilities with primary care related professionals. The shifts in spending and health inputs are associated with small to moderate reductions in infant mortality rates related to improvements in primary care access, and long term reductions in total infant mortality rates. Bhalotra et al. (2019) have shown that the combination of access to primary and hospital care leads to better health outcomes relative to only primary care. This is a plausible channel through which the increase in the supply of municipal hospitals might be affecting infant mortality in our analysis.

These results are extremely relevant, specially in a context of a universal an decentralized health system, where provision of health care occurs mainly at the municipal level, and the majority of the resources spent locally comes from local tax incomes, in opposition to intergovernmental transfers. [Discuss transfers vs own resource spending]. We are not able to formally test exactly how health inputs and outcomes would react if municipalities allocated less resources on administrative structure and more resources into investments and personnel, but the evidence here present indicates it could lead to further improvements in health outcomes, and, thus, a more efficient use of resources within the public health sector.

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Appendix

A Descriptive Statistics

Table A.1: Descriptive Statistics (at the baseline year)

	Mean	Std. Dev.	Min	Max	Obs.	Source of Data
EC 29 Variables						
Share of Municipality's Own Resource Spent in Public Health	0.138	0.068	0	0.802	5224	Datasus/SIOPS
Distance to the EC29 Target	0.012	0.068	-0.652	0.15	5224	Datasus/SIOPS
Public Revenue						
Total Revenue per capita	1225.274	2282.128	132.386	121105.017	5288	Finbra
Public Spending						
Total Spending per capita	1284.77	2395.06	129.735	127974.259	5304	Finbra
Spending by Category - per capita						
Health and Sanitation	217.08	276.14	0.037	12559.61	5286	Finbra
Transport	91.551	138.28	0	5865.789	5304	Finbra
Education and Culture	419.945	640.291	0	36319.154	5304	Finbra
Housing and Urban	116.052	301.25	0	19842.146	5304	Finbra
Social Assistance	84.052	253.836	0	13814.629	5304	Finbra
Other Categories	472.878	1201.128	32.002	65369.184	5304	Finbra
Public Health Spending						
Total Health Spending per capita	192.543	110.44	24.632	1397.575	5225	Datasus/SIOPS
Health Spending by Source - per capita						
Own Resources spending per capita	119.763	96.992	0	1232.875	5225	Datasus/SIOPS
Transfers Spending per capita	72.779	50.002	0	1099.097	5225	Datasus/SIOPS
Health Spending by Type - per capita						
Human Resources Spending per capita	71.337	61.87	0	1118.758	5225	Datasus/SIOPS
Investiments Spending per capita	14.567	26.899	0	361.969	5225	Datasus/SIOPS
3rd parties services Spending per capita	33.149	43.284	0	1041.135	5225	Datasus/SIOPS
Other Spendings per capita	73.49	52.755	0	602.699	5225	Datasus/SIOPS

Table A.1: Descriptive Statistics (at the baseline year) – *Cont.*

	Mean	Std. Dev.	Min	Max	Obs.	Source of Data
Primary Care Coverage						
Extensive Margin						
Population covered (share) by Community Health Agents	0.635	0.409	0	1	5507	Datasus/SIAB
Population covered (share) by Family Health Agents	0.311	0.383	0	1	5507	Datasus/SIAB
Intensive Margin						
N. of People Visited by Primary Care Agents (per capita)	0.271	0.285	0	2.798	5507	Datasus/SIAB
N. of People Visited by Community Health Agents (per capita)	0.121	0.18	0	1.518	5507	Datasus/SIAB
N. of People Visited by Family Health Agents (per capita)	0.15	0.252	0	1.834	5507	Datasus/SIAB
N. of Household Visits & Appointments (per capita)	1.876	2.541	0	88.85	5507	Datasus/SIAB
N. of Household Visits & Appointments by Community Health Agents (per capita)	1.072	2.156	0	85.989	5507	Datasus/SIAB
N. of Household Visits & Appointments by Family Health Agents (per capita)	0.8	1.505	0	43.389	5507	Datasus/SIAB
Health Human Resources						
N. of Health Professionals (per capita*1000)	5.104	4.825	0	187.904	5507	IBGE/AMS
N. of Doctors (per capita*1000)	1.529	2.385	0	95.132	5507	IBGE/AMS
N. of Nurses (per capita*1000)	1.159	1.636	0	95.097	5507	IBGE/AMS
N. of Nursing Assistants (per capita*1000)	1.26	1.456	0	22.009	5507	IBGE/AMS
N. of Administrative Professionals (per capita*1000)	1.155	1.251	0	36.599	5507	IBGE/AMS
Health Infrastructure						
N. of Municipal Hospitals (per capita*1000)	0.06	0.138	0	1.357	5507	IBGE/AMS
N. of Federal and State Hospitals (per capita*1000)	0.015	0.084	0	1.892	5507	IBGE/AMS
N. of Private Hospitals (per capita*1000)	0.03	0.058	0	0.609	5507	IBGE/AMS
N. of Health Facilities (per capita*1000) with Ambulatory Service	0.517	0.355	0	3.628	5493	Datasus/SIA
Primary Care Related Infrastructure and Human Resources						
Number of Health Facilities (per capita * 1000) with						
Ambulatory Service and ACS Teams	0.14	0.197	0	2.41	5493	Datasus/SIA
Ambulatory Service and Community Doctors	0.082	0.154	0	1.957	5493	Datasus/SIA
Ambulatory Service and ACS Nurses	0.072	0.156	0	2.41	5493	Datasus/SIA
Ambulatory Service and PSF Teams	0.083	0.159	0	2.41	5493	Datasus/SIA
Ambulatory Service and PSF Doctors	0.077	0.149	0	1.957	5493	Datasus/SIA
Ambulatory Service and PSF Nurses	0.075	0.149	0	2.41	5493	Datasus/SIA
Ambulatory Service and PSF Nursing Assistants	0.05	0.123	0	1.957	5493	Datasus/SIA
Ambulatorial Production						
N. Outpatient Procedures (per capita)	8.8	4.55	0	48.258	5507	Datasus/SIA
N. Primary Care Outpatient Procedures (per capita)	7.415	3.974	0	39.367	5507	Datasus/SIA
N. Low & Mid Complexity Outpatient Procedures (per capita)	9.467	5.801	0	171.126	5493	Datasus/SIA
N. High Complexity Outpatient Procedures (per capita)	0.005	0.052	0	2.58	5493	Datasus/SIA
Access to Health Services						
Prenatal Ignored	0.044	0.094	0	1	5460	Datasus/SINASC
Prenatal Visits None	0.053	0.077	0	0.921	5437	Datasus/SINASC
Prenatal Visits 1-6	0.53	0.216	0	1	5507	Datasus/SINASC
Prenatal Visits 7+	0.375	0.235	0	1	5507	Datasus/SINASC
Hospitalization						
Maternal Hospitalization Rate (women 10-49y * 1000)	50.979	36.041	0	2194.472	5507	Datasus/SIH
Infant Hospitalization Rate (pop 0-1y * 1000)	280.493	337.947	0	14410.256	5507	Datasus/SIH
Infant Hospitalization Rate - APC (pop 0-1y * 1000)	207.185	252.586	0	10000	5507	Datasus/SIH
Infant Hospitalization Rate - non-APC (pop 0-1y * 1000)	73.308	119.599	0	4410.256	5507	Datasus/SIH

Table A.1: Descriptive Statistics (at the baseline year) – *Cont.*

	Mean	Std. Dev.	Min	Max	Obs.	Source of Data
Infant Mortality Rate						
Total	23.069	26.163	0	1000	5507	Datasus/SIM
APC	2.097	7.101	0	333.333	5507	Datasus/SIM
non-APC	20.972	22.291	0	666.667	5507	Datasus/SIM
Fetal	0.003	0.078	0	3.571	5507	Datasus/SIM
Within 24h	5.554	10.146	0	333.333	5507	Datasus/SIM
1 to 27 days	13.727	15.891	0	333.333	5507	Datasus/SIM
27 days to 1 year	9.342	16.341	0	666.667	5507	Datasus/SIM
Infectious	1.999	7.03	0	333.333	5507	Datasus/SIM
Respiratory	1.515	4.454	0	142.857	5507	Datasus/SIM
Perinatal	11.041	16.32	0	666.667	5507	Datasus/SIM
Congenital	2.127	5.008	0	93.023	5507	Datasus/SIM
External	0.366	1.914	0	43.478	5507	Datasus/SIM
Nutritional	0.601	3.221	0	166.667	5507	Datasus/SIM
Other	0.87	3.597	0	142.857	5507	Datasus/SIM
Ill-Defined	4.551	10.684	0	142.857	5507	Datasus/SIM
Fertility						
Rates of Birth per Woman (10-49y)	0.055	0.017	0.002	0.169	5507	Datasus/SINASC
Birth Oucomes						
Apgar 1	8.183	0.903	1	9	5428	Datasus/SINASC
Apgar 5	8.663	0.885	1	9	5082	Datasus/SINASC
Low Birth Weight (<2.5k)	0.066	0.032	0	0.5	5507	Datasus/SINASC
Premature Birth	0.093	0.107	0	1	5507	Datasus/SINASC
Sex Ratio at Birth	1.074	0.247	0.154	5	5505	Datasus/SINASC

Table A.1: Descriptive Statistics (at the baseline year) – *Cont.*

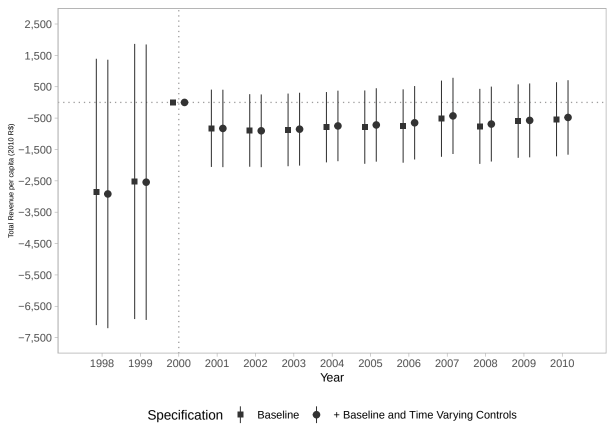
	Mean	Std. Dev.	Min	Max	Obs.	Source of Data
Controls						
Population (1,000)	29.773	178.831	0.711	9968.485	5507	IBGE/Census
GDP per capita (2010 R$)	9.531	11.231	1.365	271.779	5507	IBGE/Census
'Bolsa Familia' transfers per capita (2010 R$)	0	0	0	0	5507	IBGE/Census
Life Expectancy	68.385	3.962	57.46	77.24	5507	IBGE/Census
Expected Years of Study	8.337	1.794	2.29	13.02	5507	IBGE/Census
Iliteracy Rate (above 18y old)	23.626	13.516	1	63.01	5507	IBGE/Census
Income per capita	338.35	192.807	62.65	1759.76	5507	IBGE/Census
Share of Population Below Poverty Line	0.411	0.228	0.007	0.908	5507	IBGE/Census
Gini Coefficient	0.547	0.068	0.3	0.87	5507	IBGE/Census
Access to Sewage Network	0.251	0.302	0	0.993	5507	IBGE/Census
Access to Garbage Collection Service	0.535	0.271	0	1	5507	IBGE/Census
Access to Water Network	0.583	0.241	0	1	5507	IBGE/Census
Access to Electricity	0.869	0.165	0.081	1	5507	IBGE/Census
Urbanization Rate	0.602	0.227	0	1	5507	IBGE/Census
Average Neighbors Spending Health Spending per capita (2010 R$)	206.387	125.041	1.741	3298.403	5504	Finbra
Municipality's Spending in Human Resources (% of Total Revenue)	0.415	0.109	0	1.242	5304	Finbra

Notes: Authors' own tabulation. Statistics for IBGE/AMS data refer to the year 1999 and statistics for all remaining variables refer to the baseline year o 2000. Data sources indicated in the table.

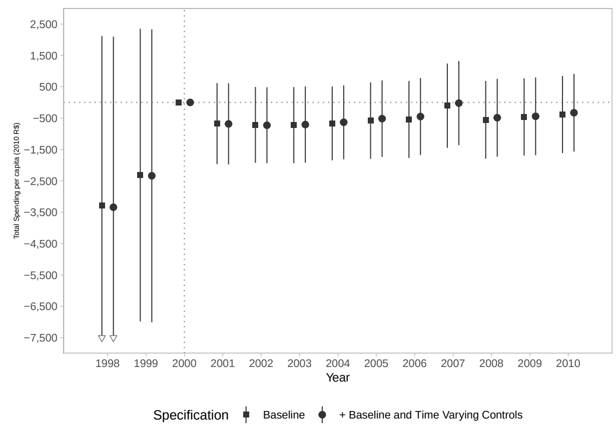
B Dynamic Fiscal Reactions

Figure B.1: Fiscal Reactions

(a) Total Revenue



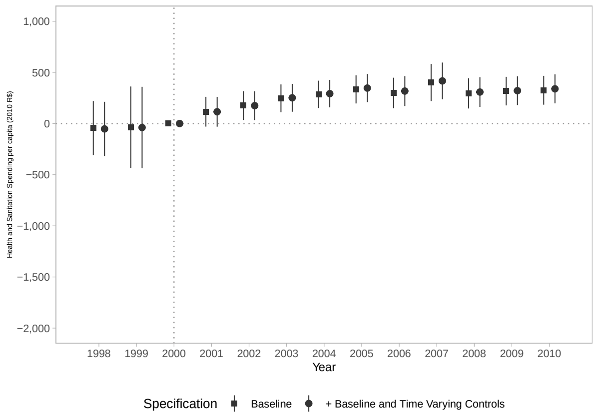
(b) Total Public Spending



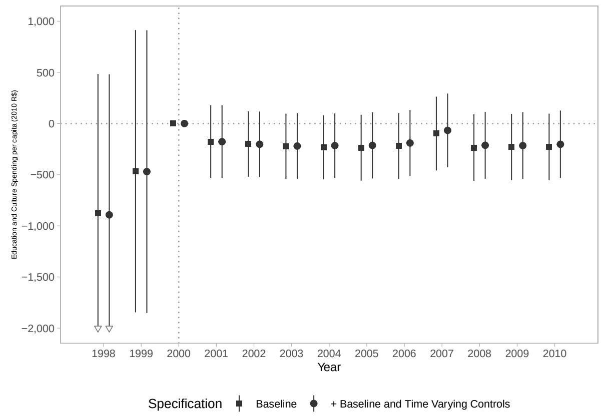
Notes: The number of observations is 64224. DiD Estimates from Equation 2. Independent variable is the distance to the EC/29 target in p.p. Square dots represent the baseline model with municipality and state-year fixed effects. Round dots represent our preferred specification (Column 3 in regression Tables). Lines represent 95% confidence intervals. Arrows, when present, indicate confidence intervals out of the plot bounds. Standard errors are clustered in the municipality level.

Figure B.2: Effects on Public Spending per capita - By Category

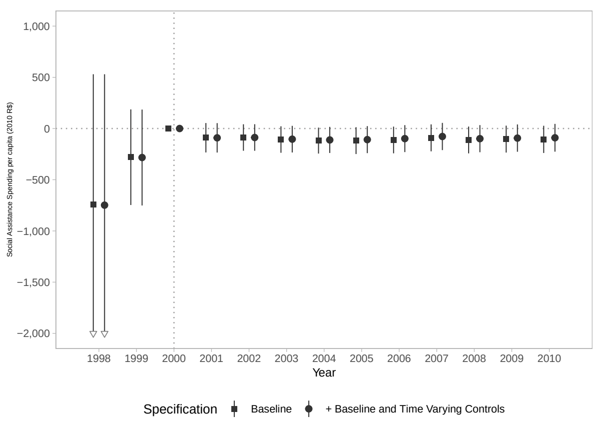
(a) Health and Sanitation



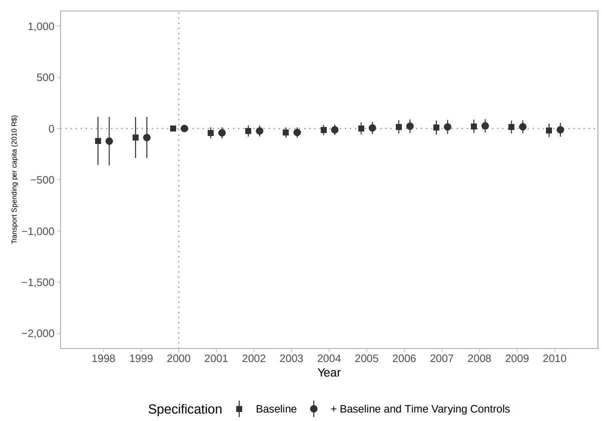
(b) Education and Culture



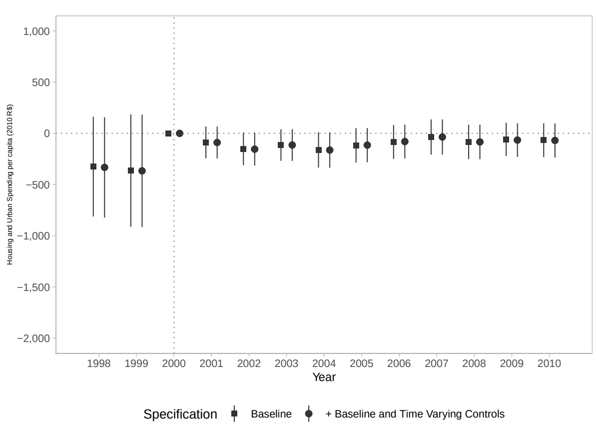
(c) Social Assistance



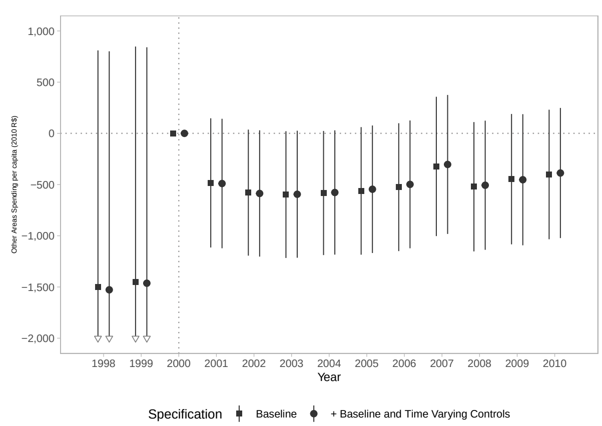
(d) Transport



(e) Housing and Urban



(f) Spending in Other Categories



Notes: The number of observations is 64224. DiD Estimates from Equation 2. Independent variable is the distance to the EC/29 target in p.p. Square dots represent the baseline model with municipality and state-year fixed effects. Round dots represent our preferred specification (Column 3 in regression Tables). Lines represent 95% confidence intervals. Arrows, when present, indicate confidence intervals out of the plot bounds. Standard errors are clustered in the municipality level.

C Effects on Infant Mortality Rate - Extended

Table C.1: Infant Mortality Rates - Extended

	With IMR Ill-defined Trend				Without IMR Trends	
	(1)	(2)	(3)	(4)	(5)	(6)
A. Infant Mortality Rate						
Total	-5.015	-3.772	-3.831	-3.889	-2.062	-2.12
	(3.435)	(2.853)	(2.836)	(2.828)	(3.128)	(3.121)
Amenable to Primary Care	-0.361	-0.866	-0.893	-0.905	-0.841	-0.853
	(0.603)	(0.553)	(0.553)	(0.554)	(0.553)	(0.553)
Non-Amenable to Primary Care	-4.653	-2.907	-2.939	-2.984	-1.222	-1.267
	(3.245)	(2.645)	(2.632)	(2.624)	(2.924)	(2.918)
B. By timing						
Fetal	-0.008	-0.007	-0.008	-0.008	-0.008	-0.008
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Within 24h	-2.275*	-2.083**	-2.07**	-2.071**	-1.896*	-1.898**
	(1.225)	(0.98)	(0.979)	(0.976)	(0.969)	(0.967)
1 to 27 days	-4.228*	-2.883	-2.911	-2.922	-2.239	-2.249
	(2.555)	(2.064)	(2.052)	(2.046)	(2.073)	(2.067)
27 days to 1 year	-0.787	-0.89	-0.92	-0.967	0.176	0.129
	(1.435)	(1.248)	(1.246)	(1.243)	(1.561)	(1.559)
C. By Cause of Death						
Infectious	-0.374	-0.811	-0.82	-0.831	-0.794	-0.805
	(0.567)	(0.535)	(0.535)	(0.534)	(0.538)	(0.538)
Respiratory	-0.494	-0.507	-0.511	-0.517	-0.465	-0.471
	(0.474)	(0.411)	(0.409)	(0.409)	(0.406)	(0.406)
Perinatal	-5.349**	-3.648*	-3.69*	-3.707*	-3.159	-3.176
	(2.571)	(2.015)	(2.007)	(2.002)	(1.962)	(1.957)
Congenital	-0.235	-0.169	-0.16	-0.157	-0.15	-0.147
	(0.463)	(0.436)	(0.434)	(0.434)	(0.435)	(0.434)
External	0.024	-0.049	-0.037	-0.034	-0.036	-0.033
	(0.183)	(0.165)	(0.165)	(0.166)	(0.165)	(0.166)
Nutritional	-0.204	-0.328	-0.33	-0.343	-0.298	-0.311
	(0.246)	(0.231)	(0.232)	(0.232)	(0.225)	(0.226)
Other	-0.183	-0.123	-0.132	-0.139	-0.138	-0.144
	(0.201)	(0.199)	(0.198)	(0.198)	(0.198)	(0.198)
Ill-Defined	1.8**	1.862**	1.849**	1.84**	2.977**	2.968**
	(0.849)	(0.776)	(0.779)	(0.779)	(1.379)	(1.38)

Notes: The number of observations is 64482. DiD Estimates from Equation 1. Independent variable is the distance to the EC/29 target in p.p. Column 1 presents the baseline model with municipality and state-year fixed effects. Column 2 adds baseline socioeconomic controls from the Census interacted with time. Column 3 adds controls for GDP per capita and *Bolsa Familia* transfers per capita. Column 4 adds fiscal controls. Column 5 removes from the specification in Column 3 the trend of baseline ill-defined infant mortality. Column 6 removes this trend for the specification in Column 4. Covariates omitted. Standard errors in brackets are clustered in the municipality level. $p < 0.10$, $p < 0.05$, $p < 0.01$

D Infant Mortality Rates Elasticity

Table D.1: *Back of the Envelope* Infant Mortality Rates Elasticity

	Health and Sanitation Spending (Finbra)				Health Spending (Siops)			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Infant Mortality Rate								
Total	-0.156	-0.116	-0.115	-0.119	-0.138	-0.059	-0.060	-0.061
Amenable to Primary Care	-0.123	-0.292	-0.294	-0.305	-0.109	-0.150	-0.154	-0.157
Non-Amenable to Primary Care	-0.159	-0.098	-0.097	-0.101	-0.141	-0.050	-0.051	-0.052
By timing								
Fetal	-1.912	-1.650	-1.842	-1.887	-1.696	-0.847	-0.967	-0.971
Within 24h	-0.294	-0.265	-0.257	-0.264	-0.261	-0.136	-0.135	-0.136
1 to 27 days	-0.221	-0.148	-0.146	-0.151	-0.196	-0.076	-0.077	-0.077
27 days to 1 year	-0.060	-0.067	-0.068	-0.073	-0.054	-0.035	-0.036	-0.038
By Cause of Death								
Infectious	-0.134	-0.287	-0.283	-0.294	-0.119	-0.147	-0.149	-0.151
Respiratory	-0.234	-0.237	-0.233	-0.241	-0.207	-0.122	-0.122	-0.124
Perinatal	-0.347	-0.234	-0.231	-0.238	-0.308	-0.120	-0.121	-0.122
Congenital	-0.079	-0.056	-0.052	-0.052	-0.070	-0.029	-0.027	-0.027
External	0.047	-0.095	-0.070	-0.066	0.042	-0.049	-0.037	-0.034
Nutritional	-0.243	-0.386	-0.379	-0.404	-0.216	-0.198	-0.199	-0.208
Other	-0.151	-0.100	-0.105	-0.113	-0.134	-0.051	-0.055	-0.058
Ill-Defined	0.284	0.289	0.281	0.286	0.252	0.149	0.147	0.147

Notes: Elasticity of Infant Mortality Rates estimated using $ImrE_s = \frac{\%\ \text{Change in Infant Mortality Rates}}{\%\ \text{Change in Health Spending}}$. Percent changes for IMRs calculated using effects presented in Table 5 and baseline IMRs. Percent changes for Finbra and SIOPS spending calculated using effects presented in Table 1 and baseline spending. See Table A for baseline statistics. The different specifications columns uses the estimates from the correspondent column in the regression tables