ECONSTOR
Make Your Publications Visible.

A Service of

ZBW Leibniz-Informationszentrum Wirtschaft
Leibniz Information Centre for Economics

Marques, Renan; Maciel, Mateus; Zuchowski, David

Working Paper

Under pressure? Forced migration and public health

GLO Discussion Paper, No. 1748

Provided in Cooperation with:
Global Labor Organization (GLO)

Suggested Citation: Marques, Renan; Maciel, Mateus; Zuchowski, David (2026) : Under pressure? Forced migration and public health, GLO Discussion Paper, No. 1748, Global Labor Organization (GLO), Essen

This Version is available at:
https://hdl.handle.net/10419/340847

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

WWW.ECONSTOR.EU

Mitglied der Leibniz-Gemeinschaft

Under pressure?
Forced migration and public health*

Renan Marques
Duke University

Mateus Maciel
University of Tübingen & GLO

David Zuchowski
University of Valencia & GLO

April 29, 2026

Abstract

We study how Venezuelan refugee inflows affect healthcare outcomes and municipal public finances in Brazil's universal, decentralized public healthcare system. For identification, we exploit cross-municipality variation in refugee exposure and use distance to Brazil's only official border crossing with Venezuela as an instrument. A one-percentage-point increase in the local refugee share raises overall mortality by 4.2 percent and infant mortality by up to 9 percent. We show these effects operate through both the poorer baseline health of arriving refugees and congestion in local health facilities. Municipalities increase the share of spending on healthcare, but absent compensating federal transfers, they do so at the expense of education's budget share. These results highlight the limits of decentralized service provision in absorbing the health and fiscal costs of concentrated migration shocks.

JEL Classification: H75, J61, I10
Keywords: Forced migration, refugees, public health, Brazil

*Corresponding author: Renan Marques, Sanford School of Public Policy, Duke University, Durham, North Carolina, USA, E-mail: renan.marques@duke.edu. The authors thank Marcos Rangel, Arkadev Gosh, Hannah Postel, Jonathan Zhang, João Pereira dos Santos, Anna Sanz-de-Galdeano, Paula Sarmiento, Midori Wakabayashi, Breno Braga, and seminar participants at Duke University, Universidade Católica de Brasília, Universitat de València, Kyiv School of Economics (KSE), United Nations University (UNU-MERIT) in Maastricht, and the 2025 APPAM Annual Meeting for helpful comments and suggestions.

1 Introduction

Forced migration has reached unprecedented levels in recent years. Large inflows of forced migrants can place severe pressure on host regions' healthcare systems, particularly in low- and middle-income countries. While these countries hosted nearly three-quarters of the more than 120 million displaced people worldwide in 2024 (UNHCR, 2025), they often face limited fiscal and administrative capacity to absorb such shocks (Besley and Persson, 2014; Castro *et al.*, 2019). Yet the empirical literature on the health consequences of refugee inflows in developing countries remains scarce and provides mixed evidence.[1] Furthermore, the underlying mechanisms remain largely unexplored, particularly the question of how local governments adjust their fiscal resources in response to large refugee inflows.

In this paper, we examine the effects of the sudden inflow of Venezuelan refugees on local healthcare outcomes and municipal public finances in Brazil. Driven by the humanitarian crisis under Chávez and Maduro, the number of Venezuelans in Brazil surged from around 2,000 in 2010 to approximately 570,000 in 2024 (R4V Coordination Platform for Refugees and Migrants from Venezuela, 2026). Venezuelan refugees were granted full access to Brazil's universal public healthcare system (SUS).[2] Due to geographic factors, the inflow was heavily concentrated in municipalities near the northern border. This geographic concentration, combined with Brazil's highly decentralized federal structure, makes this setting particularly suitable for studying the capacity of a universal and decentralized healthcare system in a middle-income country to respond to a sudden, large-scale forced-migration shock.

Two main channels can link refugee inflows to pressure on local health systems. First, forced migrants often arrive with poorer baseline health due to difficult living conditions in their countries of origin and limited access to healthcare before and during their

[1] For instance, Baez (2011) document significant adverse health effects in Tanzanian communities hosting refugees, whereas Aygün *et al.* (2021) find no causal increase in mortality in Turkey despite a larger refugee shock.

[2] According to the National Supplementary Health Agency (ANS), approximately 75% of Brazilians rely solely on SUS, making it the main provider for both locals and Venezuelan refugees (see Figure A1 in the Appendix).

journey (Broner, 2019; Doocy *et al.*, 2022).[3] Refugee inflows involving migrants with systematically worse health conditions can therefore alter the composition of the local population, which we refer to as the *composition channel*. Second, while related studies on the spread of infectious diseases due to inflow of displaced populations emphasize the negative consequences of excluding migrants from public health systems (Ibáñez *et al.*, 2021) and the benefits of programs such as vaccination campaigns (Muñoz-Blanco and Frattini, 2024), increased demand for healthcare services can also generate congestion when local supply and public resources fail to adjust to the larger patient population. We refer to this as the *congestion channel*.[4] Both channels can put substantial pressure on local health systems. Furthermore, anecdotal evidence from Brazil suggests that decentralized provision amid restricted local resources was insufficient to meet the increased demand in the most affected municipalities: local authorities warned about mounting pressure on health services in the absence of adequate federal support (Rádio Senado, 2017; Globo Notícias, 2018a,b). To shed light on this dimension, we also examine the *fiscal response* to the refugee inflow.

To identify the causal effects of the forced migration shock on healthcare outcomes and public finances, we exploit cross-municipality variation in exposure to Venezuelan refugees. We instrument refugee exposure with the distance from each municipality to Pacaraima, Brazil's only official border crossing with Venezuela, located in the state of Roraima. This approach draws on the high geographic concentration of the refugee inflow near the border: natural barriers such as the Amazon rainforest limited migrants' access to more distant, wealthier municipalities in southern Brazil. Furthermore, municipality-level fiscal data allow us to explore the underlying mechanisms by distinguishing, for instance, between spending financed from own-source municipal revenues and federal transfers.

We find that a one-percentage-point increase in the local refugee share raises mortality by 4.2 percent and infant mortality by up to 9 percent. We provide evidence for both

[3]Related evidence shows that healthcare access during the prenatal period can generate persistent improvements in health and later-life outcomes among immigrant populations (Miller *et al.*, 2022).

[4]Evidence from the education sector documents that congestion pressures arise when migrant inflows outpace infrastructure and funding adjustments (Contreras and Gallardo, 2022; Morales, 2022; Assaad *et al.*, 2023).

channels through which forced migration affects local health outcomes. On the composition side, our heterogeneity analysis shows that the share of Venezuelans among hospital patients rises more than proportionally to their population share, suggesting that the deterioration in health indicators is partly driven by the poorer baseline health of incoming refugees. On the congestion side, we document higher hospital occupancy rates, shorter lengths of stay, and more hospitalizations for ambulatory care-sensitive conditions (ACSCs), which could be prevented through timely primary care, in municipalities with greater refugee exposure. Turning to the fiscal response, we find that healthcare spending does not keep pace with the surge in demand. Furthermore, in the absence of compensating federal transfers, affected municipalities finance higher healthcare spending from own-source revenues by directing a disproportionate share of budget growth toward health, at the expense of education's budget share. Overall, our results highlight the limits of decentralized health systems in absorbing large, geographically concentrated migration shocks.

This study makes several contributions to the existing literature. First, we contribute to research on how immigration and forced migration affect host-country health systems and local health outcomes. In high-income settings, the evidence generally points to no significant or positive effects of immigration (Giuntella *et al.*, 2018; Bettin and Sacchi, 2020; Grabowski *et al.*, 2026). In low- and middle-income countries, the evidence is mixed. For instance, Baez (2011) find significant adverse health effects in Tanzanian communities hosting refugees, while Aygün *et al.* (2021) document substantial congestion in the Turkish public healthcare system following the arrival of Syrian refugees but find no causal effect on mortality. The authors do not emphasize the role of Turkey's relatively centralized healthcare system but instead attribute this difference to Turkey's greater healthcare availability compared with low-income Tanzania. Moreover, Ibáñez *et al.* (2021) show that inflows of Venezuelan refugees in Colombia increased the spread of infectious and vaccine-preventable diseases. We extend this literature by providing the first evidence on mortality and healthcare utilization from a universal and decentralized health system in a middle-income country where forced migrants have full and immediate access to healthcare. Crucially, we examine both the composition and congestion channels, offering new insight

into how these mechanisms shape health outcomes amid large displacement shocks.

Second, we contribute to work on how migration shocks affect local public finances and governments' capacity to maintain service provision. The fiscal effects of immigration depend on the type of migration, host-country institutions, and time horizon. Studies of economic immigration in the United Kingdom find positive net fiscal contributions (Dustmann *et al.*, 2010; Dustmann and Frattini, 2014), whereas for refugee immigration in other European states, the short-run fiscal balance tends to be negative, reflecting the time needed for labor market integration (Ruist, 2015, 2020; Gál, 2019; Aldén and Hammarstedt, 2019; Yogo, 2017). However, studies show that integration policies such as cash assistance and language training can improve these outcomes over time (LoPalo, 2019; Foged *et al.*, 2023; Lebow *et al.*, 2024; Åslund *et al.*, 2024). Much less is known about fiscal effects in middle-income countries. The closest study is Valencia *et al.* (2020), who provide evidence that migration inflows can tighten municipal budgets before generating longer-term gains in Colombia. Our paper goes further by linking fiscal reallocation directly to health system congestion and mortality. We show that when federal transfers fail to adjust, municipalities finance rising health costs by redirecting budget growth toward health, compressing education's budget share. To our knowledge, this tradeoff between public services has not been documented in the context of forced migration.

Third, we contribute to the growing body of research on the Venezuelan displacement crisis, the largest in Latin America's recent history. Existing work on Brazil highlights effects on labor markets and gender outcomes (Shamsuddin *et al.*, 2021; Ryu and Paudel, 2022) and on crime (Marques, 2025), but beyond Ibáñez *et al.* (2021), who examine the spread of infectious diseases in Colombia, little is known about how the inflow of Venezuelan refugees affected public health, fiscal sustainability, or healthcare provision. In a recent study, Brito (2025) exploits within-city variation in Roraima to examine effects on crime, public education, and voting behavior, finding no effect on crime or school congestion but significant increases in support for far-right candidates driven by cultural perceptions rather than economic competition. While his analysis focuses on the political and social consequences of refugee reception at the neighborhood level, our paper

examines how the same crisis reshaped population health and the fiscal capacity of the healthcare system at the municipal level, the administrative level at which local budgets are managed, and services are organized in Brazil's decentralized healthcare system. Related evidence from Colombia and Ecuador documents important consequences for labor markets, political behavior, and migrant integration but focuses largely on short-run socioeconomic adjustments rather than health-system capacity.[5] Our paper introduces a new dimension to this literature by providing the first evidence on how the Venezuelan crisis affected population health and by examining the capacity of a universal, decentralized health system to absorb a large, concentrated forced migration shock.

The remainder of the paper is organized as follows. Section 2 describes the surge of Venezuelan refugee inflows to Brazil and provides the conceptual framework and descriptive evidence of the relationship between Venezuelan refugee inflows and public health in affected regions. Section 3 describes the data and outlines the empirical framework. Section 4 presents the main results on health outcomes and assesses their robustness. Section 5 examines the underlying mechanisms and fiscal response. Section 6 concludes.

2 Background and descriptive evidence

2.1 Venezuela's collapse and the surge of refugee flows to Brazil

Venezuela, once among the wealthiest nations in Latin America due to its substantial oil reserves, has experienced a severe economic and social decline since 2013 (ECLAC, 2021). The election of Hugo Chávez in 1998 marked a turning point in the country's political and economic trajectory (Vera, 2015; Aray and Vera, 2024). Initially, the country benefited from high oil revenues, but Chávez's administration pursued an increasingly polarizing agenda. Following his death, Nicolás Maduro took office in 2013 amid allegations of electoral fraud (Corrales, 2020). As oil prices collapsed in 2014–2015 and international sanctions tightened, the country plunged into a humanitarian crisis, triggering a mass

[5] See, for example, Rozo and Vargas (2021), Rozo *et al.* (2026), Ibáñez *et al.* (2026), Amuedo-Dorantes *et al.* (2025), Peñaloza-Pacheco (2022), Lebow (2022), Lombardo and Peñaloza-Pacheco (2025), and Olivieri *et al.* (2021, 2022).

exodus of Venezuelans.

The crisis manifested most acutely in widespread food insecurity, with acute malnutrition becoming alarmingly common among children (Doocy *et al.*, 2019), and in the near-collapse of the public healthcare system. Between 2014 and 2018, around one in three doctors left the country (PAHO, 2018), leaving hospitals critically understaffed. Those who remained faced persistent shortages of medicines, equipment, and essential supplies, while hospitals endured frequent power outages and water disruptions (Human Rights Watch, 2020). Deaths from otherwise preventable diseases rose sharply, and infant and maternal health indicators deteriorated markedly (Page *et al.*, 2019). The authoritarian regime's human rights abuses and suppression of political opposition compounded these conditions, further accelerating emigration (Human Rights Watch, 2020). By June 2025, an estimated 7.9 million Venezuelans had left their homeland, of whom approximately 6.9 million settled in Latin American and Caribbean countries (R4V Coordination Platform for Refugees and Migrants from Venezuela, 2026).

Figure 1 shows the migration wave to Brazil. The left panel plots the annual inflow and cumulative stock of Venezuelans from 2010 to 2023, showing that arrivals accelerated sharply after 2015, coinciding with the collapse in crude oil prices shown in the right panel. Most arrivals were children and adults under 40.[6] The scale of the Venezuelan refugee inflow is striking. In the 2010 census, only 2,165 Venezuelans resided in Brazil; by 2025, that number is estimated to have reached roughly 730,000 (R4V Coordination Platform for Refugees and Migrants from Venezuela, 2026).

Figure 2 highlights Pacaraima, a small city in Brazil's northern state of Roraima, and the location of the only official land crossing between Brazil and Venezuela. According to Brazil's International Traffic System (STI), nearly 70% of all Venezuelans entering Brazil since 2015 have done so via Pacaraima. This concentration reflects geography, cost, and transport constraints. Pacaraima is connected to Venezuelan population centers by road, making it the most accessible route for overland migration. Furthermore, major

[6]Figure A3 in the Appendix presents the age and sex composition of these inflows for each year of inflow.

airlines suspended direct commercial flights between Brazil and Venezuela in 2016 (El Pais, 2016). With no direct flight connections and costly indirect routes, overland entry through Pacaraima became the dominant option, concentrating the refugee shock in one of Brazil's least populated and fiscally weakest states.

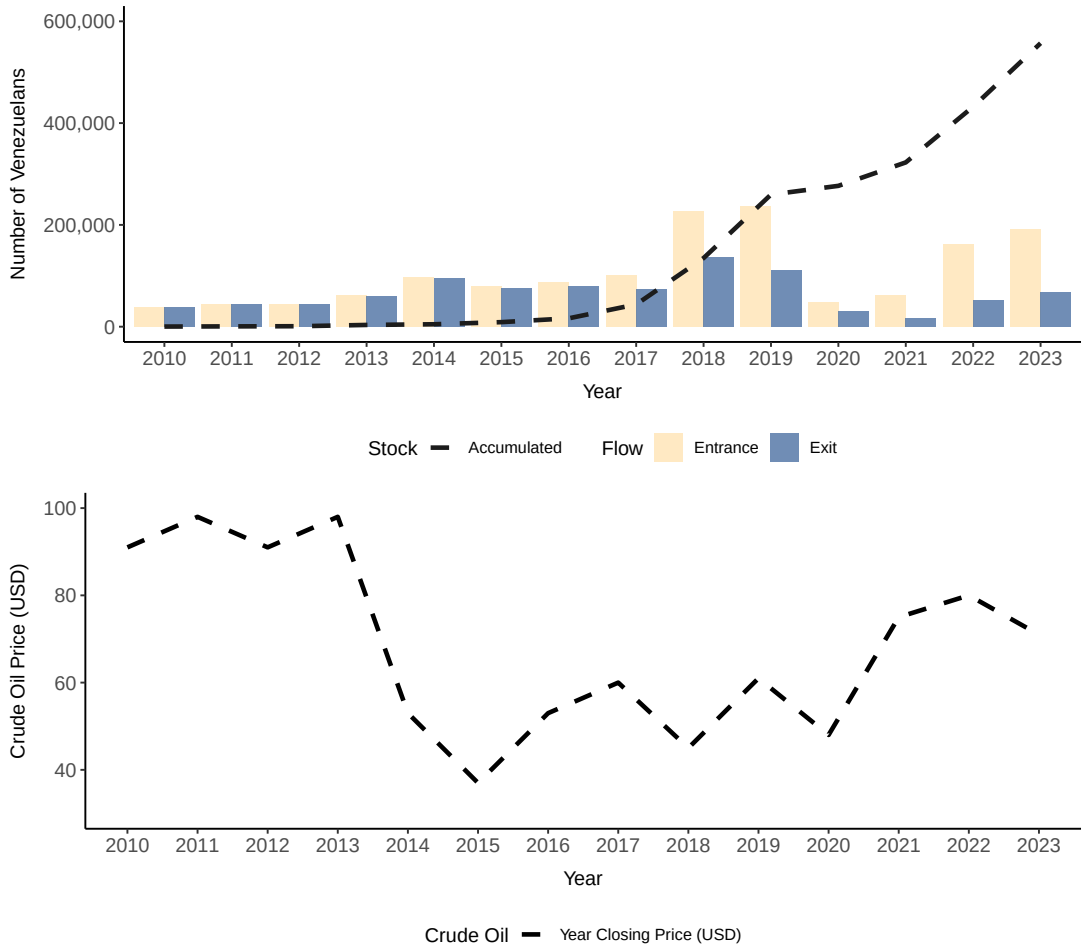

Figure 1: Yearly flow and accumulated stock of Venezuelans in Brazil and Historical Crude Oil Prices (2010–2023)

Notes: This plot illustrates the yearly flow and accumulated stock of Venezuelan migrants and refugees in Brazil. The black line represents the yearly accumulated stock since 2010. It is calculated using the yearly net inflow of Venezuelans. The sharp decrease in migration flows during 2020 and 2021 are attributed to the closing of borders during the COVID-19 pandemic. The data refers to all Brazilian ports of entry. The end of year closing price of oil shown is adjusted for inflation using the headline CPI. Source: Authors' calculation from the International Traffic System (STI) organized by Brazilian Federal Police. Data made publicly available by the International Migration Observatory (OBMigra). Crude oil prices are from the West Texas Intermediate (WTI or NYMEX).

Figure 2: Brazil, Venezuela, and Roraima, the most affected region

Notes: This figure presents a map of Brazil (shaded blue) and Venezuela (shaded yellow). The green-shaded area is the state of Roraima in the North Region of Brazil. The blue dot represents the port of entry located in the city of Pacaraima. Source: Authors' creation.

2.2 Brazil's decentralized health system and the migration shock

Brazil's Unified Health System (*Sistema Único de Saúde*, SUS) is a decentralized, publicly funded healthcare system established by the 1988 Constitution with the mandate to provide free and universal care to all residents, regardless of nationality (Castro *et al.*, 2019). Grounded in the principles of universality, equity, and comprehensiveness, SUS operates through an extensive network of primary care units, emergency facilities, and hospitals. Its design reflects Brazil's federative structure, with responsibilities and financing shared across federal, state, and municipal governments. While this architecture enables local responsiveness to health needs, it also produces fiscal and administrative asymmetries

that shape the system's capacity to absorb sudden demand shocks.

Financing flows primarily from the federal government to subnational units through a combination of block grants and earmarked transfers, including the *Piso da Atenção Básica* (Primary Care Floor) and program-specific allocations for medium- and high-complexity care (Massuda *et al.*, 2023). States manage regional hospitals and specialized services, while municipalities bear primary responsibility for frontline delivery: family health teams, immunization, preventive care, and initial emergency response. This division of labor means that even when hospital services are formally funded at the state level, municipalities remain the first point of contact for patients and must cover staffing, primary referrals, and acute care from their own budgets until intergovernmental transfers adjust. The decentralized model has supported a rapid expansion of coverage since the 1990s, but persistent funding gaps and uneven administrative capacity have constrained improvements in service quality and equity (Castro *et al.*, 2019).

These structural features mean that health facilities in many parts of Brazil operate close to capacity even under normal conditions. In poorer and more remote areas, municipalities face chronic shortages of medical personnel, essential drugs, and diagnostic infrastructure. A sudden rise in demand, whether due to epidemics or migration inflows, can thus lead to congestion of the local healthcare system and result in longer waiting times and potentially deteriorating health outcomes. In fact, anecdotal evidence from Roraima suggests that exactly such congestion occurred after the massive inflow of Venezuelan refugees.

As early as May 2017, senators from Roraima warned on the floor of the federal Senate that the surge in refugee arrivals was overwhelming the state's healthcare infrastructure. Senator Ângela Portela reported that rising demand for medical care had already exceeded local capacity and described the federal government's response as inadequate, cautioning that without broad intervention the social situation in the state would become "unsustainable" (Rádio Senado, 2017). By early 2018, a delegation of state legislators presented former President Temer with a detailed report documenting the crisis: the State Health Secretariat (Sesau) had recorded over 30,000 additional medical consultations attributable to Venezuelan patients over the preceding four years, and the public health network was

described as operating under severe strain (Globo Notícias, 2018a). At the municipal level, Boa Vista's government reported that it had been enrolling Venezuelan families in social programs and providing care across all health units, but emphasized that sustained federal support had not materialized (Globo Notícias, 2018b). This evidence suggest that municipalities had to absorb the frontline fiscal burden of the crisis while federal transfers remained largely unresponsive.

The quantitative evidence corroborates these reports. Table A1 shows that Roraima experienced the fastest population growth of any Brazilian state during this period. Furthermore, Figure 3 provides descriptive evidence of deteriorating health outcomes and an increase in birth rates in municipalities of Roraima. The figure plots trends in mortality, infant mortality, as well as birth and hospitalization rates in Roraima relative to the rest of Brazil. A clear divergence emerges around 2017, with sharp increases across all indicators in the border region during the peak of Venezuelan inflows. The rest of Brazil, by contrast, exhibits relatively stable trends throughout the period. The rise in birth rates begins even earlier, prior to 2017, consistent with anecdotal evidence on Venezuelan mothers crossing the border to give birth in Brazil due to the deteriorating conditions of the Venezuelan healthcare system (El Pais, 2018; Reuters, 2018). Overall, the timing of the divergence in healthcare outcomes between municipalities in Roraima and rest of Brazil aligns with the institutional strain documented by local authorities, suggesting that the pressures they described were accompanied by measurable worsening of population health.

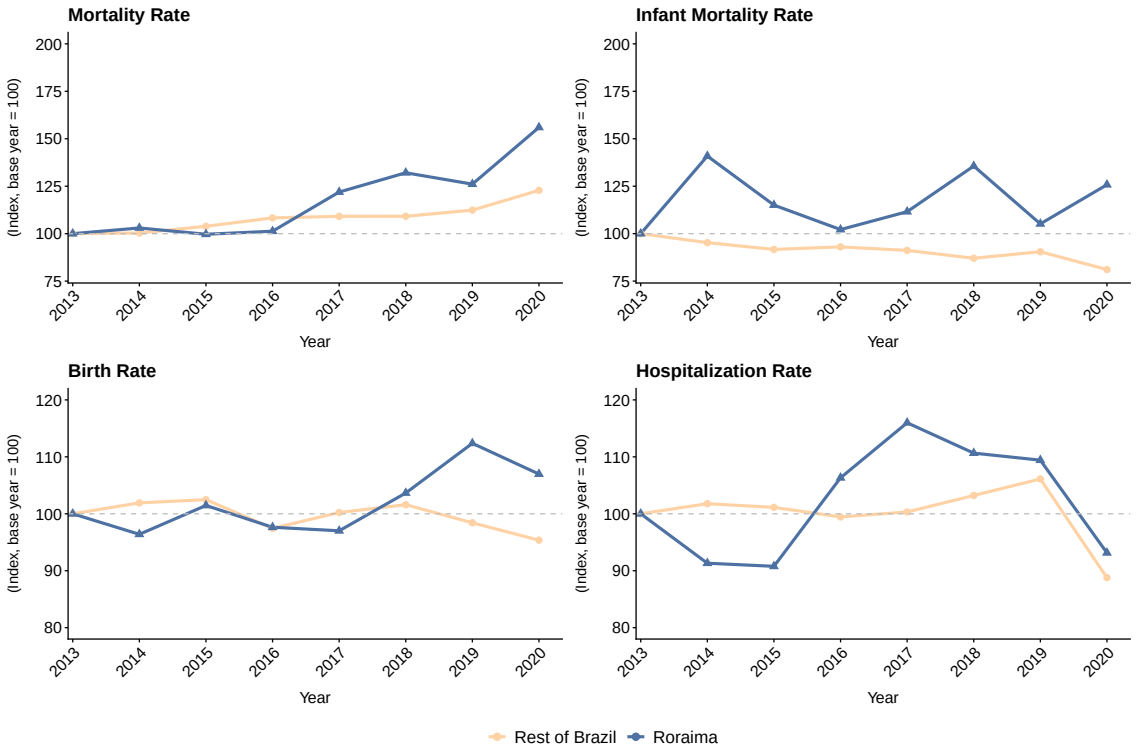

Figure 3: Trends in Mortality, Infant Mortality, Birth, and Hospitalization Rates: Roraima vs. Rest of Brazil

Notes: This figure shows trends (indexed to the first year = 100) in overall mortality, infant mortality, birth rates, and hospitalization rates by municipality of residence for Roraima (treated) and the rest of Brazil (control). Roraima is colored blue, while the rest of Brazil is displayed as yellow. Authors' calculation using hospitalization data from DATASUS-SIH; births from DATASUS-SINASC, mortality, and infant mortality from DATASUS-SIM.

3 Data and empirical strategy

3.1 Data sources

We compile a municipality-year panel covering all 5,570 Brazilian municipalities over the period 2013-2020. Municipalities are Brazil's smallest administrative unit and bear primary responsibility for frontline healthcare service delivery, including primary healthcare, making them the natural unit of analysis for studying the local effects of migration shocks. Table A2 in the Appendix provides summary statistics.

Health and fiscal outcomes. We combine multiple administrative records from Brazil's Ministry of Health and National Treasury to construct municipality-year measures of

health outcomes, service utilization, healthcare supply, and fiscal responses.

Mortality outcomes are derived from the Mortality Information System (SIM), while birth rates come from the Live Birth Information System (SINASC). Hospitalization data are obtained from the Hospital Information System (SIH), which records all publicly financed admissions along with patient demographics, diagnosis codes (ICD-10), and length of stay. Using ICD-10 codes, we group deaths and hospitalizations by cause to distinguish conditions sensitive to healthcare access or quality.[7] Supply-side indicators such as the number of hospital beds, physicians, and nurses are drawn from the National Registry of Health Facilities (CNES) and linked to SIH to calculate occupancy rates.[8]

For fiscal outcomes, we use municipal revenue and expenditure data from the Public Finance Statistics and Government Intermediate Account (FINBRA). Specifically, we collect information on the Municipal Tax on Services (ISS), the Municipal Property Tax (IPTU), and the municipal share of the Tax on the Circulation of Goods and Services (ICMS).[9] From the Public Health Budget Information System (SIOPS), we obtain data on total municipal health spending and its decomposition by funding source (own revenues and intergovernmental transfers).

All outcomes expressed as rates are standardized by municipal population estimates that incorporate official projections of the Venezuelan population, compiled by the Ministry of Health and the Brazilian Institute of Geography and Statistics (IBGE).

Venezuelan forced migration. Accurate and time-varying data on the number of Venezuelan refugees and migrants at the municipal level are not available. We therefore follow Marques (2025) and construct a proxy for the differential intensity of exposure to Venezuelan forced migration using microdata from the Brazilian School Census. This

[7]We follow the Brazilian Ministry of Health's official classification of Ambulatory Care Sensitive Conditions (ACSC) established by Portaria MS/SAS No. 221 of April 17, 2008, which identifies 15 diagnostic groups, including immunization-preventable diseases, gastrointestinal infections, asthma, hypertension, and diabetes, for which timely primary care should prevent hospitalization or death. The full list of ICD-10 codes is available at https://bvsms.saude.gov.br/bvs/saudelegis/sas/2008/prt0221_17_04_2008.html

[8]These figures exclude health workers employed directly by international humanitarian organizations or temporary military field structures not registered in CNES.

[9]The ICMS is a state-level tax. However, municipalities receive a 25% revenue-sharing quota (*cota-parte*), of which at least 75% is allocated based on local value added, with the remaining share following state-defined criteria.

annual census is administrated by the National Institute of Educational Studies and Research (INEP) and contains individual-level records for all students enrolled in public and private schools across the country. For each municipality and year, we calculate the ratio of Venezuelan students enrolled in primary and secondary schools to total enrollment, and use this ratio as proxy for the local Venezuelan population share.[10]

The validity of the proxy rests on whether the share of Venezuelan school-age children mirrors the share of Venezuelan adults and thus the total number of Venezuelan migrants across municipalities, for which we draw on two features of the Brazilian institutional setting. First, primary and secondary education is compulsory, and access to public schools is free. The Brazilian Statute of Refugees (Law 9.474/1997) further guarantees asylum seekers and refugees the right to access education, so we expect that most children who migrated with their families enrolled in school upon settlement. Second, as shown in Figure A3 in the Appendix, the inflow of Venezuelans during the crisis included a substantial share of children under the age of fifteen.

A remaining concern is whether the proxy mainly captures family migration rather than specific migrant profiles, such as single adults or young workers. The Colombian data provide external validation, as the 2018 National Census records the full Venezuelan population, including adults. As shown in Figure A2, the share of Venezuelan students is strongly correlated ($\rho = 0.94$) with the overall Venezuelan population share across municipalities. This supports the proxy's validity beyond households with school-age children and across distinct national contexts.

Figure 4 maps the share of Venezuelan students across municipalities in four years of our sample. The spatial pattern closely tracks the aggregate migration flows documented

[10]An alternative measure, used by Shamsuddin *et al.* (2022), can be constructed from residence permit applications, which identify the municipality of each applicant. However, we consider this measure inadequate for our purposes for two reasons. First, each migrant appears only once, in the year the request was filed, which requires the strong assumption that migrants do not relocate internally. Second, this measure would substantially understate the Venezuelan population in Brazil, as residence permit holders accounted for only about half of Venezuelans living in the country by the end of 2019, with the remainder having applied for or been granted asylum. Marques (2025) validates the same proxy we use by comparing it to residence permit applications, finding a strong spatial correlation between the two measures. He also shows that the school-census-based proxy identifies Venezuelan presence in more than twice as many municipalities as this administrative record.

in Figure 1, with exposure rising sharply in northern border municipalities and gradually diffusing to other regions over time. Importantly, our proxy captures the differential intensity of exposure across municipalities over time, rather than the exact number of Venezuelan residents.[11] Thus, it aligns with our identification strategy, which relies on relative differences in exposure to estimate causal effects on health and fiscal outcomes.

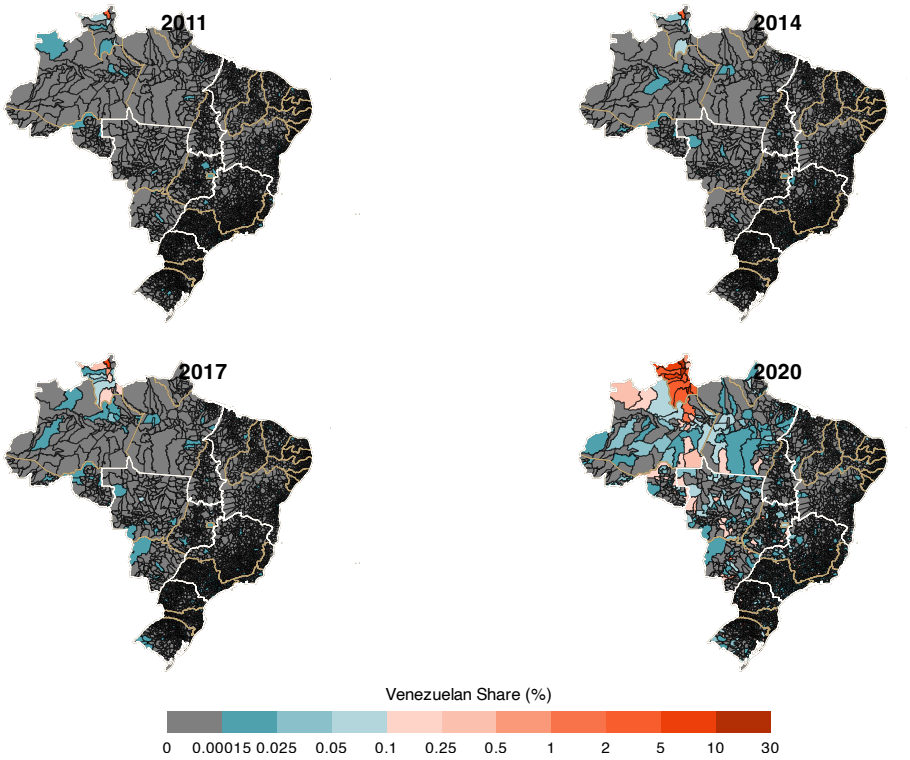

Figure 4: Distribution of Venezuelan Students across Brazilian municipalities

Notes: The figure illustrates the share of Venezuelans in each municipality for 2011, 2014, 2017, and 2020. The share is approximated by leveraging the ratio of Venezuelan students to the total student population. Authors' calculation using the Brazilian School Census.

Control variables. To account for time-varying differences in economic resources and social protection coverage that may independently affect both healthcare demand and spending, we collect a set of municipality-level covariates. Private healthcare coverage is measured using data from the National Supplementary Health Agency (ANS), which reports the share of the population enrolled in private health insurance plans. Socioeconomic

[11]We recognize that our proxy for the share of Venezuelans may introduce bias in both directions. If municipalities with better school infrastructure and higher education spending also have stronger healthcare systems, the proxy could overstate exposure among better-resourced municipalities. Conversely, under-enrollment of Venezuelan children in poorer or more remote municipalities, where access to schooling is limited, would lead to an underestimate of migrant presence.

conditions are captured through GDP per capita estimates from the IBGE and the per capita value of transfers from the *Bolsa Família* conditional cash transfer program, obtained from the Ministry of Social Development (MDS).

3.2 Empirical Strategy

We estimate the causal effect of Venezuelan forced migration on municipal health outcomes and fiscal responses using two-stage least squares (2SLS). By instrumenting the local migrant share with each municipality's distance to the border crossing at Pacaraima, our identification exploits the exogenous geographic variation in the distribution of Venezuelan migrants arising from proximity to the Venezuelan border.[12]

In particular, we define the instrument as:

$$\text{Predicted Venezuelan Inflow}_{m,t} = \frac{\text{Net Inflow}_t}{\text{Distance}_m} \tag{1}$$

where NetInflow_t is the aggregate net inflow of Venezuelans to Brazil in year t, obtained from the International Traffic System (STI) administrated by the Brazilian Federal Police, and Distance_m is the shortest travel distance in kilometers from the border crossing in Pacaraima to municipality m, calculated using the GraphHopper Matrix API.[13] Our parameter of interest is the effect of a one-percentage-point increase in the local Venezuelan population share on health and fiscal outcomes at the municipality-year level.

The first stage regresses the Venezuelan population share in municipality m and year t, constructed from school census data as described above, on the predicted inflow. In estimation, we scale the predicted inflow by 10,000 for readability; first-stage coefficients

[12]This strategy follows a standard approach in the migration literature, where distance-based instruments are commonly used to isolate plausibly exogenous variation in migrant settlement patterns. See, for example, Dustmann *et al.* (2017), Ibáñez *et al.* (2021), Aksu *et al.* (2022), Knight and Tribin (2023), Marques (2025), and Zuchowski (2025).

[13]We use the instrument in levels throughout our 2SLS specifications. This choice reflects the nature of our mechanism: health system capacity constraints bind on absolute patient volumes, not proportional changes. Given that our specification already includes municipality fixed effects, the identifying variation comes from within-municipality changes in absolute migration exposure. A municipality with fixed hospital capacity responds to the actual number of additional patients seeking care, not to percentage changes in population. Using levels therefore, appropriately weights municipalities by absolute exposure, which is the policy-relevant margin for understanding pressure on public health systems.

therefore represent the change in Venezuelan student share per 10,000-person increase in predicted inflow. The fitted values from this regression are then used in the second stage to estimate the causal effect on the outcome of interest ($y_{m,t}$):

$$\text{Venezuelan Share}_{m,t} = \beta \, \text{Predicted Venezuelan Inflow}_{m,t} + \mathbf{X}_{m,t}\boldsymbol{\gamma} + \alpha_m + \alpha_{s,t} + \eta_{m,t} \quad (2)$$

$$y_{m,t} = \theta \, \widehat{\text{Venezuelan}} \, \text{Share}_{m,t} + \mathbf{X}_{m,t}\boldsymbol{\gamma} + \alpha_m + \alpha_{s,t} + \varepsilon_{m,t} \quad (3)$$

In both stages, α_m denotes municipality fixed effects, which absorb all time-invariant differences across municipalities, including geographic characteristics, historical infrastructure, and baseline health conditions. $\alpha_{s,t}$ denotes state-by-year fixed effects, which control for common shocks and policy changes affecting all municipalities within a given state and year, such as state-level health budgets, epidemics, or political cycles. The vector $\mathbf{X}_{m,t}$ includes time-varying municipal controls: private health insurance coverage, per capita GDP, and per capita *Bolsa Família* transfers. Standard errors are clustered at the municipality level.

The exclusion restriction requires that, conditional on municipality fixed effects, state-year fixed effects, and time-varying controls, distance to the Pacaraima crossing affects health and fiscal outcomes only through its effect on the local Venezuelan population share. We argue that this assumption is plausible for several reasons. First, prior to the Venezuelan crisis, distance to Brazil's northern border had limited relevance for public policy planning or fiscal allocation. Second, Brazil's national health system distributes resources primarily on the basis of population size and need indicators, both of which are accounted for in our controls. Third, the sudden and externally driven nature of the migration shock makes it unlikely that pre-existing trends in health outcomes or spending were systematically correlated with geographic proximity to the border. Appendix Figure A4 provides direct evidence: within-state cross-sectional correlations between distance to Pacaraima and 2013 levels of health outcomes, socioeconomic conditions, and healthcare infrastructure are all statistically insignificant, consistent with geographic exposure being orthogonal to

pre-existing municipal characteristics.

A related concern is that distance to Pacaraima may proxy for broader remoteness or underdevelopment, which could independently shape outcomes. Municipality fixed effects absorb these time-invariant differences, including chronic infrastructure deficits and historically weak fiscal capacity, while state-year fixed effects absorb shocks common to all municipalities within a state, including Roraima-specific policy responses. Identification, therefore, comes from the differential impact of the migration shock across municipalities within the same state, as captured by the interaction between distance to Pacaraima and the time-varying intensity of the migration wave, net of municipality and state-year fixed effects.

Our 2SLS estimates capture a local average treatment effect (LATE), the effect for municipalities whose exposure to Venezuelan migrants was driven by their proximity to Pacaraima. These complier municipalities are plausibly those most relevant for the policy question at hand: geographically proximate to the border, smaller in size, and typically more constrained in fiscal and healthcare capacity. The concentration of effects in the North region, documented in Section 4.3, is consistent with this interpretation, suggesting that the LATE primarily reflects municipalities that absorbed the most intense migration pressures rather than the average effect across Brazil.

Table 1 reports the first-stage estimates. The coefficient on the predicted inflow is positive and statistically significant, confirming that municipalities closer to Pacaraima experienced substantially larger increases in the Venezuelan population share. The Kleibergen-Paap F-statistics are well above conventional thresholds, supporting the relevance of the instrument. We present our results under several specifications that progressively add controls and fixed effects. Our simplest specification includes only municipality fixed effects and year fixed effects, with no time-varying controls. We then add the vector of controls $\mathbf{X}_{m,t}$, and subsequently include state-by-year fixed effects to arrive at the most saturated model. This progression serves two purposes. First, it allows the reader to assess the sensitivity of the estimates to the inclusion of controls that could themselves be affected by the migration shock. Second, the inclusion of state-by-year fixed effects,

while valuable for absorbing state-level confounders, substantially restricts the identifying variation by forcing comparisons to occur only among municipalities within the same state and year. This may be particularly problematic for the most heavily affected state, Roraima, where the small number of municipalities and limited within-state heterogeneity in health infrastructure mean that state-year fixed effects absorb much of the variation that drives the aggregate health effects we seek to estimate. Thus, by reporting estimates across different specifications, we allow the reader to assess the sensitivity of our results to the inclusion of increasingly restrictive sets of fixed effects and controls.

Table 1: First-Stage Results of the 2SLS Estimates

	Venezuelan Student Share (%)			
	(1)	(2)	(3)	(4)
Predicted Venezuelan Inflow	0.7195***	0.7199***	0.6124***	0.6127***
	(0.0052)	(0.0052)	(0.0166)	(0.0166)
Observations	44,066	44,056	43,915	43,905
F-statistic (1st stage)	7,364.5	7,376.9	9,271.0	9,279.4
Controls		✓		✓
Municipality FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
State × Year FE			✓	✓

Notes: The dependent variable is the share of Venezuelan students (multiplied by 100). The main regressor is the predicted inflow of Venezuelan migrants, scaled to units of 10,000 people. Coefficients represent the percentage point change in the Venezuelan student share associated with a 10,000-person increase in predicted migrant inflows. Standard errors are clustered at the municipality level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

4 Impact of Venezuelan refugee inflows on local health outcomes

4.1 Baseline results

Table 2 reports estimates of the effect of the Venezuelan population share on local health outcomes. Each panel corresponds to a different outcome variable, and columns progressively add controls and fixed effects following the specification sequence described in

Section 3.2. OLS estimates in Columns (1)–(4) show positive but statistically insignificant associations between migrant exposure and mortality. The 2SLS estimates in Columns (5)–(8) are consistently larger and more precisely estimated, consistent with attenuation bias in OLS. First, classical measurement error in the school-enrollment proxy mechanically compresses OLS coefficients toward zero. Second, if migrants disproportionately settle in municipalities with better baseline health infrastructure and service provision, OLS may partly reflect favorable selection, which can further bias the estimates downward. Both forces, therefore, push the OLS estimates toward zero. The IV strategy addresses these concerns by exploiting plausibly exogenous variation in migrant exposure generated by geographic settlement patterns rather than migrant sorting.

For mortality and infant mortality, which vary primarily at the local level and are less affected by centralized referral systems, we prefer the most saturated specification in Columns (7)–(8), which includes municipality fixed effects, state-by-year fixed effects, and time-varying controls. For births and hospitalizations, our preferred specifications are Columns (5)–(6), which include municipality and year fixed effects. These outcomes depend heavily on state-level capacity and referral networks; adding state-by-year fixed effects absorbs much of this variation and attenuates the coefficients, as discussed in Section 3.2.

We find that a one-percentage-point increase in the Venezuelan share raises overall mortality by approximately 4.2%, infant mortality by 6–9%, and hospitalization rates by roughly 2.7%. Birth rates also increase modestly, reflecting the expansion of the population served by the public system. Furthermore, the imprecisely estimated and smaller coefficients for births and hospitalizations in Columns (7)–(8) should not be interpreted as evidence of no local effect. Both outcomes are expressed per capita, so increases in the numerator occur alongside rapid population growth, mechanically offsetting one another. In states such as Roraima, where only two public maternity wards serve the entire population, stable per-capita rates can mask large increases in absolute caseloads.

Table 2: Estimates of health outcomes on migrant share

	OLS				2SLS			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: **Mortality Rate (log)**								
Venezuelan Share	0.0094	0.0096	0.0043	0.0044	0.0422***	0.0409***	0.0419***	0.0421***
	(0.0100)	(0.0095)	(0.0165)	(0.0166)	(0.0004)	(0.0005)	(0.0055)	(0.0055)
Observations	44,383	44,383	44,226	44,226	44,066	44,066	43,915	43,915
Panel B: **Infant Mortality Rate (log)**								
Venezuelan Share	0.0296	0.0295	0.0727*	0.0732*	0.0662***	0.0678***	0.0864***	0.0917***
	(0.0458)	(0.0464)	(0.0415)	(0.0425)	(0.0019)	(0.0023)	(0.0265)	(0.0267)
Observations	44,560	44,560	44,398	44,398	44,240	44,240	44,084	44,084
Panel C: **Birth Rate (log)**								
Venezuelan Share	0.0423*	0.0423*	0.0239	0.0244	0.0071***	0.0071***	-0.0189	-0.0155
	(0.0251)	(0.0250)	(0.0322)	(0.0316)	(0.0019)	(0.0021)	(0.0116)	(0.0119)
Observations	44,560	44,557	44,398	44,397	44,240	44,237	44,084	44,083
Panel D: **Hospitalization Rate (log)**								
Venezuelan Share	0.0109	0.0105	-0.0148	-0.0147	0.0271***	0.0287***	0.0006	0.0052
	(0.0147)	(0.0140)	(0.0127)	(0.0122)	(0.0030)	(0.0032)	(0.0116)	(0.0119)
Observations	44,560	44,560	44,398	44,398	44,240	44,240	44,084	44,084
Controls		✓		✓		✓		✓
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
State x Year FE			✓	✓			✓	✓

Notes: This table reports the estimated effects of Venezuelan migrant inflows on a range of health outcomes at the municipality of occurrence of the event. Panels A reports crude mortality rates; Panel B covers infant mortality; Panel C shows birth rates; Panels D reports total hospitalization rates. Columns (1)–(4) show OLS estimates, Columns (5)–(8) report two-stage least squares (2SLS) estimates using distance to the Pacaraima border as an instrument for Venezuelan share. All models include municipality and year fixed effects, and some also include state-by-year fixed effects. Control variables (when included) are private health coverage, Bolsa Família spending per capita, and per capita GDP. Due to the large number of zeros—since not all municipalities have hospitals or maternity wards—we apply the inverse hyperbolic sine (IHS) transformation to infant mortality, hospitalization and birth outcomes. Coefficients can be interpreted as the semi-elasticity of each outcome with respect to a one percentage-point increase in the Venezuelan share of the population (share × 100). Mean of outcomes (pre-crisis, 2013-2014): Mortality Rate = 389.50 per 100,000; Infant Mortality Rate = 22.72 per 1,000; Birth Rate = 642.44 per 100,000; Hospitalization Rate = 316.74 per 10,000. Observation counts vary across panels because IHS-transformed outcomes (Panels C–D) retain municipality–year cells with zero values, while log-transformed outcomes (Panels A–B) drop them. Counts also vary across columns because the inclusion of state-by-year fixed effects drops singletons, that is, municipality–year cells that are the only observation remaining in their state–year group after missing values are removed, and the IV specification creates additional singletons through the first-stage fixed-effects structure. Standard errors are reported in parentheses. * p<0.1; ** p<0.05; *** p<0.01.

Complementary indicators of system congestion reinforce this interpretation. Table 3 shows that bed-occupancy rates increase significantly and average length of stay declines in more exposed municipalities, indicating that hospitals operate at or above capacity even when per-capita admission rates appear relatively stable.[14] These patterns provide

[14]Although hospital funding in SUS flows primarily through state governments, bed occupancy reflects congestion driven by local demand and thus captures the pressure that refugee inflows place on the health infrastructure serving each municipality.

direct evidence of the congestion channel: as patient volumes rise, facilities discharge patients faster to accommodate incoming cases, compressing treatment duration rather than expanding supply. An alternative interpretation is that shorter stays reflect a shift in case mix toward less severe patients. However, the simultaneous increase in ACSC hospitalization rates makes a purely compositional explanation unlikely, since these are precisely the conditions that tend to increase when primary care systems become congested and manageable cases are not treated in time.

Municipalities with higher exposure also exhibit larger increases in ambulatory-care-sensitive (ACSC) mortality and hospitalization rates. ACSC conditions are those typically preventable through timely primary care, so rising ACSC rates reflect two reinforcing processes. First, as primary care units become overwhelmed, manageable conditions more often progress to hospital-level severity. Second, incoming migrants arrived with higher baseline prevalence of untreated chronic conditions, vaccination gaps, and nutritional deficiencies. ACSC measures thus capture both the pressure on local service delivery and the integration of a more vulnerable population, consistent with both the congestion and composition channels.

Table 3: Estimates of health system congestion indicators on migrant share

	OLS				2SLS			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: **ACSC Mortality Rate (log)**								
Venezuelan Share	0.0150	0.0153	-0.0046	-0.0047	0.0258***	0.0233***	0.0285***	0.0254***
	(0.0113)	(0.0112)	(0.0155)	(0.0150)	(0.0007)	(0.0009)	(0.0073)	(0.0073)
Observations	42,257	42,257	42,125	42,125	41,953	41,953	41,827	41,827
Panel B: **ACSC Hospitalization Rate (log)**								
Venezuelan Share	-0.0233	-0.0236	-0.0305**	-0.0308**	0.0391***	0.0401***	0.0282**	0.0272**
	(0.0149)	(0.0147)	(0.0125)	(0.0125)	(0.0021)	(0.0022)	(0.0127)	(0.0129)
Observations	44,560	44,560	44,398	44,398	44,240	44,240	44,084	44,084
Panel C: **Average Length of Stay (days)**								
Venezuelan Share	-0.0119	-0.0124	0.0042	0.0038	-0.0305***	-0.0363***	-0.0144	-0.0196
	(0.0110)	(0.0112)	(0.0174)	(0.0177)	(0.0015)	(0.0018)	(0.0170)	(0.0172)
Observations	25,545	25,545	25,535	25,535	25,305	25,305	25,296	25,296
Panel D: **Beds Occupancy Rate (%)**								
Venezuelan Share	-0.0994	-0.1129	-0.4890*	-0.5049*	0.6175***	0.5638***	0.5693**	0.5144**
	(0.1825)	(0.1845)	(0.2951)	(0.2921)	(0.0142)	(0.0174)	(0.2414)	(0.2432)
Observations	25,537	25,537	25,527	25,527	25,297	25,297	25,288	25,288
Controls		✓		✓		✓		✓
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
State x Year FE			✓	✓			✓	✓

Notes: This table reports the estimated effects of Venezuelan migrant inflows on a range of health system congestion indicators at the municipality of occurrence. Panel A presents ambulatory-care-sensitive (ACSC) mortality rates (log). Panel B shows ACSC hospitalization rates (log). Panel C presents the average length of hospital stay in days. Panel D reports the percentage of hospital bed occupancy in SUS facilities. Columns (1)–(4) display OLS estimates, while Columns (5)–(8) show two-stage least squares (2SLS) estimates that use distance to the Pacaraima border as an instrument for Venezuelan share. All models include municipality and year fixed effects, and some also include state-by-year fixed effects. Control variables, when included, are private health coverage, Bolsa Família spending per capita, and per capita GDP. ACSC mortality and hospitalization outcomes are log-transformed, average length of stay is measured in levels, and bed occupancy is expressed as a percentage. Municipalities without SUS hospital beds are coded as missing for occupancy rates. Panels C and D therefore use a restricted sample of approximately 25,500 municipality–years corresponding to localities with at least one SUS inpatient bed; the remaining panels retain the full sample. Clustered standard errors are reported in parentheses. * p<0.1; ** p<0.05; *** p<0.01..

4.2 Heterogeneity by nationality

To further disentangle the composition and congestion channels, we examine whether Venezuelans are overrepresented among those experiencing adverse health events. Tables 4–6 report 2SLS estimates where the dependent variables are the shares of Venezuelans among deaths, births, and hospitalizations. If the effects shown earlier were driven solely by system congestion affecting all patients equally, we would expect the Venezuelan share of health events to rise in proportion to their population share. Disproportionate

overrepresentation, by contrast, indicates that migrants contribute to worsening aggregate outcomes also through the composition channel, due to refugees' poorer baseline health.[15]

Table 4: 2SLS Estimates of Nationality Share of Deaths on Venezuelan Student Share

	Nationality Share of Deaths			
	Brazilian	Venezuelan	Other	Missing
	(1)	(2)	(3)	(4)
Panel A: **Mortality**				
Venezuelan Share	-0.0028**	0.0133***	-0.0018***	-0.0087***
	(0.0013)	(0.0005)	(0.0006)	(0.0012)
Observations	43,914	43,914	43,914	43,914
Panel B: **ACSC Mortality**				
Venezuelan Share	0.0016	0.0119***	-0.0001	-0.0134***
	(0.0047)	(0.0015)	(0.0012)	(0.0039)
Observations	41,826	41,826	41,826	41,826
Panel C: **Infant Mortality**				
Venezuelan Share	-0.0216***	0.0068***	0.00001	0.0118***
	(0.0056)	(0.0001)	(0.00001)	(0.0035)
Observations	44,083	44,083	44,083	44,083
Controls	✓	✓	✓	✓
Municipality FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
State × Year FE	✓	✓	✓	✓

Notes: This table reports two-stage least squares (2SLS) estimates of the effect of Venezuelan student share on the share of death records by nationality. Control variables are private health coverage, Bolsa Família spending per capita, and per capita GDP. Standard errors are clustered at the municipality level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

A one-percentage-point increase in the local Venezuelan share raises the Venezuelan share among hospital patients by roughly 3.2 percentage points and among deaths by about 1.3 percentage points. This indicates that Venezuelans account for a disproportionate fraction of hospitalizations and mortality cases. Infant outcomes display a similar pattern: the Venezuelan share of births and infant deaths rises sharply in high-exposure

[15]Note that under a mechanical scenario in which Venezuelans appear in health events exactly in proportion to their population share, a one-percentage-point increase in the Venezuelan population share would yield a one-percentage-point increase in the Venezuelan share of health events, implying a coefficient of exactly one. Estimated coefficients above one therefore indicate overrepresentation beyond what population growth alone would predict.

municipalities. However, as many infant records lack nationality information and migrant newborns are less likely to have documentation at delivery, these estimates are likely conservative. Together, these findings show evidence consistent with the composition channel and the anecdotal evidence that migrants arrived with poorer baseline health.

Table 5: 2SLS Estimates of Birth Characteristics on Venezuelan Student Share

	Nationality of the Mother	
	Brazilian	Other
	(1)	(2)
Venezuelan Share	-0.0119***	0.0124***
	(0.0012)	(0.0012)
Observations	44,083	44,083
Controls	✓	✓
Municipality FE	✓	✓
Year FE	✓	✓
State × Year FE	✓	✓

Notes: This table reports two-stage least squares (2SLS) estimates of the effect of Venezuelan student share on birth outcomes. The dependent variables are the shares (in percent) of live births in each category. Columns (1) and (2) show effects on the newborn's mother's nationality. Control variables are private health coverage, Bolsa Família spending per capita, and per capita GDP. Standard errors are clustered at the municipality level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table 6: 2SLS Estimates of Nationality Share of Hospitalizations on Venezuelan Student

	Nationality Share of Hospitalizations		
	Brazilian	Venezuelan	Other
	(1)	(2)	(3)
Venezuelan Share	-0.0320***	0.0324***	-0.0004
	(0.0007)	(0.0006)	(0.0003)
Observations	25,287	25,287	25,287
Controls	✓	✓	✓
Municipality FE	✓	✓	✓
Year FE	✓	✓	✓
State × Year FE	✓	✓	✓

Notes: This table reports two-stage least squares (2SLS) estimates of the effect of Venezuelan student share on the share of hospitalization records by nationality. Control variables are private health coverage, Bolsa Família spending per capita, and per capita GDP. Standard errors are clustered at the municipality level. Missing category omitted due to unavailable disaggregation. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

4.3 Robustness checks, dynamics, and alternative specifications

As a next step, we examine the robustness of our findings along several dimensions: the temporal dynamics of the reduced-form relationship, an alternative identification strategy, and a battery of sample and measurement sensitivity tests.

Dynamics. Figure 5 presents reduced-form event-study estimates of the relationship between predicted Venezuelan inflows and municipal health outcomes, following an approach similar to Knight and Tribin (2023). In practice, we interact year indicators with the predicted inflow using our distance instrument.[16]

The estimates show that the reduced-form relationship strengthens after 2016 for most outcomes. Mortality exhibits modest increases beginning in 2016–2017, with larger and

[16]Coefficients are expressed relative to the pre-crisis reference year 2013. This specification does not require imposing an arbitrary treatment year, as identification exploits continuous variation in predicted migration intensity across municipalities and years. For visualization purposes, we apply an inverse hyperbolic sine (IHS) transformation to the instrument, as it takes very small values in 2013–2015 and increases substantially for some municipalities after 2016. Without this transformation, extreme values in later years dominate the scale. The transformation affects only this figure as our main 2SLS estimates use the instrument in levels.

more precisely estimated effects toward 2019. Infant mortality responds earlier, with positive and statistically significant coefficients in the immediate post-2013 years, followed by weakening of the effect around 2018 and a subsequent increase. This timing is consistent with early anecdotal evidence that Venezuelan women sought prenatal and maternal care in Brazil amid severe shortages of food, medicines, and obstetric services in Venezuela (Leal, 2022). The early onset of the effect on infant mortality, preceding the intensification of the refugee inflow, supports our decision not to rely on a classical difference-in-differences specification that would impose an arbitrary treatment year. Births show little systematic response, with coefficients close to zero and imprecisely estimated throughout the period. Hospitalizations display the clearest dynamic pattern: coefficients are near zero before 2016, increase sharply from 2017, and remain positive and statistically significant through 2020.

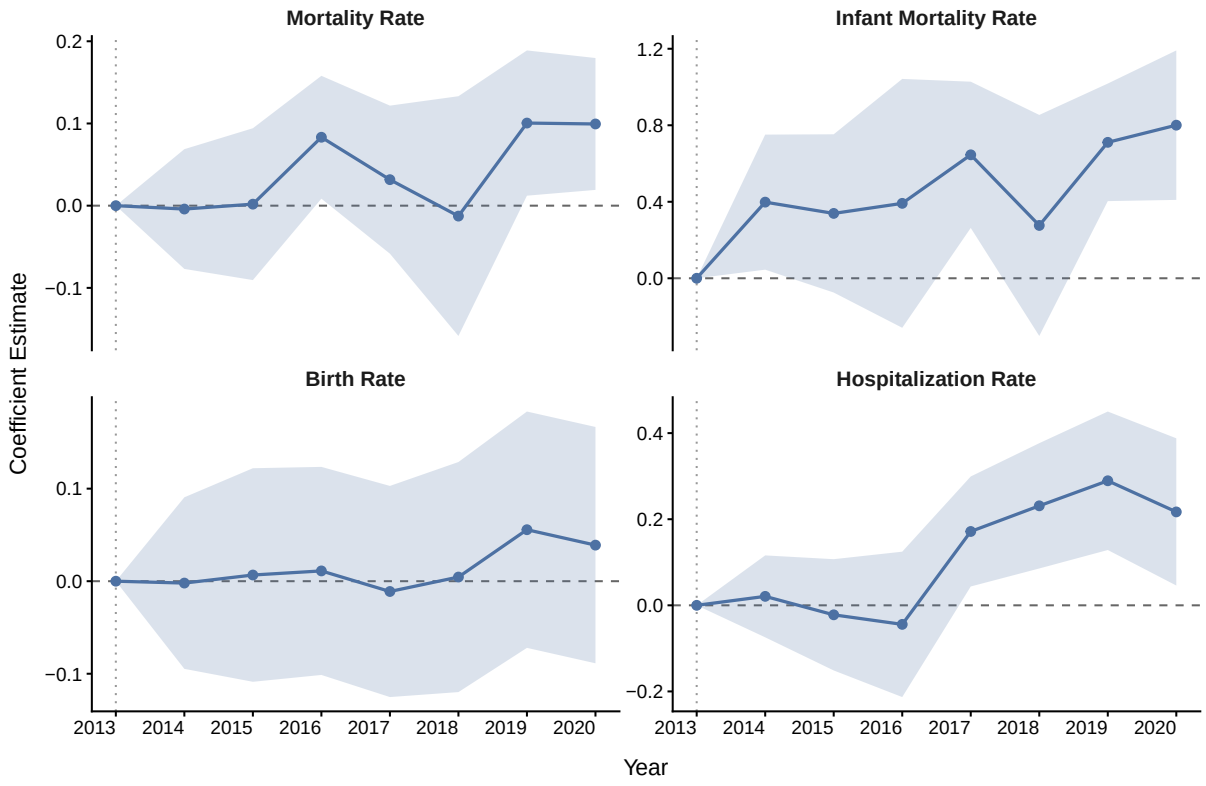

Figure 5: Reduced-form event-study: predicted Venezuelan inflow and municipal health outcomes

Notes: This figure plots reduced-form event-study coefficients from regressions of municipal health outcomes on interactions between calendar year indicators and predicted Venezuelan inflow exposure, normalized to the omitted reference year 2013 (vertical dashed line). The predicted inflow instrument is transformed using the inverse hyperbolic sine (IHS) to account for its highly skewed distribution. Points show coefficient estimates and whiskers denote 95% confidence intervals. All regressions include municipality fixed effects. Mortality and infant mortality models additionally include state-by-year fixed effects; birth and hospitalization models include year fixed effects only. Control variables are private health coverage, Bolsa Família spending per capita, and per capita GDP. Standard errors are clustered at the municipality level. Outcomes are expressed in logarithms; birth and hospitalization outcomes use the inverse hyperbolic sine (IHS) transformation to accommodate zero values. Data sources: SUS-SIH (hospitalizations), SUS-SINASC (births), and SUS-SIM (deaths and infant mortality).

Alternative identification: event-study difference-in-differences. As an alternative identification strategy that does not rely on instrumental variable assumptions or the share of Venezuelan students as a proxy for migrant exposure, we implement an event-study difference-in-differences design. To do so, we define municipalities in Roraima as treated and all other Brazilian municipalities as controls and interact treatment status with a full set of event-time indicators. Following Figure 1, which documents that the collapse in oil prices and the intensification of the inflow of Venezuelan refugees began in

2015, we define the pre-treatment period as 2013–2015.

We present the results of the dynamic difference-in-differences approach for the main eight health outcomes in Figures A10 and A11 in the Appendix. Coefficients in the pre-treatment period are close to zero and statistically insignificant, supporting the parallel trends assumption. Post-treatment coefficients diverge sharply after 2015, indicating a persistent deterioration in health outcomes in Roraima municipalities that coincides with the intensification of migration inflows. The dynamic patterns closely mirror the baseline IV results: mortality, birth rates, and hospitalization rates increase following the onset of the crisis, along with rising congestion as measured by ACSC mortality rates and bed occupancy rates. The exception is infant mortality, for which, as discussed before, the early treatment onset, preceding the intensification of the crisis, makes the difference-in-differences estimates unreliable. However, taken together, the overall alignment between the event-study evidence, obtained under an alternative set of identifying assumptions, and our baseline IV estimates strengthens the causal interpretation of our findings.

To benchmark magnitudes across designs, Table A6 reports implied percentage changes relative to pre-crisis means based on the preferred IV estimates and the corresponding post-treatment average DiD coefficient from the specification underlying the event-study figures. Because the IV captures the marginal effect of a one-percentage-point increase in local refugee exposure, whereas the DiD captures the average post-crisis differential for the most exposed state, the raw coefficients are not directly comparable in levels. For mortality and the main congestion outcomes, scaling the DiD percentage effects by the IV semi-elasticities yields implied multiples of roughly 4–10, consistent with the substantially higher refugee concentration in Roraima relative to the municipality-level exposure changes underlying the IV estimates. This calibration aligns closely with the main results, where a 1 pp increase in Venezuelan share raises mortality by about 4.2% and congestion outcomes by 2–4%, so the larger border-state shock naturally maps into larger DiD effects. Births remain an exception, reflecting the geographical concentration of maternity care in Roraima.

Leave-one-out by region. To examine whether the results are driven by a specific region of Brazil, we implement a leave-one-out analysis that sequentially excludes each of Brazil's five macro-regions. Tables A4 and A5 show that the results remain stable to dropping each of the regions except the North. As expected, excluding the North region makes estimates insignificant, because this region contains the municipalities with the highest exposure to the refugee shock.

North region. Since municipalities in the North region, which were most affected by the inflow of Venezuelans, differ substantially from those in other parts of Brazil, we restrict the sample to these municipalities to assess whether such compositional differences could confound our results. Figure A8 reports the corresponding two-stage least squares estimates. The results closely mirror the baseline patterns, confirming that our findings are not driven by structural differences between municipalities in the North and those in other parts of Brazil.

Excluding Roraima. To assess whether the most affected region drives the results, we exclude all municipalities in the state of Roraima. As the primary entry point for Venezuelan migrants, Roraima accounts for a large share of the identifying variation in migration exposure. Figure A6 in the Appendix shows that point estimates become statistically insignificant when Roraima is excluded. This attenuation reflects the highly concentrated nature of the migration shock and is consistent with the LATE interpretation of our IV estimates: the instrument generates the most variation for municipalities closest to the border, and the causal effects are most precisely identified there.

Large municipalities. To check whether results are driven by a few large urban centers with distinct healthcare infrastructures and administrative capacities, we exclude all municipalities with more than 500,000 residents. Figure A7 in the Appendix shows that estimates remain stable, indicating that the findings do not reflect health dynamics specific to Brazil's largest cities.

Fixed population denominator. To test whether results are mechanically driven by changes in population denominators, we re-estimate the preferred specifications fixing the population denominator at its pre-crisis (2015) level for all subsequent years. Because migration directly increases municipal population counts, per-capita health rates may attenuate true changes in utilization or mortality if population growth dilutes the numerator. Figure A5 shows that estimates are stable and, if anything, larger in magnitude, ruling out the concern that denominator effects explain the baseline findings.

Occurrence versus residence-based outcomes. Our baseline analysis uses occurrence-based outcomes, which count events in the municipality where they took place. This choice aligns with our focus on system congestion, as occurrence-based measures capture pressure on the facilities where patients seek and receive care. To verify that results do not solely reflect patient referrals into service hubs, we replicate the analysis using residence-based outcomes, which attribute events to the municipality where patients live. Table A3 in the Appendix shows that the effects remain positive and statistically significant, though smaller in magnitude. The distinction between the two measures helps disentangle the congestion and composition channels. Occurrence-based rates are more sensitive to the congestion channel, capturing facility-level pressure from rising patient volumes, whereas residence-based rates are more sensitive to the composition channel, reflecting the poorer baseline health of migrants in their communities of settlement. The consistency of effects across both measures again indicates that the two channels operate jointly, reinforcing the interpretation that the deterioration in public health reflects both increased system pressure and the arrival of a more vulnerable population.

5 Fiscal and system response

Our findings on the deterioration in health outcomes raise the question of why Brazil's universal healthcare system failed to absorb the migration shock. This section examines how exposure to Venezuelan refugees translated into fiscal adjustments, staffing responses,

and infrastructure constraints at the municipal level, helping explain why the composition and congestion channels materialized into a deterioration of health outcomes.

Fiscal adjustment and spending composition. Figure 6 reports 2SLS estimates of the effect of migration exposure on health spending and municipal revenues, presenting results using both a time-varying population denominator and a fixed pre-crisis denominator. The distinction matters because the Venezuelan inflow mechanically inflates the denominator; thus, per-capita measures computed with a time-varying population could remain constant even if total spending increases.

When population is held fixed at its pre-crisis level, a one-percentage-point rise in the migrant share increases own-source health spending by 1.4%. Under the varying denominator, this effect disappears, not because municipalities failed to raise spending, but because the population grew faster than budgets could follow. At a mean of roughly R$118 per capita per year in Roraima (compared with R$340 nationally), the 1.4% increase represents approximately R$1.65 per person, a modest absolute adjustment from an already low base. Spending financed through federal and state transfers shows no significant response under either denominator specification, confirming that intergovernmental fiscal adjustment did not accompany the demand shock.[17]

To understand the moderate increase in spending amid the lack of transfers, we examine the source of the increase in municipal spending. One possibility is that municipalities benefited from the inflow of refugees through higher tax revenues. Figure 6 shows that ICMS revenues remain stable, while ISS and IPTU revenues increase when using the fixed pre-crisis denominator. Rising ISS and IPTU revenues more than covered the estimated increase in own-source health spending; however, the simultaneous rise in health's budget

[17]Figure A12 provides further evidence using the difference-in-differences specification described in Section 4.3. Healthcare spending from own resources increases after 2016; however, spending financed through federal and state transfers shows no statistically significant increase. This confirms that local governments bore the immediate fiscal burden while intergovernmental transfers failed to adjust.

share still compressed education's share within the overall municipal budget. [18] Figure 7 illustrates these budgetary adjustments.[19] Earlier in the crisis, from 2015 to 2017, health spending barely moved. However, between 2017 and 2020, the period of sharpest migration inflow, municipalities in Roraima increased the share of their budgets devoted to health by nearly eight percentage points, compressing education's budget share. This pattern suggests that in the absence of federal transfers, municipalities financed rising health costs from own-source revenue growth while reprioritizing health within their budget composition.

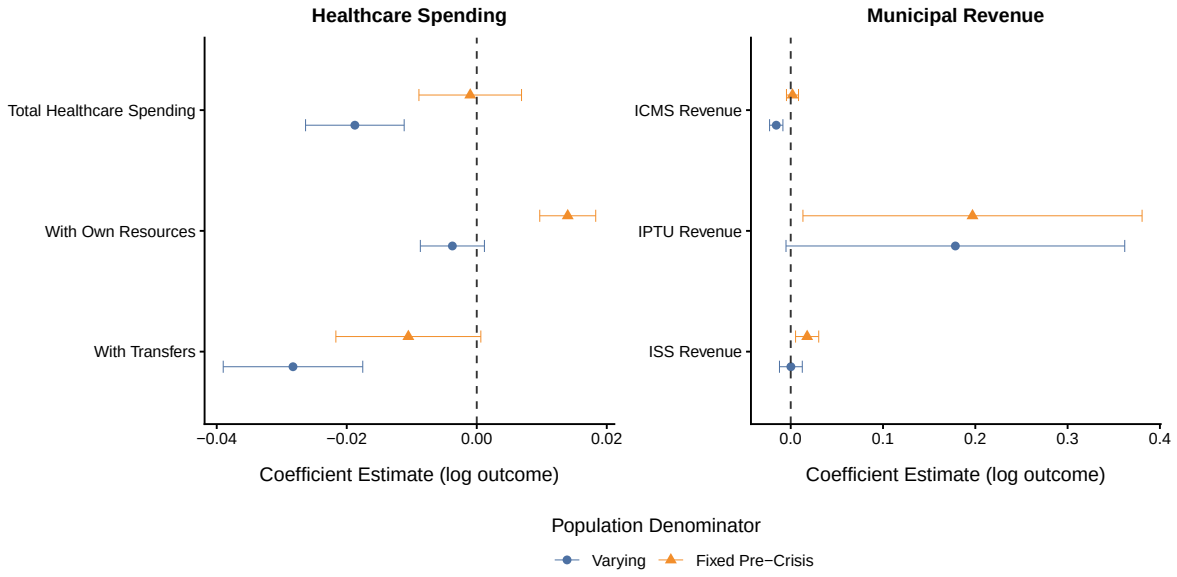

Figure 6: IV ESTIMATES OF HEALTHCARE SPENDING AND MUNICIPAL REVENUES ON MIGRANT SHARE

Notes: This figure reports two-stage least squares (2SLS) estimates of the effect of Venezuelan migration exposure on municipal fiscal outcomes. All models include municipality fixed effects and state-by-year fixed effects. Controls include private health insurance coverage, per capita Bolsa Família spending, and per capita GDP. Standard errors are clustered at the municipality level. Outcomes are expressed per capita, deflated to 2022 Brazilian Reais. Outcomes are calculated using either the varying municipal population or the fixed pre-crisis (2015) population as the denominator. Data sources: SUS-SIOPS (spending) and FINBRA (revenue).

[18] To illustrate the magnitudes: the estimated increase in ISS revenues of approximately 1.8 percent corresponds to roughly R$0.79 per capita per year (evaluated at the Roraima pre-crisis mean of R$44.55). The estimated increase in IPTU revenues of approximately 20 percent corresponds to roughly R$0.60 per capita (at a pre-crisis mean of R$3.04). ICMS revenue sharing shows no statistically significant response. Combined, the implied increase in own-tax revenues is approximately R$1.39 per capita, which exceeds the estimated R$1.09 per capita increase in own-source health spending, suggesting that revenue growth was the primary financing source rather than reallocation from other budget functions.

[19] See also the dynamic patterns in Figure A9 in the Appendix.

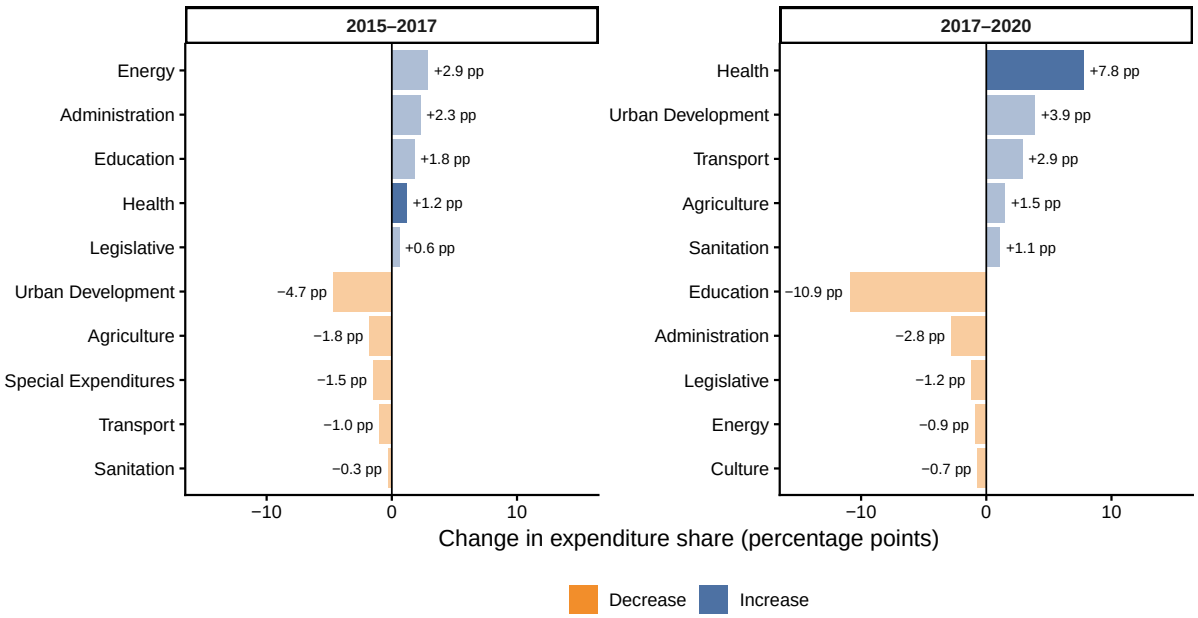

Figure 7: Reallocation of municipal spending shares in Roraima, 2015–2020

Notes: This figure plots changes in average municipal expenditure shares (percentage points, pp) by spending function for municipalities in Roraima over two subperiods: 2015–2017 and 2017–2020. Bars report the change in the spending share within each function (end year minus start year). Positive values denote increases and negative values denote decreases. Within each panel, functions are ordered by largest increases (top) followed by largest decreases (bottom). Colors distinguish increases and decreases; the Health category is visually highlighted.

Health workforce and infrastructure. Next, we provide descriptive evidence on whether and how fiscal pressures translated into changes in the supply of healthcare workforce and infrastructure. Figure 8 shows that, in the early phase of the crisis, between 2015 and 2017, Roraima municipalities expanded healthcare personnel substantially: number of total doctors grew by over 15% and number of nurses by over 19%. While there appears to be a decrease in the number of beds, potentially due to the need for cost cuts, this initial expansion of staff suggests that local governments attempted to scale up supply as the migration shock intensified. In the subsequent period, between 2017 and 2020, however, these efforts ceased. This temporal pattern aligns with the fiscal evidence: municipalities initially expanded their workforce using available resources, but could not sustain these additional costs once own-source revenues were exhausted and federal transfers failed to adjust. While they reallocated funds from education toward health to finance the increased spending, they were unable to further expand health

expenditure amid binding budget constraints.[20]

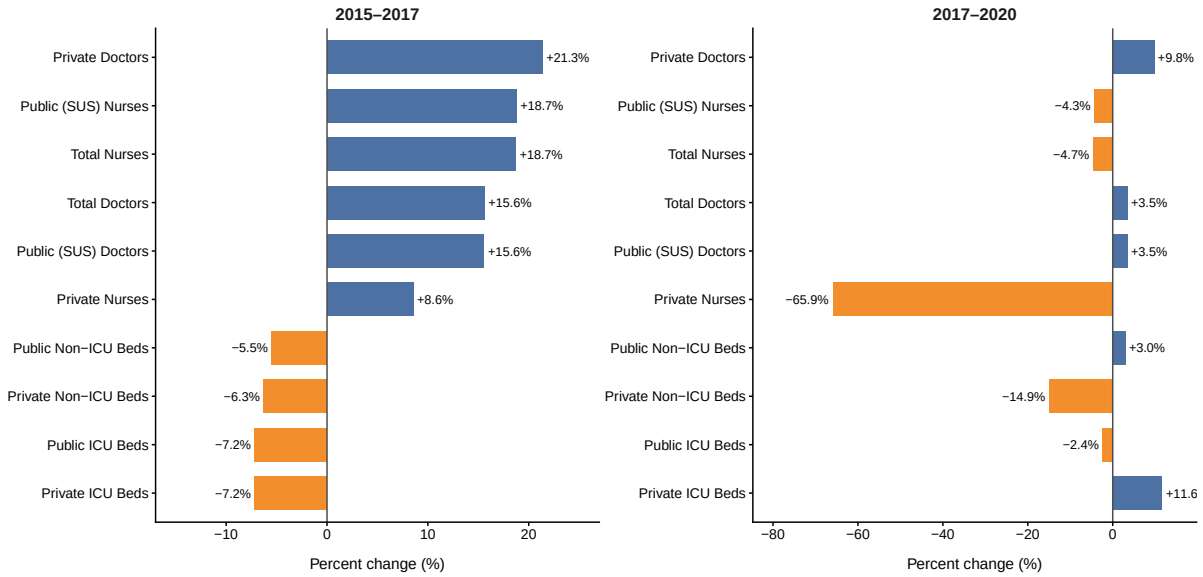

Figure 8: Growth in healthcare staffing and infrastructure in Roraima, 2015–2020

Notes: This figure plots the percent change in healthcare staffing (doctors and nurses) and hospital bed availability (ICU and non-ICU) for municipalities in Roraima over two subperiods: 2015–2017 and 2017–2020. Variables are measured per municipality and averaged across all municipalities in Roraima. Staffing is split into total, public (SUS), and private categories. Beds are split into public and private, and ICU and non-ICU. Data source: CNES (staffing and hospital infrastructure).

Interpretation. Why did Brazil's universal healthcare system fail to absorb the migration shock? The evidence points to the institutional architecture of the country's health system. Although SUS guarantees universal access, municipalities bear primary responsibility for delivering primary care and emergency services while depending heavily on intergovernmental transfers to finance them. When the migration shock arrived, federal and state transfers failed to adjust, leaving local governments to absorb the additional demand from their own resources. Constrained by limited fiscal autonomy and budget rules, municipalities reallocated existing resources: raising own-source health spending while cutting education spending. Staffing expanded initially but could not be sustained without additional intergovernmental support, and infrastructure, which requires longer lead times and larger capital outlays, showed no meaningful response. These supply-side rigidities

[20]This evidence is also consistent with the 2SLS estimates on the supply of healthcare personnel and on hospital bed availability presented in Figures A13 and A14 in the Appendix, respectively.

amplified the composition channel. Migrants arrived with elevated needs for primary and chronic care, but the primary care system was already operating near capacity. As a result, manageable conditions more often progressed to hospital-level severity, reinforcing the congestion. The combination of a vulnerable incoming population and a delayed fiscal response thus explains why health indicators deteriorated even in a system that, in principle, guarantees equal and universal access.

6 Concluding remarks

This paper studies the effect of the Venezuelan refugee inflow on local healthcare outcomes and municipal public finances in Brazil. Using an instrumental variable approach that exploits geographic variation in exposure to the migration shock, we find that a one-percentage-point increase in the local refugee share raises mortality by 4.2 percent and infant mortality by up to 9 percent.

We find evidence for two complementary channels: change in composition of local population and congestion of the local healthcare system. On the composition side, the share of Venezuelans among hospital patients rises more than proportionally to their population share, indicating that the deterioration in health indicators is partly driven by the poorer baseline health of incoming refugees. On the congestion side, municipalities with greater refugee exposure exhibit higher hospital occupancy rates, shorter lengths of stay, and more hospitalizations for ambulatory care-sensitive conditions that could be prevented through timely primary care. Furthermore, we find that the fiscal response does not keep pace with the surge in demand. In the absence of compensating federal transfers, affected municipalities finance higher healthcare spending from own-source revenues by shifting resources away from other areas, most notably education.

The fiscal reallocation points to potentially important longer-run welfare costs of concentrated migration shocks under decentralized service provision. In particular, the compression of education's budget share suggests that non-migrant children in highly exposed municipalities may bear part of the adjustment burden through reduced invest-

ment in schooling inputs, infrastructure, or educational quality. While quantifying these downstream effects is beyond the scope of this paper, the result highlights an intertemporal policy trade-off: absent timely federal support, local governments may protect urgent health needs only by reducing spending on human capital accumulation, with potentially persistent consequences for inequality and long-run local development.

Taken together, our findings suggest that universal legal access does not guarantee effective access when fiscal capacity is uneven across levels of government. Without rapid federal support, decentralized governance can amplify rather than buffer shocks, as municipalities with limited fiscal autonomy face binding constraints that force trade-offs between health and other local priorities.

References

Aksu, E., Erzan, R. and Kirdar, M. G. (2022). The impact of mass migration of Syrians on the Turkish labor market. *Labour Economics*, **76**, 102183.

Aldén, L. and Hammarstedt, M. (2019). Refugee immigration and public-sector finances: Evidence from Sweden. *FinanzArchiv / Public Finance Analysis*, **75** (3), 297–322.

Amuedo-Dorantes, C., Ibáñez, A. M., Rozo, S. V. and Traettino, S. (2025). Fertility responses to granting legal status: Evidence from Venezuelan forced migrants in Colombia. *Economic Development and Cultural Change*, **74** (1), 277–303.

Aray, H. and Vera, D. (2024). A tale of oil production collapse. *Resources Policy*, **93**, 105044.

Åslund, O., Engdahl, M. and Rosenqvist, O. (2024). Limbo or leverage? Asylum waiting and refugee integration. *Journal of Public Economics*, **234**, 105118.

Assaad, R., Ginn, T. and Saleh, M. (2023). Refugees and the education of host populations: Evidence from the Syrian inflow to Jordan. *Journal of Development Economics*, **164**, 103131.

Aygün, A., Kirdar, M. G. and Tuncay, B. (2021). The effect of hosting 3.4 million refugees on native population mortality. *Journal of Health Economics*, **80**, 102534.

Baez, J. E. (2011). Civil wars beyond their borders: The human capital and health consequences of hosting refugees. *Journal of Development Economics*, **96** (2), 391–408.

Besley, T. and Persson, T. (2014). Why do developing countries tax so little? *Journal of Economic Perspectives*, **28** (4), 99–120.

Bettin, G. and Sacchi, A. (2020). Health spending in Italy: The impact of immigrants. *European Journal of Political Economy*, **65**, 101932.

Brito, C. (2025). Sheltering refugees in cities: Crime, public services, and voting, mimeo.

Broner, T. T. (2019). Venezuela's humanitarian emergency. *Human Rights Watch*.

Castro, M. C., Massuda, A., Almeida, G., Menezes-Filho, N. A., Andrade, M. V., De Souza Noronha, K. V. M., Rocha, R., Macinko, J., Hone, T., Tasca, R., Giovanella, L., Malik, A. M., Werneck, H., Fachini, L. A. and Atun, R. (2019). Brazil's unified health system: The first 30 years and prospects for the future. *The Lancet*, **394** (10195), 345–356.

Contreras, D. and Gallardo, S. (2022). The effects of mass migration on the academic performance of native students. Evidence from Chile. *Economics of education review*, **91**, 102314.

Corrales, J. (2020). Democratic backsliding through electoral irregularities: The case of Venezuela. *European Review of Latin American and Caribbean Studies*, (109), 41–65.

Doocy, S., Page, K. R., Liu, C., Hoaglund, H. and Rodríguez, D. C. (2022). Venezuela: Out of the headlines but still in crisis. *Bulletin of the World Health Organization*, **100** (8), 466–466A.

—, Ververs, M.-T., Spiegel, P. and Beyrer, C. (2019). The food security and nutrition crisis in Venezuela. *Social Science & Medicine*, **226**, 63–68.

Dustmann, C. and Frattini, T. (2014). The fiscal effects of immigration to the UK. *The Economic Journal*, **124** (580), F593–F643.

—, — and Halls, C. (2010). Assessing the fiscal costs and benefits of A8 migration to the UK. *Fiscal Studies*, **31** (1), 1–41.

—, Schönberg, U. and Stuhler, J. (2017). Labor Supply Shocks, Native Wages, and the Adjustment of Local Employment*. *The Quarterly Journal of Economics*, **132** (1), 435–483.

ECLAC (2021). *Preliminary overview of the economies of Latin America and the Caribbean 2020*. Santiago.

El Pais (2016). Latam suspende os voos à Venezuela. https://brasil.elpais.com/brasil/2016/05/30/internacional/1464622067_483110.html, accessed on: March 11, 2026.

El Pais (2018). Cruzar a fronteira para conseguir dar a luz. https://brasil.elpais.com/brasil/2018/09/04/politica/1536079388_175129.html, accessed on: March 11, 2026.

Foged, M., Hasager, L., Peri, G., Arendt, J. N. and Bolvig, I. (2023). Intergenerational spillover effects of language training for refugees. *Journal of Public Economics*, **220**, 104840.

Giuntella, O., Nicodemo, C. and Vargas-Silva, C. (2018). The effects of immigration on NHS waiting times. *Journal of Health Economics*, **58**, 123–143.

Globo Notícias (2018a). Autoridades de Roraima pedem "socorro" para lidar com imigração e querem "interiorização" de venezuelanos. https://g1.globo.com/rr/roraima/noticia/autoridades-de-roraima-pedem-socorro-para-lidar-com-imigracao-e-querem-interiorizacao-de-venezuelanos.ghtml, accessed on: February 13, 2026.

Globo Notícias (2018b). Deputados pedem a Temer campo de refugiados em Roraima para abrigar venezuelanos. https://g1.globo.com/rr/roraima/noticia/deputados-federais-pedem-ajuda-ao-presidente-michel-temer-para-lidar-com-imigracao-venezuelana-em-rr.ghtml, accessed on: February 13, 2026.

Grabowski, D. C., Gruber, J. and McGarry, B. E. (2026). Is immigration good for health? The effect of immigration on older adult mortality in the United States, Working Paper 34791, National Bureau of Economic Research. Available at: https://www.nber.org/papers/w34791. Accessed on: March 24, 2026.

Gál, Z. (2019). Fiscal consequences of the refugee crisis. *International Migration*, **57** (5), 341–354.

Human Rights Watch (2020). Venezuela: Events of 2020. In *World Report 2021*.

Ibáñez, A. M., Rozo, S. V., Bahar, D. and Urbina, M. J. (2026). Protecting the vulnerable: How migrant regularization reduces crime and empowers women. *Journal of Development Economics*, **179**, 103667.

—, — and Urbina, M. J. (2021). Forced migration and the spread of infectious diseases. *Journal of Health Economics*, **79**, 102491.

Knight, B. and Tribin, A. (2023). Immigration and violent crime: Evidence from the Colombia-Venezuela border. *Journal of Development Economics*, p. 103039.

Leal, M. d. C. (2022). Necessidades e desafios relativos à saúde sexual e reprodutiva de mulheres adultas e adolescentes migrantes. https://arcadados.fiocruz.br/citation?persistentId=doi:10.35078/3B7S4N, accessed on: November 20, 2025.

Lebow, J. (2022). The labor market effects of Venezuelan migration to Colombia: Reconciling conflicting results. *IZA Journal of Development and Migration*, **13** (1).

—, Moreno-Medina, J., Mousa, S. and Coral, H. (2024). Migrant exposure and anti-migrant sentiment: The case of the Venezuelan exodus. *Journal of Public Economics*, **236**, 105169.

Lombardo, C. and Peñaloza-Pacheco, L. (2025). Skilled immigration and firm-level upgrading as exports boosters in a developing country, CESifo Working Paper 11645.

LoPalo, M. (2019). The effects of cash assistance on refugee outcomes. *Journal of Public Economics*, **170**, 27–52.

Marques, R. (2025). Forced migration and violent crime: Evidence from the Venezuelan exodus to Brazil. *The Journal of Development Studies*, **61** (2), 194–216.

Massuda, A., Paschoalotto, M. A. C., Bigoni, A., Malik, A. M., Safatle, L. and de Oliveira, W. K. (2023). *Sustainability and Resilience in the Brazilian Health System*. Country report, Partnership for Health System Sustainability and Resilience

(PHSSR), London, commissioned via LSE Consulting, London School of Economics and Political Science.

Miller, S., Wherry, L. R. and Aldana, G. (2022). *Covering Undocumented Immigrants: The Effects of a Large-Scale Prenatal Care Intervention*. Working Paper 30299, National Bureau of Economic Research.

Morales, C. (2022). Do refugee students affect the academic achievement of peers? Evidence from a large urban school district. *Economics of Education Review*, **89**, 102283.

Muñoz-Blanco, L. and Frattini, F. F. (2024). Vaccines on the move and the war on polio, Working Paper, Fondazione Eni Enrico Mattei.

Olivieri, S., Ortega, F., Rivadeneira, A. and Carranza, E. (2021). Shoring up economic refugees: Venezuelan migrants in the Ecuadoran labor market. *Migration Studies*, **9** (4), 1590–1625.

—, —, — and — (2022). The labour market effects of Venezuelan migration in Ecuador. *The Journal of Development Studies*, **58** (4), 713–729.

Page, K. R., Doocy, S., Reyna Ganteaume, F., Castro, J. S., Spiegel, P. and Beyrer, C. (2019). Venezuela's public health crisis: A regional emergency. *The Lancet*, **393** (10177), 1254–1260.

PAHO (2018). PAHO's response to maintaining an effective technical cooperation agenda in Venezuela and neighboring member states, information Document CE162/INF/22.

Peñaloza-Pacheco, L. (2022). Living with the neighbors: The effect of Venezuelan forced migration on the labor market in Colombia. *Journal for Labour Market Research*, **56** (1), 14.

R4V Coordination Platform for Refugees and Migrants from Venezuela (2026). R4V: Latin America and the Caribbean, Venezuelan refugees and migrants in the region. https://www.r4v.info/, accessed: 2026-03-18.

Reuters (2018). Pregnant Venezuelan women going to Brazil to give birth. https://www.reuters.com/article/world/pregnant-venezuelan-women-going-to-brazil-to-give-birth-idUSKCN1L713B/, accessed on: March 11, 2026.

Rozo, S. V., Quintana, A. and Urbina, M. J. (2026). Electoral effects of integrating forced migrants: Evidence from a southern country. *World Development*, **198**, 107190.

— and Vargas, J. F. (2021). Brothers or invaders? How crisis-driven migrants shape voting behavior. *Journal of Development Economics*, **150**, 102636.

Ruist, J. (2015). The Fiscal Cost of Refugee Immigration: The Example of Sweden. *Population and Development Review*, **41** (4), 567–581.

— (2020). The fiscal aspect of the refugee crisis. *International Tax and Public Finance*, **27** (2), 478–492.

Ryu, H. and Paudel, J. (2022). Refugee inflow and labor market outcomes in Brazil: Evidence from the Venezuelan exodus. *Population and Development Review*, **48** (1), 75–96.

Rádio Senado (2017). Senadores alertam sobre a migração de venezuelanos para o Brasil. https://www12.senado.leg.br/radio/1/noticia/2017/05/10/senadores-alertam-sobre-a-migracao-de-venezuelanos-para-o-brasil, accessed on: February 13, 2026.

Shamsuddin, M., Acosta, P. A., Schwengber, R., Fix, J. and Pirani, N. (2022). The labor market impacts of Venezuelan refugees and migrants in Brazil, mimeo.

—, —, Schwengber, R. B., Fix, J. and Pirani, N. (2021). Economic and fiscal impacts of Venezuelan refugees and migrants in Brazil, policy Research Working Paper 9797, World Bank.

UNHCR (2025). Global trends. Forced displacement in 2024, copenhagen, Denmark. Available at: https://www.unhcr.org/global-trends-report-2024. Accessed on: March 24, 2026.

Valencia, O., Angarita, M., Santaella, J. and De Castro, M. (2020). Do immigrants bring fiscal dividends? The case of Venezuelan immigration in Colombia, inter-American Development Bank Working Paper.

Vera, L. (2015). Venezuela 1999–2014: Macro-policy, oil governance and economic performance. *Comparative Economic Studies*, **57** (3), 539–568.

Yogo, U. T. (2017). Are refugees a fiscal burden for Europe? Evidence from a panel VAR analysis. *SSRN Electronic Journal*.

Zuchowski, D. (2025). Migration response to an immigration shock: evidence from Russia's aggression against Ukraine. *Journal of Economic Geography*, **25** (1), 21–40.

Appendix

Figure A1: Private Healthcare Insurance Coverage by Municipality in 2022

Source: Authors' calculation using ANS data.

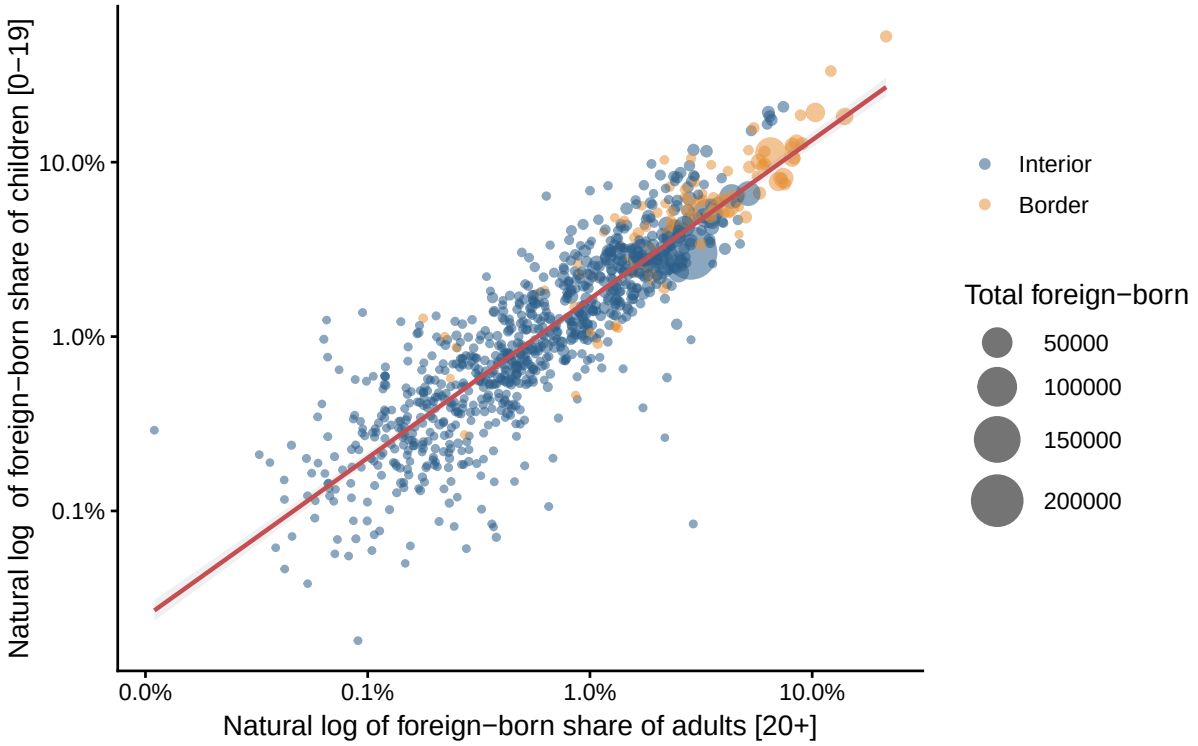

Figure A2: Spatial Correlation: Foreign-Born Children vs. Adults (Shares) in Colombia (2018)

Source: Authors' calculation using DANE CNPV 2018. Venezuelans account for 87% of the foreign-born population in the 2018 census.

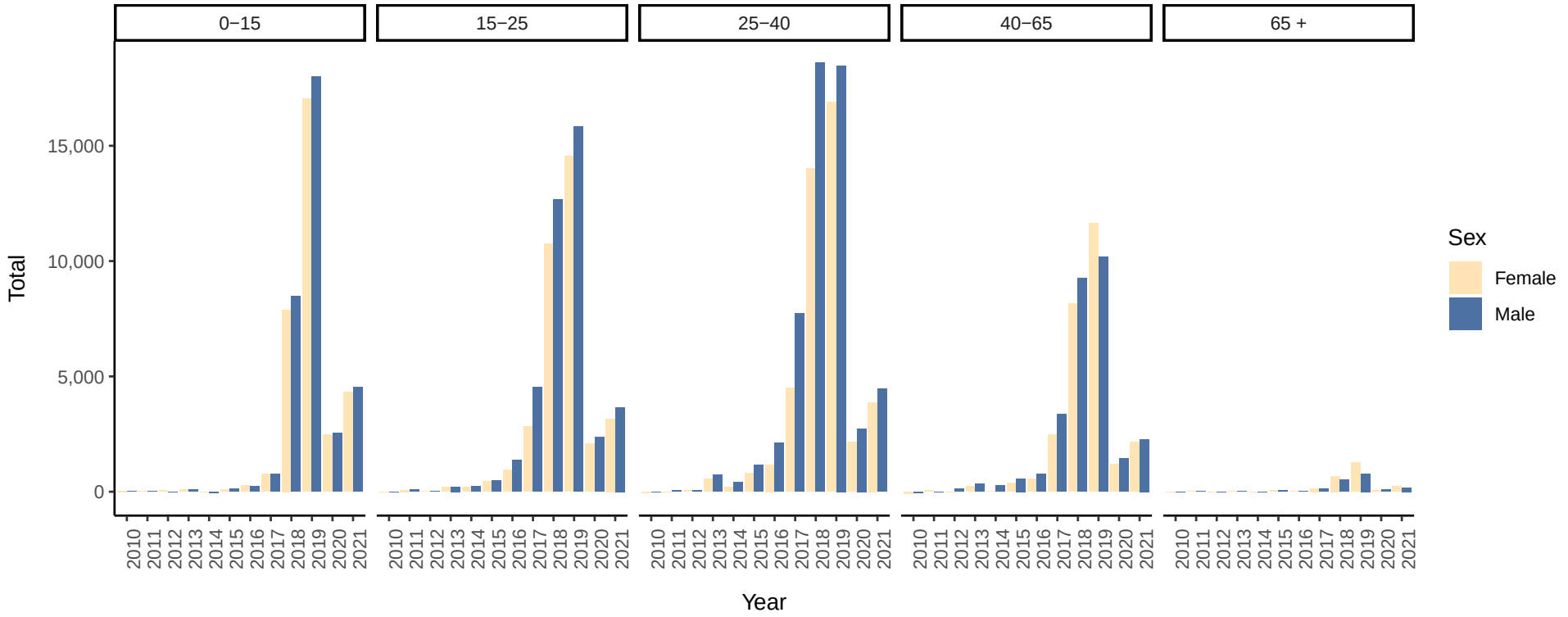

Figure A3: Yearly Net Inflow of Venezuelans to Brazil - by Age and Sex (2010–2021)

Source: Authors' calculation from the International Traffic System (STI) organized by Brazilian Federal Police. Data made publicly available by the International Migration Observatory (OBMigra).

Table A1: Population Growth by State in Absolute and Percentage Terms

	2010-2014		2015-2021	
State	Growth	% Growth	Growth	% Growth
Acre	52948	6.92	75211	9.04
Alagoas	67824	2.12	85702	2.61
Amapá	67895	9.78	98197	12.60
Amazonas	266488	7.50	335588	8.63
Bahia	285672	2.00	359564	2.46
Ceará	223253	2.59	336081	3.77
Distrito Federal	166793	6.31	243366	8.54
Espírito Santo	188304	5.24	267771	6.99
Goiás	409242	6.70	585896	8.85
Maranhão	164338	2.45	234788	3.40
Mato Grosso	129046	4.16	277887	8.45
Mato Grosso do Sul	131102	5.26	185260	6.98
Minas Gerais	551494	2.76	718332	3.48
Paraná	344806	3.24	481891	4.35
Paraíba	69263	1.80	127368	3.24
Pará	401595	5.18	500582	6.07
Pernambuco	251549	2.79	357476	3.84
Piauí	81912	2.60	31702	0.98
Rio Grande do Norte	125811	3.89	162154	4.78
Rio Grande do Sul	214894	1.97	239818	2.15
Rio de Janeiro	422996	2.59	622211	3.69
Rondônia	73411	4.59	142977	8.55
Roraima	43150	9.40	139385	27.15
Santa Catarina	377595	5.96	538923	7.93
Sergipe	86700	4.11	109646	4.95
São Paulo	1645607	3.89	2272325	5.12
Tocantins	72329	5.12	98544	6.55

Notes: Population estimates sourced from the Ministry of Health. "Growth" columns show absolute population increase during the period; "% Growth" columns show percentage change relative to the starting year.

Table A2: Summary Statistics

Variable	Mean	SD	Min	Max	Obs.	Data Source
Panel A: Instrument and Endogenous Regressor						
Predicted Venezuelan Inflow (IV)	21.7	1187.0	0.07	186,408	44,240	GraphHopper, STI
Share of Venezuelan students (%)	0.009	0.247	0.00	31.7	44,560	Ministry of Education
Panel B: Main Outcomes						
Crude mortality rate (per 100,000)	413.0	255.0	0.00	4740.0	44,563	SIM
ACSC mortality rate (per 100,000)	122.0	90.2	0.00	1,632	44,560	SIM
Infant mortality rate (per 1,000)	21.9	131.0	0.00	6,000	44,563	SIM, SINASC
Birth rate (per 100,000)	599.0	938.0	0.00	12,670	44,563	SINASC
Hospitalizations per capita (per 10,000)	297.0	434.0	0.00	8,507	44,560	SIH
ACSC hospitalizations per capita (per 10,000)	26.1	52.1	0.00	1,144	44,560	SIH
Average length of stay (days)	3.66	1.95	0.00	44.3	25,546	SIH
Hospital bed occupancy rate (%)	26.8	21.0	0.00	351.0	25,537	CNES, SIH
Panel C: Controls						
Private health insurance coverage	8.47	10.6	0.00	100.0	44,560	ANS
Bolsa Família spending per capita (deflated)	257.0	747.0	0.08	84,033	44,549	MDS
GDP per capita (constant prices)	29.6	30.8	0.52	1,299	44,560	IBGE

Notes: Summary statistics are computed at the municipality–year level for the period 2013–2020, except for the endogenous migration measure, which is available from 2010–2022. Average length of stay and hospital bed occupancy rates are coded as missing when a municipality has no hospital infrastructure (e.g., zero inpatient beds), since these indicators are defined for the location of occurrence and are mechanically undefined in the absence of hospitals. In contrast, hospitalization and mortality rates are retained and may take the value zero in municipalities without hospitals, as they represent valid event counts/rates by location.

Table A3: Estimates of health outcomes on migrant share (Municipality of Residence)

	OLS				2SLS			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: **Mortality Rate (log)**								
Venezuelan Share	0.0057	0.0059*	0.0001	0.0002	0.0124***	0.0113***	0.0075***	0.0079***
	(0.0039)	(0.0035)	(0.0075)	(0.0076)	(0.0003)	(0.0003)	(0.0020)	(0.0021)
Observations	44,559	44,559	44,398	44,398	44,239	44,239	44,084	44,084
Panel B: **Infant Mortality Rate (log)**								
Venezuelan Share	0.0203	0.0202	0.0114	0.0120	0.0360***	0.0373***	0.0264**	0.0333***
	(0.0155)	(0.0151)	(0.0207)	(0.0199)	(0.0014)	(0.0019)	(0.0117)	(0.0122)
Observations	44,560	44,560	44,398	44,398	44,240	44,240	44,084	44,084
Panel C: **Birth Rate (log)**								
Venezuelan Share	0.0098*	0.0100*	-0.0021	-0.0017	0.0026***	0.0031***	-0.0046**	-0.0038*
	(0.0056)	(0.0055)	(0.0029)	(0.0029)	(0.0004)	(0.0004)	(0.0021)	(0.0021)
Observations	44,560	44,560	44,398	44,398	44,240	44,240	44,084	44,084
Panel D: **Hospitalization Rate (log)**								
Venezuelan Share	0.0012	0.0012	-0.0060	-0.0059	0.0198***	0.0205***	0.0177***	0.0191***
	(0.0029)	(0.0030)	(0.0054)	(0.0057)	(0.0005)	(0.0005)	(0.0044)	(0.0044)
Observations	44,560	44,560	44,398	44,398	44,240	44,240	44,084	44,084
Controls		✓		✓		✓		✓
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
State x Year FE			✓	✓			✓	✓

Notes: This table reports the estimated effects of Venezuelan migrant inflows on a range of health outcomes at the municipality of residence of the individual. Panels A reports crude mortality rates; Panel B covers infant mortality; Panel C shows birth rates; Panels D reports total hospitalization rates. Columns (1)–(4) show OLS estimates, Columns (5)–(8) report two-stage least squares (2SLS) estimates using distance to the Pacaraima border as an instrument for Venezuelan share. All models include municipality and year fixed effects, and some also include state-by-year fixed effects. Control variables (when included) are private health coverage, Bolsa Família spending per capita, and per capita GDP. Due to the large number of zeros—since not all municipalities have hospitals or maternity wards—we apply the inverse hyperbolic sine (IHS) transformation to infant mortality, hospitalization and birth outcomes. Coefficients can be interpreted as the semi-elasticity of each outcome with respect to a one percentage-point increase in the Venezuelan share of the population (share × 100). Mean of outcomes (pre-crisis, 2013-2014): Mortality Rate = 389.50 per 100,000; Infant Mortality Rate = 22.72 per 1,000; Birth Rate = 642.44 per 100,000; Hospitalization Rate = 316.74 per 10,000=. Standard errors are reported in parentheses. * p<0.1; ** p<0.05; *** p<0.01..

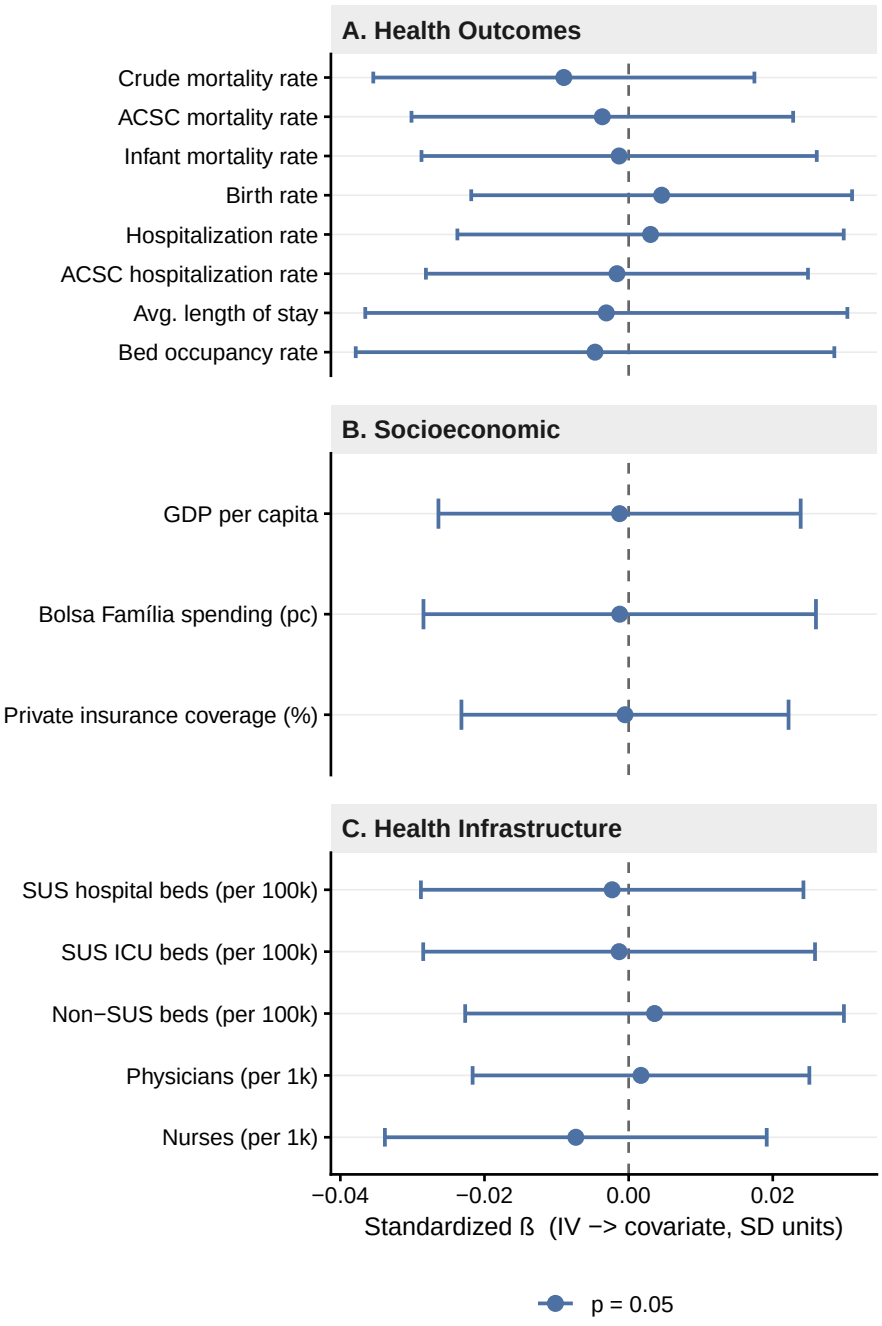

Figure A4: Pre-Treatment Balance: Distance to Pacaraima and Pre-Crisis Municipality Characteristics

Notes: This figure reports standardized OLS coefficients from cross-sectional regressions of pre-crisis municipality characteristics on the distance component of the instrument, estimated separately for each covariate using 2013 data. All regressions include state fixed effects, so identification comes from within-state variation in proximity to the Pacaraima border crossing. Both the covariate and the instrument are standardized to have mean zero and unit variance, so coefficients represent the change in the covariate (in standard deviation units) associated with a one-standard-deviation increase in geographic exposure. Outcomes are grouped into three panels: health outcomes (the eight main outcomes of the paper), socioeconomic conditions, and healthcare infrastructure. Horizontal bars denote 95% confidence intervals based on heteroskedasticity-robust standard errors.

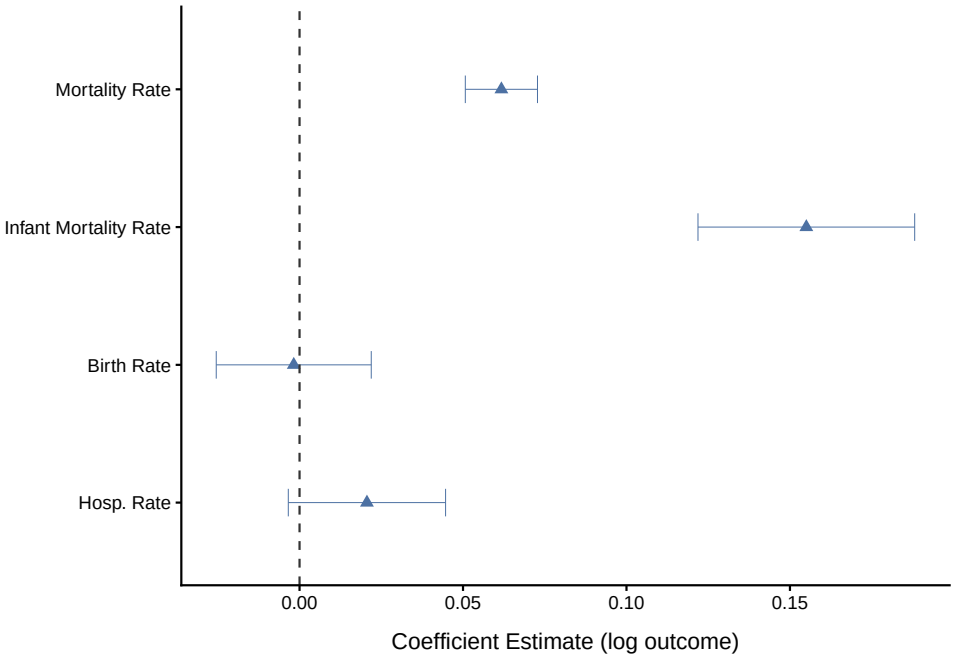

Figure A5: IV Estimates of health outcomes on migrant share - Population denominator fixed pre-crisis

Notes: This figure reports two-stage least squares (2SLS) estimates of the effect of Venezuelan migration exposure on municipal health outcomes. Outcomes are expressed as rates, with the population denominator held fixed at its pre-crisis level (2015). This approach isolates changes in health outcomes from mechanical changes in rates driven by post-2015 population growth associated with migrant inflows. All models include municipality fixed effects and state-by-year fixed effects. Control variables include private health coverage, Bolsa Família spending per capita, and per capita GDP. Due to the large number of zeros—since not all municipalities have hospitals or maternity wards—we apply the inverse hyperbolic sine (IHS) transformation to infant mortality, hospitalization and birth outcomes. Standard errors are clustered at the municipality level. Outcomes are measured based on municipality of residence. Data sources: SUS-SIH (hospitalizations), SUS-SINASC (births), and SUS-SIM (deaths and infant mortality).

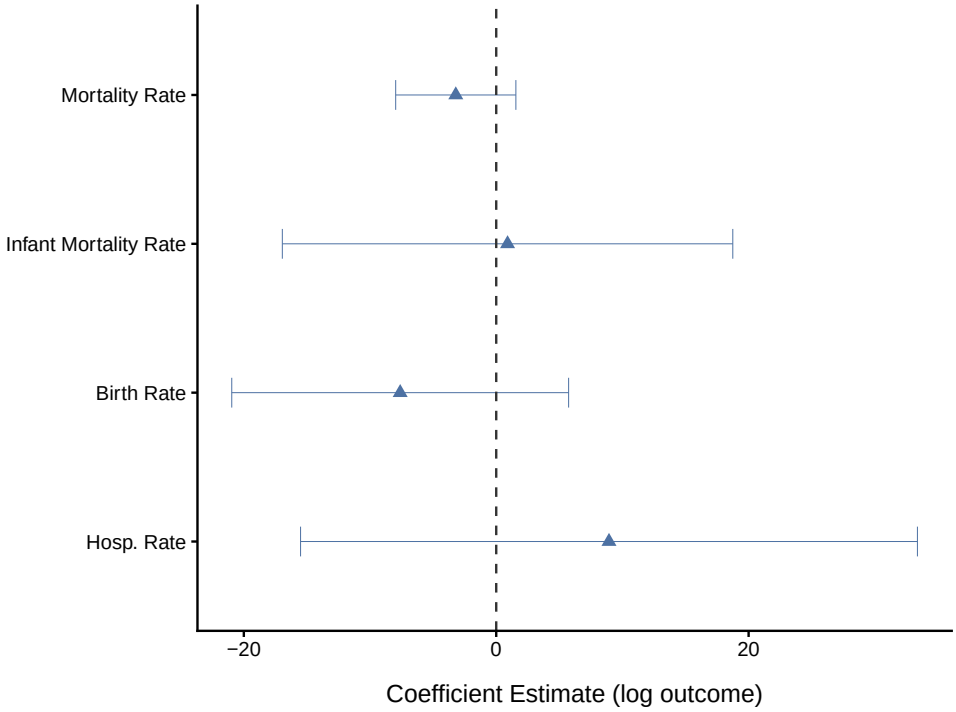

Figure A6: IV Estimates of health outcomes on migrant share - Dropped municipalities from Roraima

Notes: This figure reports two-stage least squares (2SLS) estimates of the effect of Venezuelan migration exposure on municipal health outcomes on a subsample without the municipalities from Roraima. All models include municipality fixed effects and state-by-year fixed effects. Control variables are private health coverage, Bolsa Família spending per capita, and per capita GDP. Due to the large number of zeros—since not all municipalities have hospitals or maternity wards—we apply the inverse hyperbolic sine (IHS) transformation to infant mortality, hospitalization and birth outcomes. Standard errors are clustered at the municipality level. Mortality and birth rates are expressed per 100,000 residents; hospitalization rates are expressed per 10,000 residents; and infant mortality is expressed per 1,000 live births. Outcomes are based on municipality of residence. Data sources: SUS-SIH (hospitalizations), SUS-SINASC (births), and SUS-SIM (deaths and infant mortality).

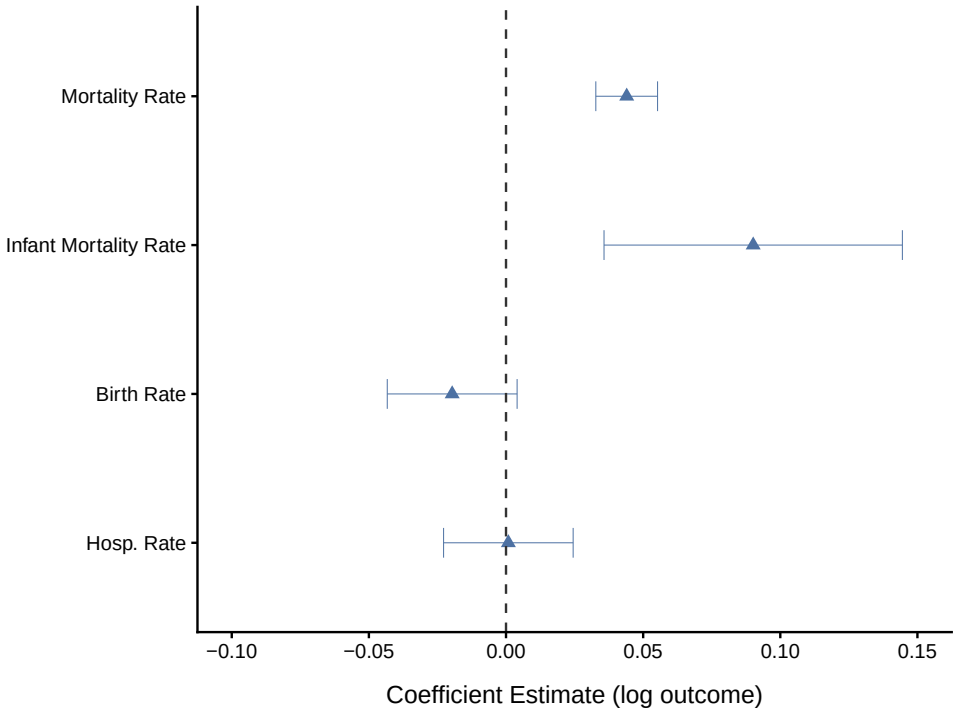

Figure A7: IV Estimates of health outcomes on migrant share - Dropped large municipalities (>500,000)

Notes: This figure reports two-stage least squares (2SLS) estimates of the effect of Venezuelan migration exposure on municipal health outcomes on a subsample without large municipalities (>500,000). All models include municipality fixed effects and state-by-year fixed effects. Control variables are private health coverage, Bolsa Família spending per capita, and per capita GDP. Due to the large number of zeros—since not all municipalities have hospitals or maternity wards—we apply the inverse hyperbolic sine (IHS) transformation to infant mortality, hospitalization and birth outcomes. Standard errors are clustered at the municipality level. Outcomes are measured per 1,000 residents based on municipality of residence. Data sources: SUS-SIH (hospitalizations), SUS-SINASC (births), and SUS-SIM (deaths and infant mortality).

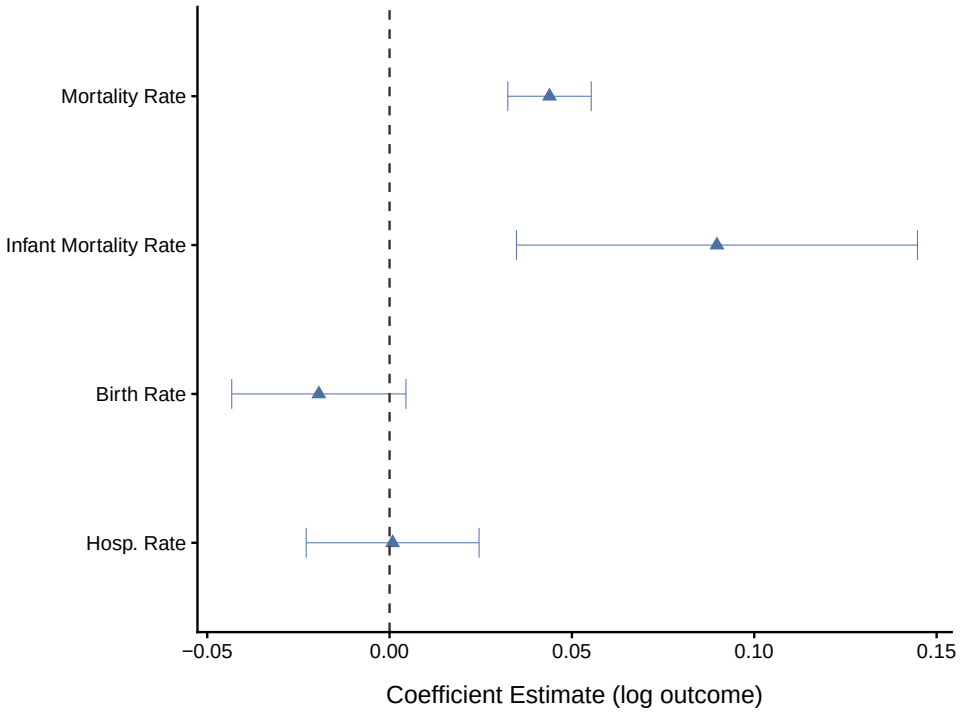

Figure A8: IV Estimates of Health Outcomes on Migrant Share — North Region Only

Notes: This figure reports two-stage least squares (2SLS) estimates of the effect of Venezuelan migration exposure on municipal health outcomes on a subsample using only municipalities in the North region (AC, AP, AM, PA, RO, RR, TO). All models include municipality fixed effects and state-by-year fixed effects. Control variables are private health coverage, Bolsa Família spending per capita, and per capita GDP. Due to the large number of zeros—since not all municipalities have hospitals or maternity wards—we apply the inverse hyperbolic sine (IHS) transformation to infant mortality, hospitalization and birth outcomes. Standard errors are clustered at the municipality level. Outcomes are measured per 1,000 residents based on municipality of residence. Data sources: SUS-SIH (hospitalizations), SUS-SINASC (births), and SUS-SIM (deaths and infant mortality).

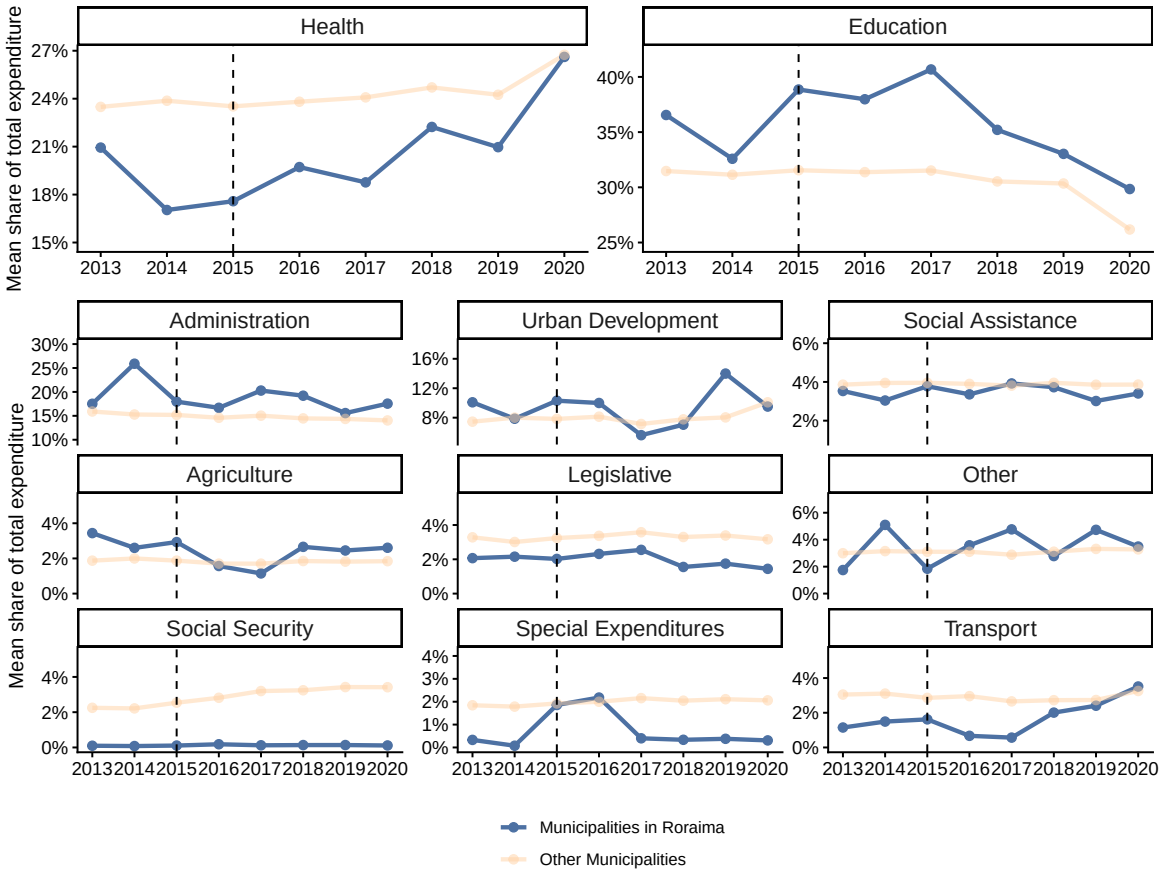

Figure A9: Municipal expenditure shares over time: Roraima vs. other municipalities

Notes: Each panel reports the mean municipal share of total expenditure by function. Top row displays Health (left) and Education (right). Bottom panels show the next largest functions from the selected set (wrapping up to three per row), including a residual Other. The dashed vertical line marks 2015. Colors and shapes highlight Municipalities in Roraima (blue - circle) versus Other Municipalities (green - triangle). Shares sum to 100% within the year. Source: FINBRA (municipal expenditures) matched to municipality UF.

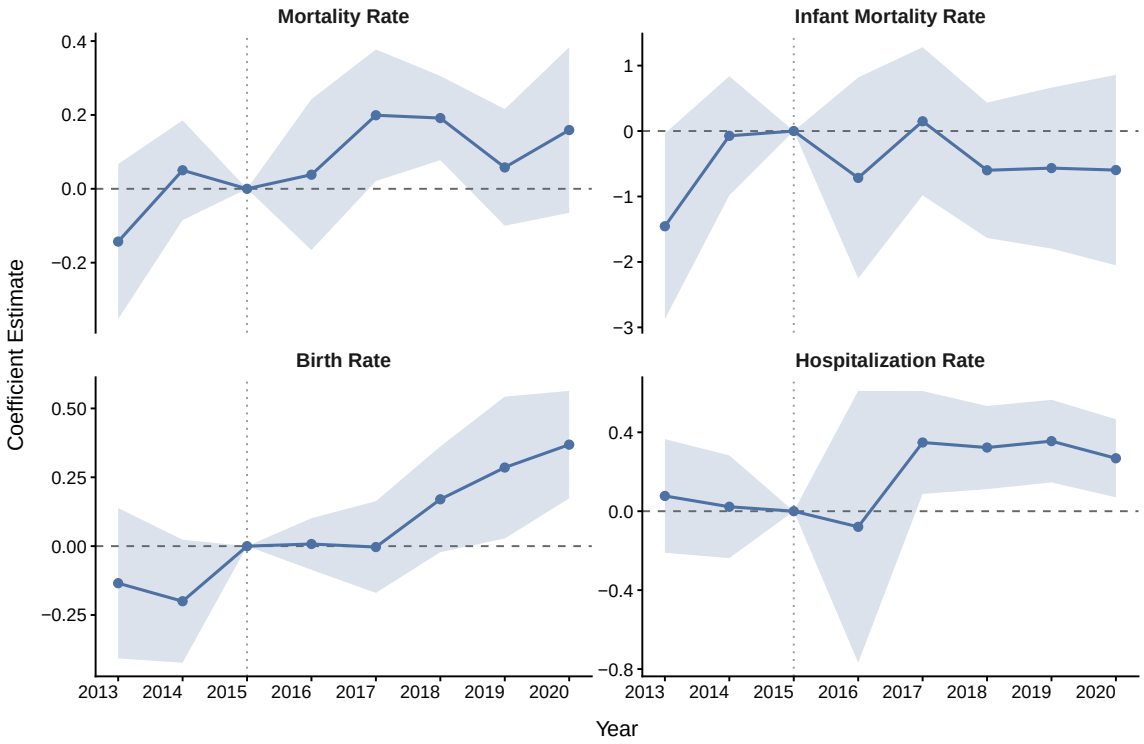

Figure A10: Event-study estimates of health outcomes (difference-in-differences) — Panel 1

Notes: This figure reports event-study estimates from a difference-in-differences specification comparing municipalities in Roraima (treated) to all other Brazilian municipalities (control), with 2015 as the reference year. Panels show effects on mortality rate (top left), infant mortality rate (top right), birth rate (bottom left), and hospitalization rate (bottom right). All models include municipality fixed effects and year fixed effects. Control variables include private health insurance coverage, Bolsa Família spending per capita, and GDP per capita. Shaded areas represent 95% confidence intervals based on standard errors clustered at the municipality level. Mortality is expressed in logs; infant mortality, hospitalization and birth outcomes use the inverse hyperbolic sine (IHS) transformation. Data sources: SUS-SIM (mortality), SUS-SINASC (births), and SUS-SIH (hospitalizations).

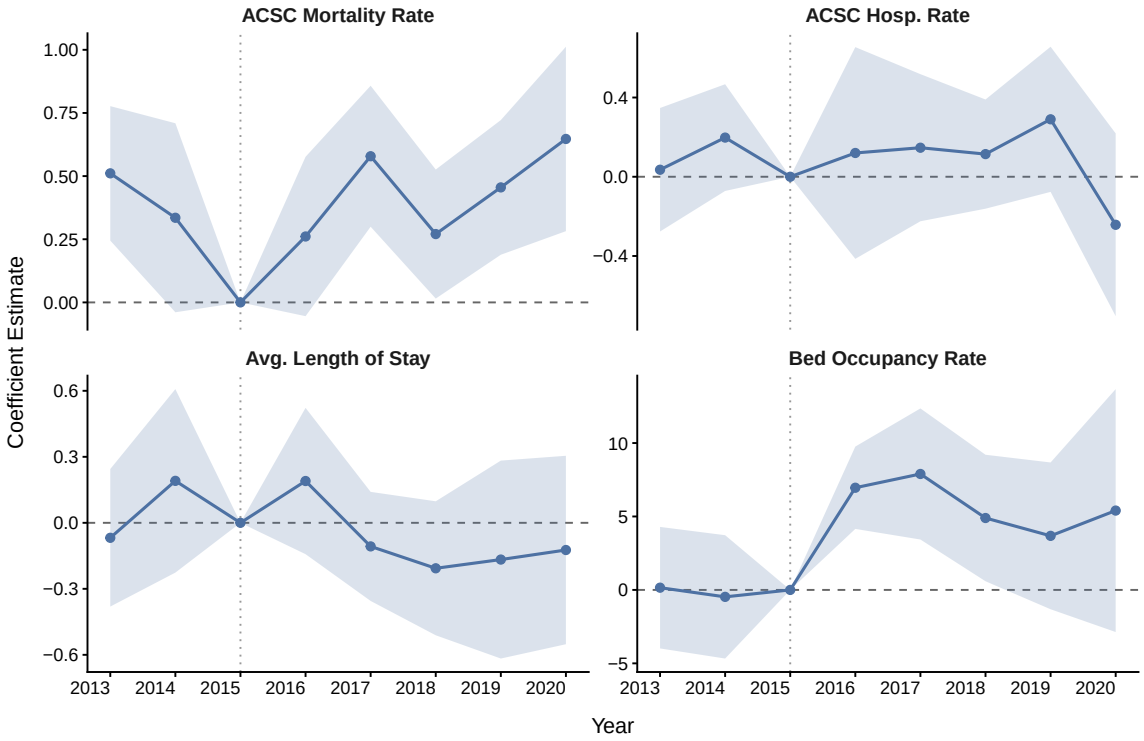

Figure A11: Event-study estimates of health outcomes (difference-in-differences) — Panel 2

Notes: This figure reports event-study estimates from a difference-in-differences specification comparing municipalities in Roraima (treated) to all other Brazilian municipalities (control), with 2015 as the reference year. Panels show effects on ACSC mortality rate (top left), ACSC hospitalization rate (top right), average length of hospital stay (bottom left), and hospital bed occupancy rate (bottom right). All models include municipality fixed effects and year fixed effects. Control variables include private health insurance coverage, Bolsa Família spending per capita, and GDP per capita. Shaded areas represent 95% confidence intervals based on standard errors clustered at the municipality level. ACSC outcomes use the inverse hyperbolic sine (IHS) transformation; average length of stay and bed occupancy are in levels. Data sources: SUS-SIM (mortality), SUS-SIH (hospitalizations and hospital capacity).

Table A4: Leave-one-out by region: Health outcomes (2SLS)

	Mortality	ACSC Mort.	Infant Mort.	Birth Rate	Hosp. Rate	ACSC Hosp.	Avg. LOS	Bed Occup.
Full	0.042***	0.029***	0.086***	0.007***	0.027***	0.039***	-0.015	0.570**
	(0.005)	(0.007)	(0.027)	(0.002)	(0.003)	(0.002)	(0.017)	(0.242)
w/o Norte	-8.253	-13.690	-53.773	-44.482	37.043	16.098	-0.620	33.181
	(7.082)	(13.775)	(37.910)	(39.603)	(34.390)	(23.915)	(27.581)	(348.386)
w/o Nordeste	0.042***	0.028***	0.086***	0.008***	0.027***	0.038***	-0.015	0.569**
	(0.005)	(0.007)	(0.027)	(0.002)	(0.003)	(0.002)	(0.017)	(0.242)
w/o Centro-Oeste	0.042***	0.029***	0.086***	0.007***	0.027***	0.039***	-0.015	0.570**
	(0.005)	(0.007)	(0.027)	(0.002)	(0.003)	(0.002)	(0.017)	(0.242)
w/o Sudeste	0.042***	0.029***	0.086***	0.010***	0.028***	0.039***	-0.015	0.575**
	(0.005)	(0.007)	(0.027)	(0.002)	(0.003)	(0.002)	(0.017)	(0.242)
w/o Sul	0.042***	0.029***	0.086***	0.005**	0.025***	0.040***	-0.015	0.570**
	(0.005)	(0.007)	(0.027)	(0.002)	(0.003)	(0.002)	(0.017)	(0.242)

Notes: Each row reports two-stage least squares (2SLS) estimates dropping one Brazilian region at a time. The endogenous variable is the share of Venezuelan students, instrumented by predicted inflows based on distance to Pacaraima. The "w/o Norte" row is empty because excluding the Norte region removes Roraima, eliminating the primary source of identifying variation. Standard errors clustered at municipality level in parentheses. All models include municipality fixed effects, year fixed effects, and state-by-year fixed effects (except births and hospitalizations which exclude state-by-year FE). Controls: private insurance coverage, Bolsa Família spending per capita, and GDP per capita. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A5: Leave-one-out by region: Fiscal outcomes (2SLS)

	Total Spending	Own Resources	Transfers
Full	-0.018***	-0.003	-0.027***
	(0.004)	(0.002)	(0.005)
w/o Norte	-4.779	-7.763	-11.876
	(4.227)	(5.145)	(11.662)
w/o Nordeste	-0.018***	-0.003	-0.027***
	(0.004)	(0.002)	(0.005)
w/o Centro-Oeste	-0.018***	-0.003	-0.027***
	(0.004)	(0.002)	(0.005)
w/o Sudeste	-0.018***	-0.003	-0.027***
	(0.004)	(0.002)	(0.005)
w/o Sul	-0.018***	-0.003	-0.027***
	(0.004)	(0.002)	(0.005)

Notes: Each row reports two-stage least squares (2SLS) estimates dropping one Brazilian region at a time. The endogenous variable is the share of Venezuelan students, instrumented by predicted inflows based on distance to Pacaraima. The "w/o Norte" row is empty because excluding the Norte region removes Roraima, eliminating the primary source of identifying variation. Standard errors clustered at municipality level in parentheses. All models include municipality, year, and state-by-year fixed effects. Controls: private insurance coverage, Bolsa Família spending per capita, and GDP per capita. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

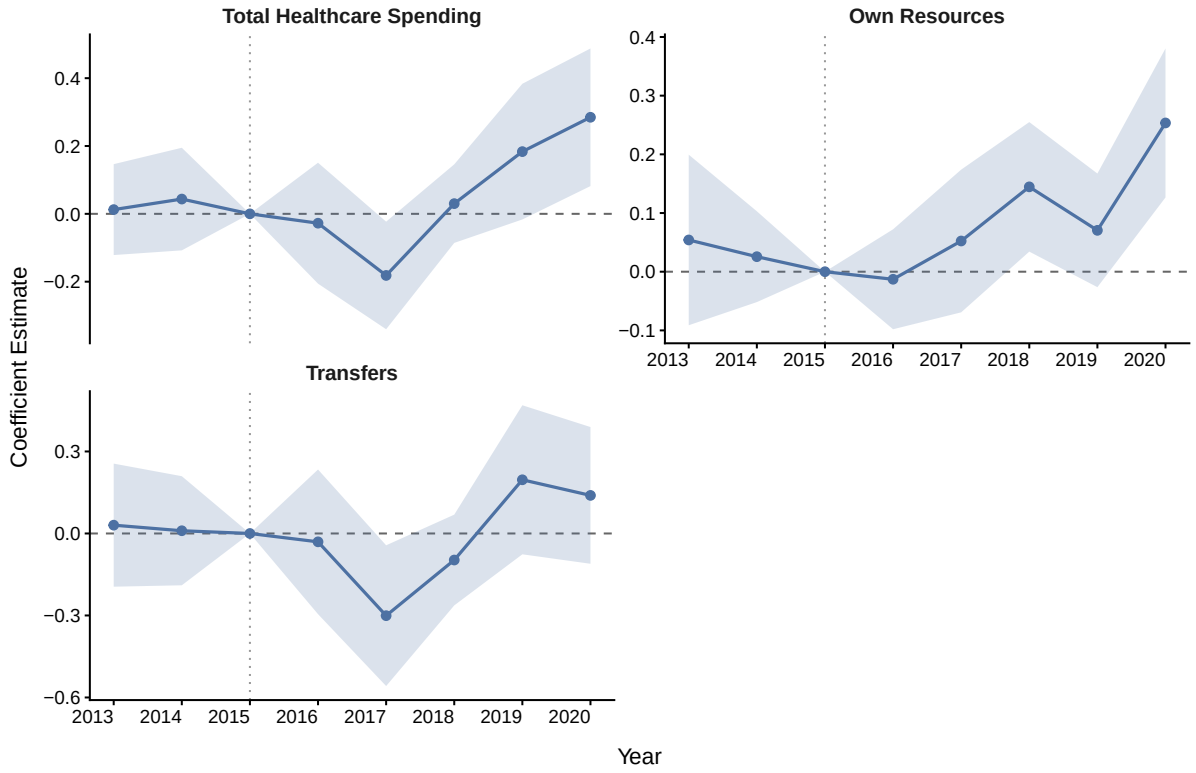

Figure A12: Event-study estimates of healthcare spending response (difference-in-differences)

Notes: This figure reports event-study estimates from a difference-in-differences specification comparing municipalities in Roraima (treated) to all other Brazilian municipalities (control), with 2015 as the reference year. The three panels show effects on total healthcare spending per capita (left), spending financed with own municipal revenues (center), and spending financed through federal and state transfers (right). All models include municipality fixed effects and state-by-year fixed effects. Control variables include private health insurance coverage, Bolsa Família spending per capita, and GDP per capita. Shaded areas represent 95% confidence intervals based on standard errors clustered at the municipality level. Outcomes are expressed in logs. Data sources: SUS-SIOPS (spending) and FINBRA (revenue).

Table A6: IV and DiD estimates: implied changes in health outcomes

		IV (per 1 pp migrant share)			DiD (Roraima vs. rest, post-2015)			
Outcome	Pre-crisis mean	$\hat{\beta}$	(SE)	% chg.	$\hat{\beta}$	(SE)	% chg.	Ratio
Mortality rate	393.80	0.042	(0.005)	4.3%	0.160	(0.073)	17.4%	4.0
Infant mortality rate	22.68	0.086	(0.027)	9.0%	0.044	(0.300)	4.4%	0.5
Birth rate	637.74	0.007	(0.002)	0.7%	0.277	(0.099)	31.9%	45.6
Hospitalization rate	314.73	0.027	(0.003)	2.8%	0.210	(0.168)	23.3%	8.3
ACSC mortality rate	116.52	0.029	(0.007)	2.9%	0.169	(0.087)	18.4%	6.3
ACSC hosp. rate	30.08	0.039	(0.002)	4.0%	0.008	(0.219)	0.8%	0.2
Avg. length of stay (days)	3.61	-0.031	(0.002)	-0.9%	-0.129	(0.171)	-3.6%	4.0
Bed occupancy rate (%)	26.89	0.619	(0.014)	2.3%	5.848	(3.028)	21.7%	9.4

Notes: IV estimates report the coefficient on Venezuelan student share (instrumented by distance to Pacaraima) from the preferred 2SLS specification for each outcome. DiD estimates report the *post* × *treated* coefficient from a two-way FE regression with Roraima as the treated group and 2015 as the treatment cutoff. Both specifications include municipality fixed effects, year fixed effects, and time-varying controls (private health coverage, Bolsa Família spending per capita, GDP per capita). The % change columns convert each estimate into an implied change relative to the pre-crisis mean. The final column reports the ratio of DiD to IV implied percentage changes and can be interpreted as the number of one-percentage-point IV exposure increases needed to generate an effect of similar economic magnitude under a local linear approximation. Pre-crisis mean is the 2013–2015 average for non-Roraima municipalities. Standard errors are clustered at the municipality level.

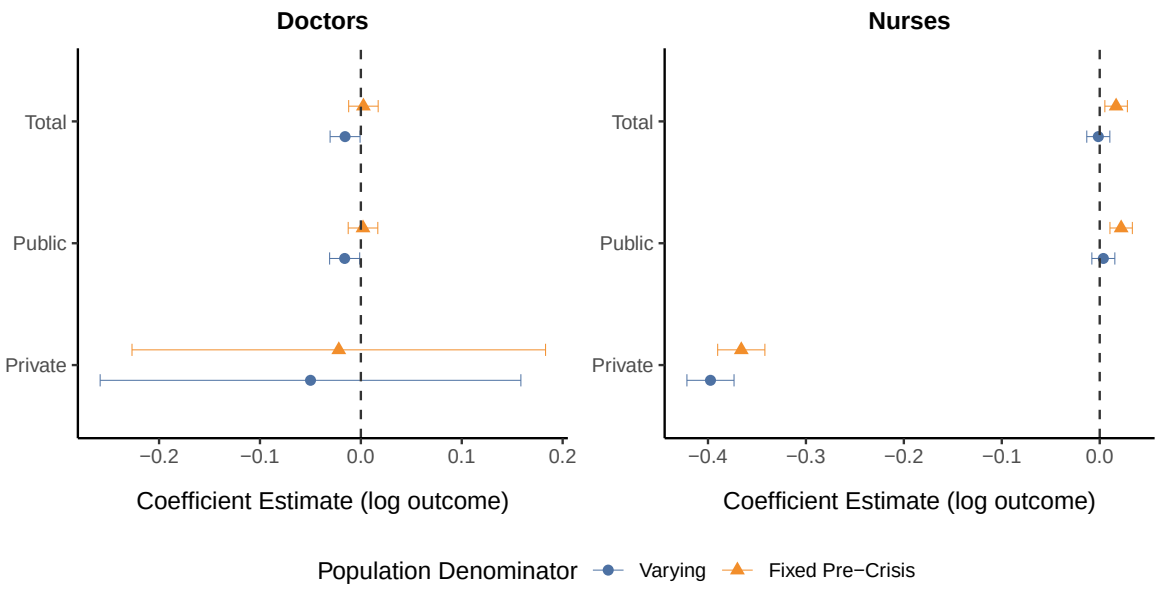

Figure A13: IV ESTIMATES OF HEALTHCARE STAFFING ON MIGRANT SHARE

Notes: This figure reports two-stage least squares (2SLS) estimates of the effect of Venezuelan migration exposure on municipal health staffing. We present results for doctors and nurses per 1,000 residents, split into *Total*, *Public (SUS)*, and *Private*. All models include municipality fixed effects and state-by-year fixed effects. Workforce composition variables are the outcomes here and are therefore not included as controls; models include private health insurance coverage, Bolsa Família spending per capita, and GDP per capita. as controls. Standard errors are clustered at the municipality level. Denominators use either the varying municipal population or the fixed pre-crisis population. Data source: CNES (staffing).

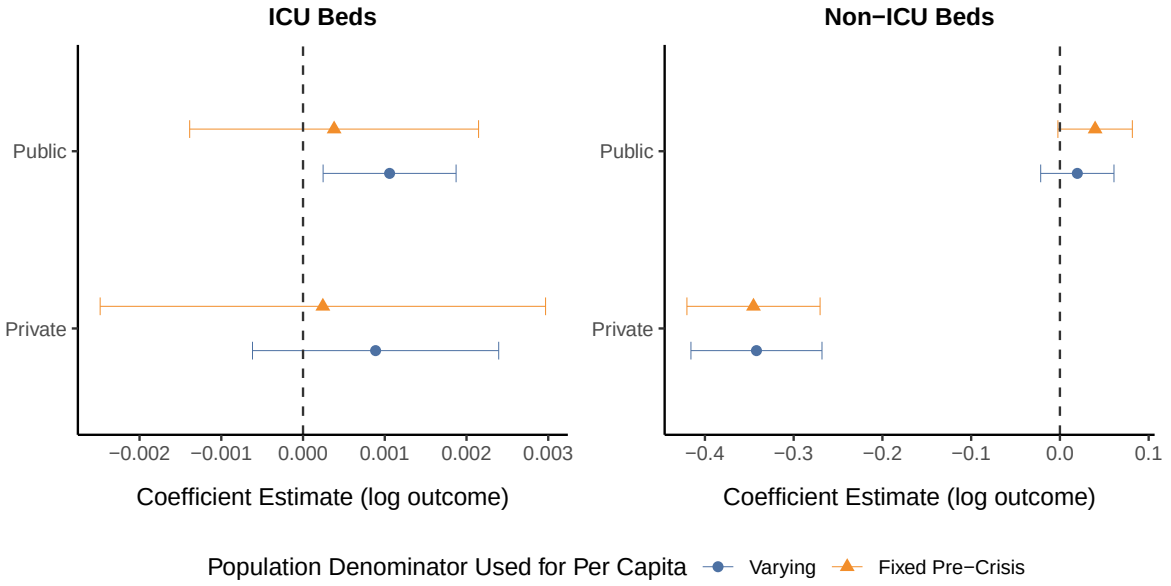

Figure A14: IV ESTIMATES OF PUBLIC AND PRIVATE HEALTHCARE INFRASTRUCTURE ON MIGRANT SHARE

Notes: This figure reports two-stage least squares (2SLS) estimates of the effect of Venezuelan migration exposure on the availability of public and private hospital beds. All models include municipality fixed effects and state-by-year fixed effects. For bed availability, these infrastructure variables are the outcomes and are therefore not included as controls; however, they enter as controls in hospitalization models elsewhere in the paper. Standard errors are clustered at the municipality level. All outcomes are expressed per 100,000 residents and transformed using the inverse hyperbolic sine (IHS) rather than the logarithm to accommodate zeros and small values. Denominators use either the varying post-crisis municipal population or the fixed pre-crisis population. Data source: CNES (hospital infrastructure).