Labor Market Effects of the Venezuelan Refugee Crisis in Brazil*

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Abstract

We use administrative panel data on the universe of Brazilian formal workers to investigate the labor market effects of the Venezuelan crisis in Brazil, focusing on the state of Roraima, where the crisis had a direct impact. The results, using difference-in-differences, show that the average monthly wage of Brazilians in Roraima increased by 3 percent compared to control states. This was primarily driven by a wage increase among those working in economic sectors and occupations with little to no involvement of refugees. Those involved in sectors and occupations with a higher share of refugees did not experience an adverse wage effect either. The study found negligible forced job displacement of Brazilian workers and evidence of them moving to occupations with fewer immigrant shares. We also find suggestive evidence that the presence of immigrants in the informal labor market offset the negative substitution effects in the formal market.

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1   Introduction

The humanitarian crisis in Venezuela, driven by the regime of Nicolás Maduro, has caused more than five million Venezuelans to flee their country. By the time this paper was written, Brazil received approximately a quarter million refugees (UNHCR, 2022), crossing the border every year at an increasing rate. Most of the refugees from Venezuela entered Brazil by land, using the only highway that connects the two countries through the Brazilian state of Roraima.

There is limited research on the potential diverse effects of the influx of Venezuelan refugees on labor market outcomes in the region. Due to data limitations, previous studies that analyzed aggregate outcomes found little evidence of an impact, particularly on wages. Our study aims to investigate the causal relationship between the refugee crisis and the labor market in the Brazilian state of Roraima, where the crisis had a direct impact. Roraima's geographical isolation from the rest of the country creates a natural experiment to examine this question. Using rich administrative data on the universe of formal Brazilian workers and a difference-in-differences approach, we compare Roraima to comparable states that did not experience the crisis. This allows us to examine potential wage and job displacement effects, taking advantage of the sociodemographic similarities among the populations in the region.

Our main findings show a small but significant positive impact on the average monthly wages of Brazilians living in the treated state. This was primarily driven by a positive wage change for those working in economic sectors and occupations with little involvement of refugees. Those involved in sectors and occupations with a higher share of refugees did not experience any significant change in wages following the crisis. We also find that the crisis did not displace Brazilians from their jobs and find evidence of them moving to occupations with fewer immigrant shares. These findings suggest that when not directly competing with native workers, Venezuelans acted as complements, increasing formal

labor market wages.

Survey data also reveals adverse effects on wages in the informal labor market. Based on the number of refugee status requests and the observations in our administrative data, we believe that many immigrants sought employment and may have found work informally, which although complemented the formal labor market, also negatively impacted the native wages of individuals in the informal labor market. This may also explain why we do not see any adverse effects in the formal labor market. For example, when we focus on the border municipality where many jobs are heavily based on manual tasks, and where there is a heavy presence of informal workers, we observe close to zero effects on wages, suggesting that any downward pressure on wages caused by Venezuelan immigrants in the formal labor market is offset by the presence of immigrants outside of it.

We contribute to the literature by providing further evidence of the effects of immigration conditional on market characteristics, specifically, the diverse effects by occupation type and economic sector. The deviation from the canonical approach to immigration is in line with Peri and Sparber (2009); Manacorda et al. (2012); Dustmann et al. (2013); Foged and Peri (2016), who argue that immigrants are imperfect substitutes to natives, have a potentially different skill set, and specializes with positive efficiency.

Refugees[1] comprise a distinct subset of immigrants due to their more vulnerable societal position. Unlike other immigrant groups, their displacement is mainly involuntary. In most cases, host countries for economic immigrants are high-income nations, whereas less-developed countries host nost of the world's refugees (Cortes, 2004; Taylor et al., 2016), primarily neighboring countries. For instance, Card (1990); Peri and Yasenov (2019); Clemens and Hunt (2019) found no significant results on the 1980 Mariel Boatlift from Cuba on Miami's wages, with Borjas (2017) arguing immigrants may act as substitutes when conditional on education level.

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[1] In the period of our study, the Venezuelans displaced by the crisis were virtually the only non-Brazilian population in the state of Roraima. Therefore, specifically for this paper, we refer to Venezuelan refugees as immigrants or foreigners, interchangeably.

Maystadt and Verwimp (2014) and Ruiz and Vargas-Silva (2016) measure the welfare of communities in Tanzania exposed to refugee camps, finding similar dynamics as our results, with refugees acting as complements and yielding positive effects. There is also evidence that the presence of a refugee camp near native settlements allows natives to benefit from favorable changes in food prices (Taylor et al., 2016), an increase in their employment (Alix-Garcia et al., 2018), and an improvement in capital and purchasing power of the local population (Cengiz and Tekgüç, 2022).

The more recent literature on the economic effects of refugees revolves around the Syrian and Venezuelan crises. For the Syrian refugee crisis, there is little evidence of the impacts in neighboring countries' labor markets (Tumen, 2016; Fallah et al., 2019; David et al., 2020). Studies on the Venezuelan exodus showed no significant effects on the labor market in Colombia (Bonilla-Mejía et al., 2020; Santamaria, 2020) and Ecuador (Olivieri et al., 2021). Bahar et al. (2021) study the labor market impacts of an extensive migratory amnesty program that granted work permits to nearly half a million undocumented Venezuelan migrants in Colombia in 2018. Their analysis indicates no significant impact of the program on hours worked, wages, or labor force participation of Colombian workers.

Ryu and Paudel (2022) addresses the crisis from the Brazilian perspective. Using a national quarterly household survey, they use a synthetic control method to study the labor market impacts of Brazilian refugees in Roraima, the affected state, finding that the crisis lowered labor force participation and employment rate in Roraima but did not find any effects on wages. We build upon the past study by employing a rigorous administrative panel dataset of the universe of formal workers in Brazil that allows us to distinguish between Brazilians and Venezuelans. It also allows us to use individual-level fixed effects to control for time-invariant unobservables and precisely distinguish our samples based on geographic location.

We organize the remainder of the paper as follows. Section 2 provides the background. Section 3 describes the data. Section 4 discusses our identification strategy and empirical

methodology. Section 5 presents the main results of our model. Section 6 explains our robustness checks based on event studies and placebo tests. Section 7 discusses the mechanisms through the immigrants are affecting native wages. Section 8 concludes.

2 Background

This section is divided into two parts. In the first part, we briefly overview the Venezuelan crisis. In the second, we explain the interaction between Venezuelan refugees and Brazilian labor market, highlighting the distinctions between formal and informal labor market.

2.1 The Venezuelan Crisis

The root causes of the Venezuelan humanitarian crisis are complex and multifaceted. Still, they can be broadly attributed to the decline in oil prices by the early 2010s, leading to political instability and economic collapse in the country. Venezuela heavily depends on oil exports (EIA, 2019; Haider, 2020). After a severe decrease in oil revenue, political instability plagued Venezuela. Hyperinflation and widespread shortages of food, medicine, and other necessities made it difficult for many people to meet their basic needs, forcing a mass exodus out of the country (Sequera, 2018; Bahar et al., 2021).

UNHCR estimated that as of 2022, more than four million Venezuelans are living as refugees, mostly in Colombia and Peru and in significant numbers in Brazil. As shown in Table A.1, the Brazilian Federal Police's border patrol reported that more than 50 thousand Venezuelans entered Roraima and stayed by 2017 (Lopes, 2018). This number corresponds to 8 percent of Roraima's total population. However, only a fraction is observed in the formal labor market. For this reason, we must assume that the causal effect of the refugee crisis on the Brazilian labor market is a composition of complementary and substitution dynamics due to the immigrants' specialization in certain formal labor market jobs, labor supply shock in the informal labor market, and labor demand caused by the

overall immigrant population shock.

Our study focuses on the early stages of Venezuelan immigration up until 2017. The analysis does not consider later years due to a state-wide crisis that hit Roraima in 2018. The crisis was triggered by a corruption scandal in the local government, which was exacerbated by the increasing influx of immigrants. The corruption scandal led to widespread disruption of public services, including the prison system, resulting in increased crime, prison escapes, a lack of healthcare services, and a general decline in the standard of living. This ultimately led to a federal government intervention in Roraima in December 2018.

2.2   Brazilian Labor Market

Mercosul (or Mercosur in Spanish) is an economic block comprised of South American countries, including Venezuela and Brazil. Members of the block are entitled to free entry, residency rights, and the ability to work in the host country's formal labor market, subject to government authorization. Recently, the Brazilian government has offered Venezuelan refugees a special status that accelerates their permission to work in the formal labor market. Venezuelan refugees must undergo a specific process and submit certain paperwork to obtain this status which takes at least several months.

In Brazil, any organization must have a Legal Person National Registry number (CNPJ) to operate legally. A Legal Person in Brazil is composed of one or more Physical Persons (individuals) generating a company or non-governmental organization. The entity's owners must declare its purpose and intended activity to the government. If an entity is not registered, it is considered informal. The costs associated with registering a company can be relatively high, leading to a higher prevalence of informality in poorer regions. Essentially, what determines whether a firm (worker) is formal or informal in Brazil is the presence of a Legal Person Registry Number, CNPJ (worker's registration with the Federal Revenue of Brazil, CPF).

Certain characteristics are specific to the formal market. According to Brazilian law, legal firms are only permitted to hire formal workers, a requirement often disregarded in impoverished areas such as Roraima. Registered means that both employers and employees are entitled to social security, and workers are entitled to certain rights that the employer must guarantee. Being a Legal Person also separates the company's responsibilities from those of its employees. Generally, workers in the formal market earn more due to these social benefits than their informal counterparts. However, employers may be at risk of labor lawsuits if they are caught hiring informal workers. According to estimates from the Brazilian Institute of Geography and Statistics (IBGE), approximately 60 percent of the workforce in northern states was in the formal labor market as of 2017 (Azeredo, 2019).

In conclusion, the labor market features in Brazil are an important factor to consider when analyzing the cost of entry for immigrants in the region. Compliance with Brazilian labor laws is a key determinant of whether a firm or worker is considered formal or informal. This can have significant implications for workers' wages and benefits. Furthermore, time was likely the main cost of entry for these Venezuelans to enter the formal job market, apart from language barriers. These factors suggest that immigrants may have sought income through the informal labor market after arriving in Brazil and before formal employment.

3 Data

Our primary dataset is the Annual Social Information Survey (RAIS), which is a panel dataset maintained by the Brazilian Ministry of Labor and Employment. RAIS contains the universe of the Brazilian formal labor market, comprising information on individual workers and establishments, including employment status, occupation, industry, and wages. It is used by researchers and policymakers to understand trends and patterns in the labor

market and to inform policy decisions related to employment and labor issues in Brazil. We focus on observations from 2007 to 2017. Our pre-treatment years are 2007-13, and the post-treatment period is 2014-17. We use this cutoff because the refugee crisis intensified in 2014 based on both the data and the journalistic accounts.

The Brazilian equivalent of a Social Security Number, CPF (Physical Person Registry), identifies unique persons and is present in the data. Gender, race, age or date of birth, education, and nationality are represented by a specific code in the data. We also observe workers' occupations and firms' economic sectors[2]. For occupation, we use the first 5 digits of the Brazilian Occupation Code (CBO), while for economic sector, we use the National Registry of Economic Activities (CNAE). Table A.2 presents all CNAE's categories.

When a contract is terminated between employer and worker, it shows in the data through two variables, the termination date and the termination nature, i.e., worker's initiative, employer's initiative, transfer, retirement, etc. If the worker retained their job during the full year, there is a zero or not-available value imputation for both variables. We also observe the worker's hiring date.

We restrict our analysis to individuals employed in the private sector as refugees are not expected to exert a direct impact on the labor market of public sector employees. Furthermore, we eliminate outliers in wage data by implementing a top-coding approach at the 99th percentile.

3.1   Summary Statistics

An advantage of our data over the Continuous National Household Sample Survey (PNAD-C) household survey used in past studies is the ability to observe the individual's nationality, allowing us to differentiate our sample between Brazilians and Venezuelans. The presence of refugees in our data means they are potential substitutes for natives in the for-

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[2]Throughout this paper, we use the term 'economic sector' to refer to the industry in which a firm operates, such as retail, construction, or restaurants. We use the term 'occupation' to describe the specific job title or role of the worker within that sector, such as janitor, accountant, or waiter.

mal market. One mechanism driving the substitution is the education level of the immigrant. If immigrants are willing to accept lower wages and have a clear education profile, for instance, the majority having a high-school diploma, we could see Venezuelans replacing similar higher-paid Brazilians. For this reason, we reserve this subsection to present the demographic characteristics of treated natives and immigrants in our data for 2017, the year with the most significant immigrant presence.

Table 1 compares natives and immigrants in the state capital. Wages are reported in local currency (2017's Brazilian real). In 2017, the national minimum wage was around one thousand Brazilian reais. Brazilians in the state capital earned, on average, roughly twice this value, with Venezuelans earning roughly half of their native peers. Brazilians and Venezuelans are at comparable ages in the formal market, around 30 and 34 years, respectively. Venezuelans in the capital are generally male, of mixed race, and with a high-school diploma. None of these qualities seem too far from Roraima's Brazilian citizens' profile. Comparing both sample sizes and the education level distribution, we can conclude that if any substitution effect occurs in Roraima due to immigration, we should expect that the most affected group is the native with completed high school or in related jobs.

Table 1: Summary statistics of Brazilians and Venezuelans in the capital (2017)

			Brazilian	Venezuelan
Average Monthly Wage		Mean	2200.98	1184.69
Age		Mean	34.32	30.57
Race	White	%	14.75	5.10
	Black	%	1.81	1.38
	Indigenous	%	0.48	0.21
	Mixed	%	69.93	58.77
	Not Declared	%	13.03	34.54
Sex	Female	%	43.55	26.57
	Male	%	56.45	73.43
Education	No High School	%	18.78	15.94
	High School	%	65.59	72.90
	College	%	15.63	11.16
N			45 275	941

The other area in Roraima affected by the immigrants is the border municipality of Pacairama. Table 2 presents Pacaraima's native-immigrant comparison. Its sample is considerably smaller than the capital, with only 135 natives and 13 immigrants present in 2017. However, the ratio of Venezuelans is higher than in the capital, with 8.7 percent of the formal workers comprised of Venezuelans compared to 2 percent in the capital municipality. It is also worth noting that Venezuelans in the capital and the border are not particularly different, with the majority possessing a high-school diploma.

Table 2: Summary statistics of Brazilians and Venezuelans in the border municipality (2017)

			Brazilian	Venezuelan
Average Monthly Wage		Mean	1419.65	1131.68
Age		Mean	33.42	25.85
Race	White	%	19.26	0.00
	Black	%	0.74	0.00
	Indigenous	%	0.74	0.00
	Mixed	%	74.81	84.62
	Not Declared	%	4.44	15.38
Sex	Female	%	44.44	30.77
	Male	%	55.56	69.23
Education	No High School	%	8.15	0.00
	High School	%	82.96	92.31
	College	%	8.89	7.69
N			135	13

Another noteworthy particularity of Pacaraima is that its residents earn much less than their capital's counterpart on average almost at the same level as the immigrant. This suggests that Brazilian and Venezuelan occupations are highly heterogeneous conditional on their location. In the capital, there is a larger array of job types, allowing natives to seek jobs with less intensive manual labor, or "low-skilled jobs". At the border, job occupation is "flatter", making both nationalities compete more directly, given Venezuelans generally occupy jobs not requiring college degrees. We provide more details regarding occupations in Roraima in our mechanism section.

4 Methods

In this section, we discuss the identification strategy and the empirical strategy used to analyze the labor market impacts of the Venezuelan refugee crisis in Roraima, Brazil. The identification strategy section highlights the geographical setting of the natural experiment, while the empirical strategy section explains the econometric models used to estimate the causal effects.

4.1 Identification Strategy

The geographical setting is crucial for our identification strategy. As shown in Figure 1, Venezuela borders the Brazilian states of Amazonas and Roraima, but the Amazon rainforest, mountains, and rivers make it impossible to enter Brazil through Amazonas by land. There are no viable roads, and it would be unreasonable for refugees to undertake such a perilous journey. Venezuelans are permitted to enter Brazil, so they do not need to travel through impassable Amazonas.

Instead, people can enter Brazil from Venezuela through the state of Roraima. The BR-174 highway, represented by the vertical solid line traversing Roraima and Amazonas in Figure 1, is the only land transportation route between the two countries, which runs through Roraima starting at the Venezuelan border. This makes Roraima a key transit point in Brazil, but once refugees are in Roraima, they can only practically go as far as Amazonas by land. To reach larger coastal cities, they would need to use air routes. Therefore, Roraima is isolated from the rest of the northern states which leads many refugees to choose to enter and stay there.

This setting provides a natural experiment in which Roraima acts as the treated group. For our control group, we use states that share similar socio-geographical characteristics and are located on the Brazilian border: Acre and Amapá. Acre borders Peru and Bolivia, while Amapá borders Suriname and French Guiana. Like Roraima, these states also have

a large portion of their population concentrated in their respective capital cities and are relatively isolated. In particular, Amapá has no inland connection to the rest of Brazil and can only be reached by airplane or boat crossing the Amazon hydrographic basin to reach its capital, Macapá.

Figure 1: Map of Venezuela and Brazil's North Region
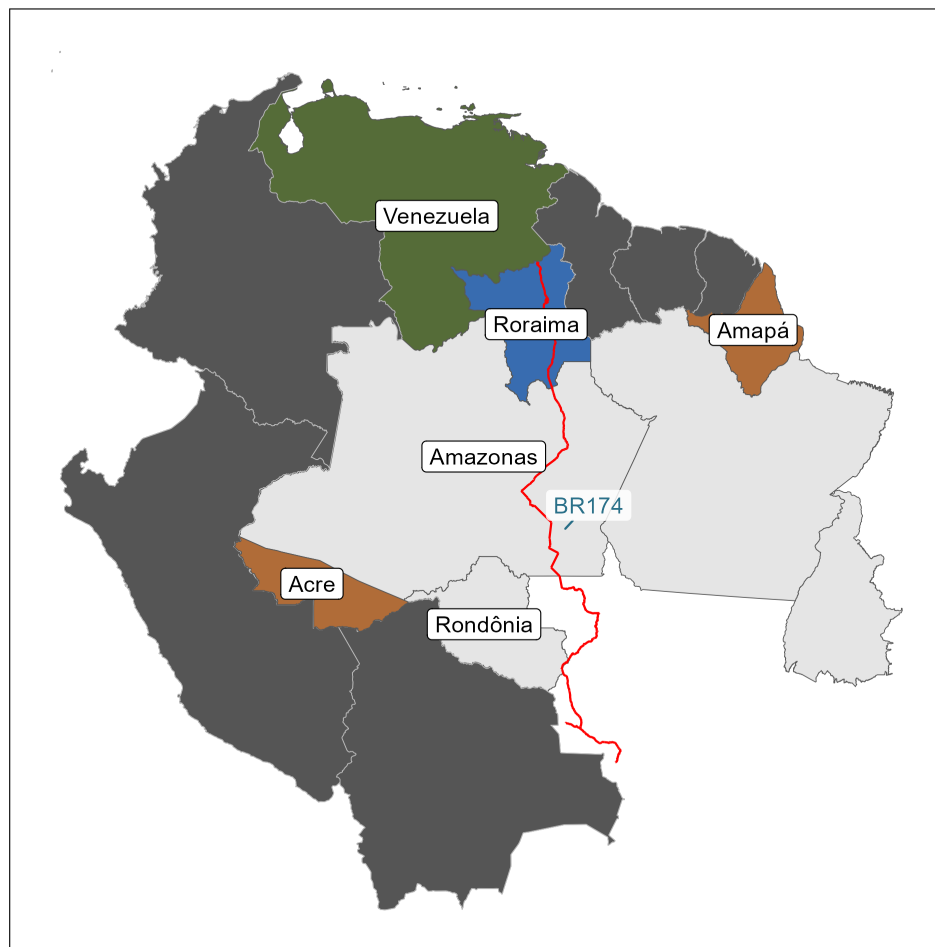
As per Borjas et al. (1997); Borjas (2003, 2006), it may be difficult to accurately assess the impacts of immigration on the labor market by considering geography alone due to the potential for spillover effects across regions. However, in our case, Roraima is isolated with high transportation costs, which limits the mobility between states or even within

municipalities in the same state. Even so, we address the potential issue of Brazilians moving from Roraima to control states after the refugee crisis, which may bias our estimates. As we explain later, we include an interaction between the individual fixed effects and the corresponding municipality, as proposed by Foged and Peri (2016) to estimate the effects of within-municipality changes in wages, devoid of the mobility effects of a worker moving away from the treated state due to the crisis.

4.1.1 Foreign Presence in RAIS

A key assumption of our paper is that refugees were not attracted to high-growth regions, but ended up in Roraima due to its geographical isolation and high transportation costs to move to cities farther from the border. To verify this, we can use the RAIS data to check the location of Venezuelan refugees in our sample. We can also examine wage trends before the crisis to confirm that Roraima's growth trend was not significantly different from the control regions, which we explore in the following subsection. Figure 2a shows the percentage of Venezuelans in the labor market anually, grouped by treatment and control states. In 2017, Venezuelans represented around 2 percent of Roraima's formal labor market, while none were observed in Amapá or Acre. Figure 2a supports our assumption by demonstrating that Venezuelans largely remained in Roraima.

It would be problematic for our experiment setting if any other nationality besides the Venezuelans had a substantial growth in population, either in Roraima or the control states. To ensure that the exponential growth of foreigners we observe is because of the Venezuelan refugees, we create Figure 2b by aggregating data on all immigrant nationalities other than Venezuelans and plotting their proportion in the formal labor market. As the figure shows, there is no significant growth in the control states and only negligible growth in Roraima following 2014. The non-zero values we observe for non-Venezuelan immigrant nationalities can be attributed to several factors. First, there is a significant presence of Haitian immigrants in control states due to United Nations peace operations

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(a) Venezuelans as % of Labor Market   (b) Other Foreigners as % of Labor Market
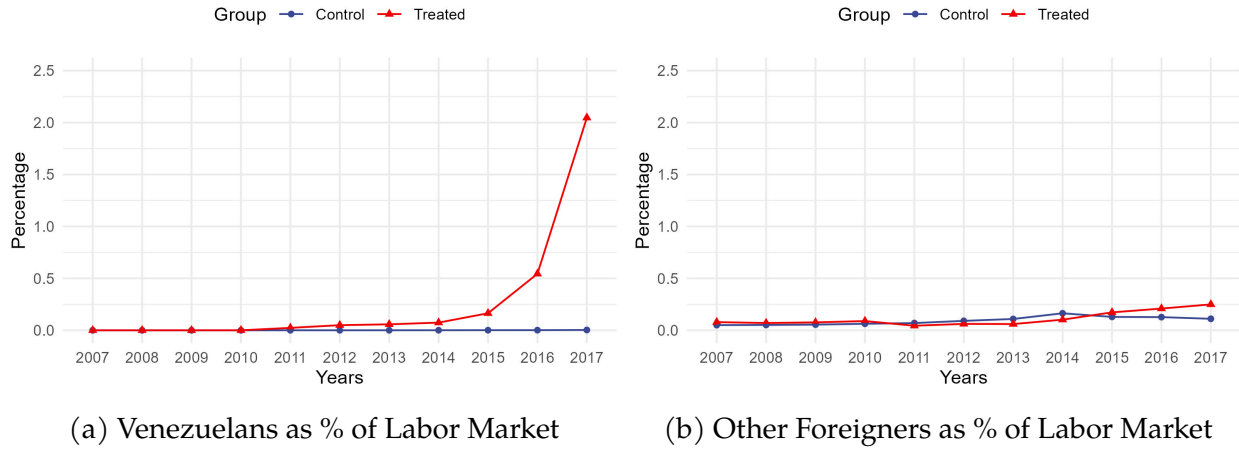
Figure 2: Proportion of non-Brazilians in the formal labor market for Roraima and the control states

in Haiti that began in the 2000s and remained constant over the study years. Second, there are observations of other Latin American and Bolivian nationals in the data in control states due to the proximity of Acre to Bolivia and the resulting natural population exchange. Finally, some of these foreigners may be Venezuelans with dual citizenship, as they only appeared in Roraima after the crisis began, as Figure 2b shows. Since there is no incremental change in these populations in either treatment of control, the non-zero values should not pose a threat to our identification strategy.

Although the RAIS data provides a good overview of Venezuelans entering Brazil and remaining in the state of Roraima, it only includes those in the formal labor market. It could compromise our identification strategy if the control states also had many Venezuelan refugees outside the formal labor market. In Appendix B, we use refugee application data to demonstrate that this is not the case. We show that only Roraima, not the control states, experienced a significant increase in the number of Venezuelan citizens seeking refugee status applications.

4.2 Empirical Strategy

To empirically test the effects of Venezuelan immigration on Brazilian wages, we use a panel model with unit and time fixed effects. Our period of interest is from 2007 to 2017, with 2014 as the start of our treatment period. Equation 1 describes the model:

$$(1) \quad y_{ist} = \beta D_{st} + f(X_{it}) + \theta_u + \alpha_t + \epsilon_{ist}$$

Here, y_{ist} is the logarithmic wage of native individual i in a state s and year t. D_{st} is the indicator variable that takes the value one if the observation is from Roraima state and the year is after 2013. θ_u is the unit fixed effects, α_t is the year fixed effect, and ϵ_{ist} is the error term clustered at the state level. $f(X_{it})$ is a function of covariates allowed to be linear in our model. Covariates are individual characteristics observed in our data: gender, race, age, and education level. Our primary parameter of interest is β, which explains the average effect of the Venezuelan refugee crisis on wages among the Brazilian citizens in Roraima.

The unit fixed effects, θ_u, either take the form of individual fixed effects, θ_i, or individual-municipality fixed effects, $\theta_{i,m}$, where m is the municipality in RAIS. Specification using individual fixed effects portrays the classic panel fixed effects estimation based on the within-individual variation. Following Foged and Peri (2016), the coefficient from the specification using individual-municipality fixed effects, on the other hand, estimates the effects of refugee influx on outcomes of native workers within their municipality spells. Despite the fact we addressed the possibility of immigrants moving around in our identification strategy, natives could be moving to other locations within and outside Roraima after the immigration shock to seek better opportunities, offsetting effects in the long run. If natives remained in place, however, we should not see systematically different estimates between the two approaches.

5   Main Results

In this section, we present the main results of our paper. In the first set of regressions using Equation 1, we explore the immigrants' formal labor market wage effects on Brazilians in the state of Roraima and its capital municipality, Boa Vista.

Table 3 reports our coefficient of interest, β, representing the returns on wages by being in Roraima after the Venezuelan crisis. Column (1) represents our model's result for the state using individual and year fixed effects. On average, Roraima experienced a 3 percent increase in wages after the exodus. Adding the covariate matrix of demographic characteristics in Column (2), there is a negligible decrease in the effect, with its overall magnitude still around the same value as the previous measurement.

Column (3) shows results from the model using individual-municipality fixed effects. If results in Column (3) were different in magnitude or precision from Columns (1) and (2), it would indicate that our geographical isolation assumption was incorrect, given the mobility of Brazilians away from Roraima, and our identification strategy would ultimately generate bias in our measurements. However, Column (3) reveals no distinction between adding the municipality component or leaving it aside, suggesting individuals in our data did not move before and after the shock.

Column (4) uses the same model as Column (2), with the covariate matrix, and individual and year fixed effects. However, we balance the panel data by removing observations with no corresponding time counterfactuals. To balance the RAIS sample, we counted only those Brazilians who appeared in the post-treatment period and worked at least one year before 2014. Any native that worked only in the pre-treatment or the post-treatment was removed. Even with this conservative sample, the result was of similar magnitude at around a 3 percent increase in wages after the crisis compared to the control groups.

The first four columns of Table 3 represented the states' sample, including all munic-

Table 3: Venezuelan Immigration Effects on Wage in Roraima and its Capital

| | Log Wage | | | | | | |
| | State | | | | State Capital | | |
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Roraima After 2013	0.031***	0.029***	0.029***	0.030***	0.031***	0.029***	0.030***
	(0.007)	(0.006)	(0.006)	(0.007)	(0.008)	(0.007)	(0.007)
Individual FE	X	X		X	X	X	X
Individual x Municipality FE			X				
Year FE	X	X	X	X	X	X	X
Covariates		X	X	X		X	X
Balanced Panel Data				X			X
N	1 898 671	1 898 671	1 898 671	1 308 633	1 581 011	1 581 011	1 071 988

[1] Standard-errors are clustered by state.

[2] Covariates are individual's race, age, age-squared, gender, and education level.

[3] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

ipalities. But Boa Vista, Roraima's capital, accounts for 90 percent of the labor market. Moreover, it is right on Highway BR-174. As confirmed by the data when we combine Figure 3 with Table 1, the vast majority of Venezuelans are located there, also confirmed by journalistic accounts. Accordingly, if we expect the state effects observed in our regressions to be due to the immigration crisis, we should also expect similar results when solely sampling the capitals.

To see this, we redo the analysis using the sample from only the state capitals. Column (5) uses the model with individual and year fixed effects, column (6) adds the covariate matrix, and column (7) uses the balancing framework we used for Column (4). The results are similar to the previous analysis, with a magnitude of around 3 percent.

Our findings indicate that immigrants acted as complements rather than substitutes to the Brazilian formal labor market workers, pushing their wages upwards. We dedicate the remainder of the paper to testing the robustness of these main results and disentangling mechanisms. From now on, we will primarily focus on the capital sample unless stated otherwise.

6 Robustness Checks

In this section, we present the event studies and placebo tests to ensure the robustness of our findings.

6.1 Event Studies

A key assumption of our study is that in the absence of treatment and conditional on individual controls and individual-year fixed effects, the likelihood of wage changes over time in treated and control states would be identical. While we cannot test the counterfactual in post-treatment years, the pre-treatment trends between the treated and control for the outcome variable should be parallel over time.

To test the assumption of parallel trends, we employ an event study where β is disaggregated for every year present in the data. The reference year for comparison is 2013, the year before the treatment started. The estimation strategy is given in Equation 2, where the indicator function D_{st} now takes a separate value for each year within the summation. β_t explains the average difference between treatment and control groups for that particular year conditional on controls and fixed effects.

$$(2) \quad y_{ist} = \sum_{\substack{t=2007 \\ t \neq 2013}}^{2017} \beta_t D_{st} + f(X_{it}) + \theta_i + \alpha_t + \epsilon_{ist}$$

If control and treated groups are comparable before treatment, then $\beta_t = 0$ for $t \in \{2007, \ldots, 2012\}$. Assuming the only disturbance in Roraima's job market after 2013 is the immigration flow, any variation in the post-treatment period estimates in treatment must be associated with the refugee crisis. We conduct event study analysis at both the state and capital levels. Desirably, effects after 2014 should be positive and slightly increasing.

The event study results for the state and the capital are plotted in Figure 3a and Figure

respectively.

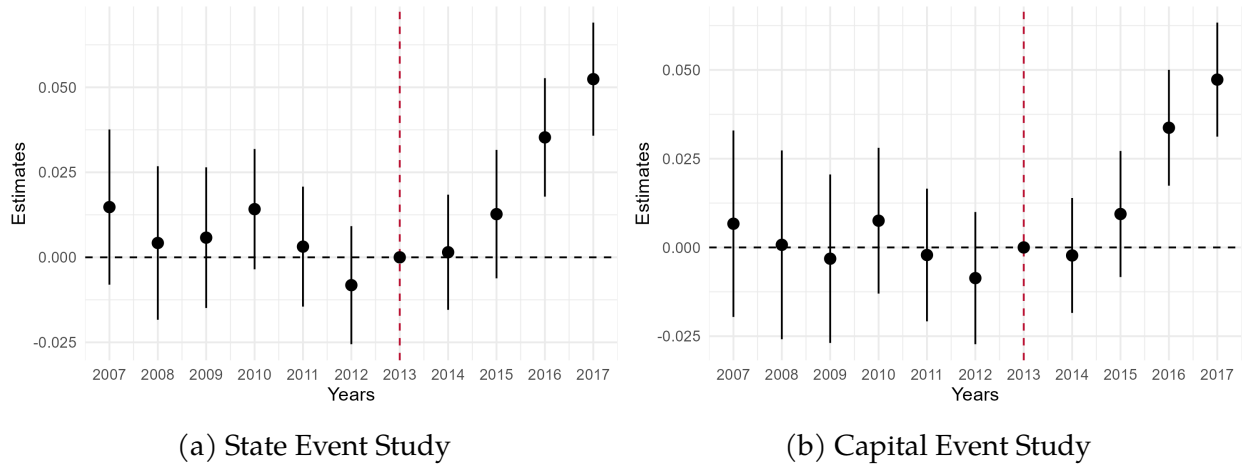(a) State Event Study (b) Capital Event Study

Figure 3: Event Study Graphs

Both the results related to the state and capital analysis reveal parallel trends in earlier years. They yield pre-treatment estimates not statistically different from zero, with an increasingly upward trend in post-treatment periods. This suggests the difference-in-differences model captured the positive effect of Venezuelans, allowing Brazilians, on aggregate, to increase their wages.

Figure 3a shows that after the crisis started, natives experienced a 3.6 percent wage increase in 2016 on average and a 5 percent increase in 2017, compared to the control states. As shown in Figure 3b, the pattern is similar for the capital municipality. An overwhelming percentage of the population in our study states reside in capital municipalities. Thus, the capital makes up a larger part of the state economy and absorbs most of the economic shock.

The event studies corroborate the argument that immigrants complement the native formal workers. However, several potential channels are driving this effect. First, we do not observe the informal labor market in the RAIS data. Immigrants seeking refugee status potentially work informally while they wait for the bureaucracy to receive a work permit. If our assumption is valid, there would be a significant presence of Venezuelans in the informal market. These individuals will positively affect wages assuming the informal

labor market is an imperfect substitute for the formal labor market. The second channel is the Venezuelan in RAIS complementing the native worker occupying jobs in different positions. Also, natives could shift to less manual-intensive jobs and increase their wages. Lastly, as suggested by Bodvarsson and Van (2006), the new population can create a labor demand shock. We devote Section 7 to disentangle the underlying mechanisms driving these effects.

6.2 Placebo Tests

Another concern regarding our findings is whether our results are driven by random effects or some particular effects happening in the control group. We conduct two placebo tests to ensure the estimated parameters are closely related to immigration shocks. The first is using the capital of Rondônia, Vila Velha, as the treatment unit. Rondônia is another bordering state in the Brazilian North region, connected to Bolivia. Results are shown in Table 4.

Table 4: Placebo Test Results using Rondônia as Treatment

| | Log Wage | | | |
| | Placebo State Capital | | | |
	(1)	(2)	(3)	(4)
Treated	−0.002	−0.004	−0.006	−0.004
	(0.011)	(0.010)	(0.010)	(0.008)
Individual FE	X	X		X
Individual x Municipality FE			X	
Year FE	X	X	X	X
Covariates		X	X	X
Balanced Panel Data				X
N	2 155 167	2 155 167	2 155 167	1 443 895

[1] Standard-errors are clustered by state.

[2] Covariates are individual's race, age, age-squared, gender, and education level.

[3] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

We follow the same model framework of our state analysis. Column (1) presents the results using individual and year fixed effects, revealing a negative 0.2 percent change in wages but which is not statistically significant. Adding covariates in Column (2) does

not change the outcome, still yielding imprecise values. Column (3) uses the interacted individual-municipality fixed effect. Any variation in results while using this specification could be attributed to Rondônia's higher population density and more connected municipalities. Nevertheless, it still presents negligible results. Lastly, Column (4) uses the balanced panel data, yielding similar results.

Second, we compare individuals from the two control states with one another. If Roraima is the only state affected by the refugee crisis, then there should be no differential effects on wages between the control states. This is what we find in Table D.1. The change in wages is neither statistically nor economically significant.

The two placebo tests suggest that the effects observed in our main results are driven by particularities found in Roraima, and not by random effects in the placebo or control groups.

7   Mechanisms

There are three main channels through which immigration could positively affect the formal labor market wages in Roraima. We list them below sorted by the decreasing strength of our measurement conditional on data quality.

1. Immigrants in the formal labor market can affect wages by substituting for certain native jobs and complimenting others. However, the complementary effects are stronger than the substitution effects, resulting in an overall positive change.

2. Immigrants working informally outside the formal market can increase wages through complementarity.

3. The presence of the immigrant population as a whole can increase native wages by boosting consumption and labor demand.

7.1   Job Displacement of Native Workers

The mechanisms listed above are based on the assumption that our main results do not suffer from selection bias. It is possible that the sample of native workers is different between pre- and post-treatment periods because of job displacement of Brazilians by the incoming Venezuelans, who are comparatively less educated and willing to accept lower wages. In that case, it would create an upward bias on Brazilian wages.

While RAIS data does not allow us to estimate (un)employment effects since it only captures information on those working in the formal labor market in a particular year, we utilize the RAIS dataset to conduct a series of regressions that examine the impact of the crisis on the displacement of native individuals from their job. Specifically, we construct a binary variable that captures changes in employment status related to dismissals. Individuals who maintain their employment throughout the year are coded as 1, while those who experience a change in status are coded as 0. Essentially, a positive coefficient would suggest that job retention in Roraima is higher on average than in the control states following the crisis, while a negative coefficient would suggest that job displacement is higher in Roraima. The categories of dismissal considered in this analysis include termination by the employer, layoff by the employer, voluntary departure by the employee, transfer, and retirement.

We utilize this binary variable as the outcome in our regression analysis, as outlined in Equation 1. This analysis aims to estimate the linear probability of native individuals in Roraima retaining their employment in the wake of the Venezuelan crisis.

Table 5 shows the results of this analysis. Columns (1) and (2), using the sample where we do not account for counterfactuals, show that the probability of job retention (or job displacement, for that matter) for Brazilians was similar between treatment and control groups. In columns (3) and (4), we balance the sample by including individuals who were observed working during the entire pre-treatment period (2007-2013), tracking if

Table 5: Employment Retention among Brazilians in Roraima

	Probability of Job Retention			
	Unbalanced Sample		Balanced Sample	
	(1)	(2)	(3)	(4)
Treated	0.001	0.002	−0.014	−0.012
	(0.040)	(0.040)	(0.060)	(0.060)
Individual FE	X	X	X	X
Year FE	X	X	X	X
Covariates		X		X
N	2 498 772	2 498 772	161 259	161 259

[1] Standard-errors are clustered by municipality.
[3] Covariates are individual's race, age, age-squared, gender, and education level.
[3] Balanced Sample includes only individuals working in immigrant occupations for the entire pre-treatment period.
[4] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

they ever changed their status after the crisis. This procedure yields a negative 1.4 percent on average job displacement. However, variations are sufficiently high not to reject the null hypothesis, allowing us to conclude there is no evidence of formal displacements due to the immigration shock.

7.2 Mechanisms in the Formal Labor Market

Now that we have established that there is no evidence of job displacement among Brazilians due to the crisis, we explore the mechanisms that lead to wage increases in the formal labor market. Economists often consider that immigration is not evenly balanced across groups of workers. For example, if high school graduates are the majority of immigrants, they potentially compete with native high school graduates, but not necessarily with individuals holding a college degree (Card, 2005, 2009; Borjas, 2017; Llull, 2018). Another dimension is occupation, wherein immigrants tend to occupy manual-intensive or low-skilled jobs (Foged and Peri, 2016), which could increase the efficiency of the market and

allow the overall average wages to grow.

7.2.1 Effects by Education Level

Our sample does not have a meaningful contrast in education among natives and immigrants. Still, there is no employment displacement although the immigrant wages are significantly lower. Hence, the question of whether there are any meaningful wage substitution effects through education cohorts arises.

We focus on the state capital sample, dividing it into three education cohorts: college-educated, high-school-educated, and low-education, or those with less than high school education. We again employ the model represented in Equation 1. Results are shown in Table 6.

Table 6: Education Results

	Log Wage								
	Education Level								
	Low Education			High School			College Degree		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Treated	0.029**	0.029**	0.050***	0.018**	0.015*	0.027***	0.028***	0.033***	0.033***
	(0.011)	(0.011)	(0.011)	(0.008)	(0.008)	(0.007)	(0.010)	(0.010)	(0.010)
Individual FE	X	X	X	X	X	X	X	X	X
Year FE	X	X	X	X	X	X	X	X	X
Covariates		X	X		X	X		X	X
Balanced Panel Data			X			X			X
N	725 586	725 586	139 405	1 512 687	1 512 687	442 464	230 692	230 692	99 664

[1] Standard-errors are clustered by municipality.
[2] Covariates are individual's race, age, age-squared, gender, and education level.
[3] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Columns (1), (2), and (3) show the results for the low education sample, Columns (4), (5), and (6) represent the high school sample, while Columns (7), (8), and (9), represent the college-educated sample. Results for low education and college-degree natives, the two groups underrepresented by Venezuelans, reveal that after the crisis, they experienced on average 3 percent increase in wages. If we balance the panel data by only keeping

individuals with counterfactuals, results for low-education individuals increases to 5 percent.

Results for high-school individuals are slightly lower in magnitude and less precise, at around 2 percent. This education level corresponds to 72 percent of all Venezuelans in Roraima's RAIS. We could assume these weaker results are due to the Venezuelan presence, however, we still observe significant positive results, implying that if substitution effects exist at all, they are being offset by other effects. We are aligned with Card (1990) and Clemens and Hunt (2019) where we do not see any negative effects for low-education or high-school individuals in the labor market. Moreover, the wage increase in the aggregate market suggests immigrants acted as a complementary workforce elsewhere, not necessarily inside the formal labor market.

7.2.2 Effects by Economic Sector and Occupation

A direct approach to test if immigrants inside the formal labor market had effects on wages, independent of education cohorts, is to explore the channels of occupation and related economic sectors.

Our first analysis consists of creating a variable measuring the Venezuelan-Brazilian ratio in a given set of firms based on economic sectors. We then sample the native workers based on the percentile of this ratio. We consider economic sectors with high immigrant concentration with a ratio above the 75th percentile, and, likewise, under the 25th percentile for low concentration.

At first glance, immigrants observed in RAIS allocated themselves to firms requiring more manual labor. These areas were, among others, retail sales, restaurants, construction, agriculture, transformation, copiers, and veterinary. The ones not related were, among others, finance, insurance, telecommunication, research, pharmaceutics, and entertainment. The generated samples' regression results are shown in Table 7.

Columns (1), (2), and (3) present results for the 75th percentile and above. They were

Table 7: Effects by Firm Economic Sector Conditional on Immigrant Presence

	Log Wage					
	High Immigrant Presence			Low Immigrant Presence		
	(1)	(2)	(3)	(4)	(5)	(6)
Treated	0.007	0.004	0.011*	0.057***	0.061***	0.067***
	(0.009)	(0.008)	(0.006)	(0.018)	(0.018)	(0.016)
Individual FE	X	X	X	X	X	X
Year FE	X	X	X	X	X	X
Covariates		X	X		X	X
Balanced Panel Data			X			X
N	674 817	674 817	283 447	77 010	77 010	42 949

[1] Standard-errors are clustered by municipality.
[2] Covariates are individual's race, age, age-squared, gender, and education.
[3] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

close to zero for our unbalanced data and at 1.1 percent when using the balanced version, failing to reject the null hypothesis at a 5 percent confidence interval. Contrarily, for economic sectors falling in the lower 25th percentile in terms of immigrant presence showed, on average, a 6 percent increase in wages after the Venezuelan crisis.

These measurements suggest heterogeneity across economic sectors when we condition on immigrant presence. Another direct approach to investigate the role of Venezuelans in the formal labor market is to sample based on workers' occupation instead of firm's economic sector, using the RAIS variable that describes their responsibilities at a job. We used the same percentile procedure as before with a slight variation. We first separated occupations where we did not observe foreigners in our data. Then we run our regressions on three samples. The first sample corresponds to individuals in the immigrant presence ratio at the 75th percentile and above, conditional on occupations where we observe immigrants. The second sample is any occupation we observe at least one Venezuelan working. Finally, the third sample is all individuals without immigrants in their occupations.

We also use the description of these occupations to assign if they are related to manual

labor. For occupations where no immigrants were observed, 51.5 percent can be considered manual. When we count the immigrant occupations, this percentage jumps to 81.8 percent. The 75th percentile cohort yields 90 percent of manual labor. Venezuelans in our data were generally cashiers, technicians, bakers, car mechanics, waiters, receptionists, painters, and others. Although we observe similar jobs in non-immigrant occupations, there was a considerable number of directors, managers, engineers, doctors, professors, etc.

The immigration wage effect regressions based on these samples are shown in Table 8.

Table 8: Effects by Worker Occupation Conditional on Immigrant Presence

	Log Wage					
	High Presence		Any Presence		No Presence	
	(1)	(2)	(3)	(4)	(5)	(6)
Treated	0.014	0.012	0.017*	0.013	0.034***	0.039***
	(0.010)	(0.010)	(0.009)	(0.009)	(0.009)	(0.009)
Individual FE	X	X	X	X	X	X
Year FE	X	X	X	X	X	X
Covariates		X		X		X
N	76 306	76 306	1 826 859	1 826 859	604 715	604 715

[1] Standard-errors are clustered by municipality.
[2] Covariates are individual's race, age, age-squared, gender, and education.
[3] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Columns (1) and (2) show the estimated effect on native wages of high immigrant concentration occupations. Columns (3) and (4) present the estimated effect on native wages in any occupation with observed immigrants. Columns (5) and (6) show the estimated effect on native wages of occupations with no immigrant presence.

These results suggest that the aggregate market's observed positive effects survive similarly to our economic sector analysis. Specifically, occupations with a high concentration of immigrants experienced on average a 1.3 percent increase in wages. In comparison,

occupations with any concentration of immigrants saw a slightly higher increase of 1.7 percent, 1.3 when controlling for covariates. In contrast, occupations with no immigrant presence had the highest wage growth at 3.5 percent, statistically significant at 1 percent.

Combining the last three sets of results gives us a better picture of what happened in Roraima: immigrants arrived, driving general wages up, likely due to labor demand and workers outside formality. However, individuals who could penetrate the formal labor market put downward pressure on native wages. This was not conditional on similar education levels solely, but directly on types of occupations and economic sectors.

7.2.3 Mobility across Occupations

We can further investigate the substitutability of formal immigrants by examining the job changes of native workers in response to immigration. This is similar to the approach taken in Foged and Peri (2016), which assumes that refugees entering the labor market took on manual-intensive jobs, potentially allowing native workers to shift into other occupations. By looking at the degree of job displacement inside the formal labor market, we can better understand whether immigration led to market efficiency changes.

To analyze the effects of immigration on native workers' job choices, we created a binary variable to indicate whether an individual in a high-immigrant occupation ever changed their occupation to a low (or no) immigrant position. We used this variable as the dependent variable in Equation 1 and present the regression results in Table 9. They correspond to a linear probability measurement of an individual being a "mover" from immigrant occupations to non-immigrant ones, between treatment and control groups.

To perform our analysis, we used two versions of the data. The first version includes all observations from the treated and control groups, while the second version is more conservative, only including individuals who consistently worked in non-immigrant occupations during the pre-treatment period. Columns (1) and (2) in the table represent the results for the first data sample, while Columns (3) and (4) represent the results for

Table 9: Occupation Mover Analysis

	Probability of Moving			
	Unbalanced Sample		Balanced Sample	
	(1)	(2)	(3)	(4)
Treated	0.005*	0.004	0.139***	0.123***
	(0.003)	(0.002)	(0.035)	(0.034)
Individual FE	X	X	X	X
Year FE	X	X	X	X
Covariates		X		X
N	1 594 710	1 594 710	23 553	23 553

[1] Standard-errors are clustered by municipality.
[2] Covariates are individual's race, age, age-squared, gender, and education level.
[3] Balanced Sample includes only individuals working in immigrant occupations for the entire pre-treatment period.
[4] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

the second sample.

The values of the first two columns indicate that, overall, there was little net change in job occupations. However, examining the conservative sample shows a significant increase in the probability of changing to a non-immigrant-related job occupation of approximately 13 percent. It is reasonable to assume that the actual effect of immigrants, who have a relatively low representation in the formal labor market on job changes lies around this value.

Moreover, our analysis in Appendix C indicates that the results of our border municipality analysis were inconclusive. Since 90 percent of occupations in the border municipality of Pacaraima involve manual tasks, immigrant workers in formal employment may have substituted for native workers with low skill levels in some sectors, but complemented native workers in other sectors. However, Pacaraima did not have sufficient opportunities in these sectors to benefit from these dynamics.

7.3 Effects in the Informal Labor Market

Our analysis so far has demonstrated that the overall market experienced positive effects during the immigration crisis. Additionally, we found that only individuals not directly involved in occupations or economic sectors with sizeable Venezuelan presence saw a wage increase in formal employment. However, if immigrants are complementary (substitute) to workers in non-manual (manual) occupations, we expect the Venezuelan immigrants in RAIS to cause wages to decline in manual labor occupations where they are concentrated. Despite this expectation, we did not observe any negative effects in these positions.

One way to interpret these results is to consider the role of Venezuelan immigrants who are not part of the formal market. We showed that many Venezuelan immigrants in the region had sought refugee status, but only a small percentage have entered the formal market. This suggests that many of them are working informally or in seek of employment. Informal workers tend to have lower levels of education and specialize in manual tasks, while those in the formal labor market often hold cognitive or technical jobs, with some overlap.

In Roraima, about 45 percent of the workforce is involved in the informal labor market. To analyze whether there are any negative impacts on wages in the informal labor market, we use data from the PNAD-C from 2012-17. PNAD-C is a representative household survey conducted by the Brazilian Institute of Geography and Statistics (IBGE) every trimester that includes socio-economic and demographic information, such as household composition, education, employment, income, migration, fertility, etc. However, a major limitation of this data is that, unlike RAIS, it does not include information on the respondents' nationality, municipality, or personal identification. This means we cannot directly analyze the impacts on Brazilian citizens or use individual fixed effects to control for time-invariant individual characteristics. As a result, the inclusion of Venezuelan immigrants in our wage regression sample overestimates the magnitude of coefficients.

We use equation 3 which is identical to equation 1 except that we use the state fixed effects term, θ_s, instead of individual fixed effects, due to PNAD-C being a repeated cross-sectional dataset at the state level.

$$(3) \quad y_{ist} = \beta D_{st} + f(X_{it}) + \theta_s + \alpha_t + \epsilon_{ist}$$

Table 10 shows the results of this analysis using equation 3. Those in the informal labor market in the Roraima experienced around a 24 percent decrease in wages compared to the control states. This is, however, a lower bound of the effect given the presence of Venezuelans in the data sample.

Table 10: Effects in the Informal Labor Market

	Log Wage in the Informal Labor Market	
	(1)	(2)
Treated	−0.243***	−0.235***
	(0.055)	(0.054)
N	33 855	33 855
Year FE	X	X
State FE	X	X
Covariates		X

[1] Standard-errors are clustered by state.
[2] Covariates are individual's race, age, age-squared, gender, and education level.
[3] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.001$

These findings suggest that native workers in the formal labor market may have benefited from the presence of immigrant workers in informal jobs by increasing their efficiency. We observed negative effects on wages in the informal labor market, but no negative effects for jobs with a significant Venezuelan presence in RAIS together with positive effects in jobs not related to immigration, confirming that the refugees in informal employ-

ment may have depressed wages locally, but offset the substitution effect of formally hired immigrants.

7.4 Consumption Effects of Refugees

Finally, we examine the impacts of the refugee crisis on labor demand in Roraima. We follow Bodvarsson et al. (2008) by considering the fact that immigrants not only supply labor but also demand goods and services in the local economy, which can create employment opportunities and increase the earnings of the host population. To examine whether the refugee crisis increased consumption in Roraima, we use data from the Commerce Monthly Survey (CMS) by the IBGE. CMS measures sales volumes in the formal labor market using the state's January 2014 sales as a reference point. For example, if Roraima shows 115 points in formal sales in March 2015, it means that sales have increased by 15 percent since January 2014.

To measure the effects of the refugee crisis on consumption, we use three different regression models. First, we use an ordinary least squares (OLS) model that excludes control states and fixed effects, to directly examine the relationship between the number of Venezuelans in Roraima (as measured by RAIS) and the local sales volume. Second, we add back the control states and use a two-way fixed effect regression with a continuous treatment variable represented by the number of immigrants. Finally, we use the same regression model as before but with a binary treatment variable. In all cases, we use RAIS data to measure the monthly number of Venezuelans as a proxy for the total immigrant population in Roraima.

Equation 4 represents the models:

$$(4) \quad log(CI_{st}) = \beta D_{st} + \theta_s + \alpha_t + \epsilon_{ist}$$

where the outcome variable, $log(CI_{st})$ is the log of monthly state-level retail sales volume index, θ_s is the state fixed effects, and α_t is the month fixed effects. D_{st} represents the net amount of Venezuelans by the hundreds for each month extracted from RAIS if the model employed is OLS or the Continuous Treatment model. For the binary treatment, it becomes an indicator function valuing 1 after 2013. We exclude the fixed effects and the sample from the control states in our OLS measurement.

Table 11: Consumption Analysis

| | Sales Index | | |
	OLS	Continuous Treatment	Binary Treatment
	(1)	(2)	(3)
Hundreds of Venezuelans	0.031***	0.027***	
	(0.005)	(0.009)	
Treat			0.287***
			(0.068)
State FE		X	X
Month FE		X	X
N	132	396	396

[1] Standard-errors are clustered by state.
[2] * p < 0.1, ** p < 0.05, *** p < 0.01

Table 11 shows that an increase of one hundred Venezuelans in RAIS leads to a 3 percent increase in sales in our OLS analysis, the same for the continuous treatment model. Our binary treatment study yielded a 30 percent increase in sales after the Venezuelan humanitarian crisis if we compare Roraima with Acre and Amapá.

There were 1,500 Venezuelans in the formal labor market in the state of Roraima in 2017. Therefore, based on our calculations using the estimates from the continuous treatment model, we find that the additional 1,500 Venezuelans in RAIS in 2017, likely resulted in a 45 percent increase in sales. This estimate is within the confidence interval derived from our binary treatment analysis. It is important to note that the number of Venezuelans in RAIS is a proxy for the entire Venezuelan refugee population in Roraima since not all were

involved in the formal economic sector and that the number of Venezuelans in the formal labor market is positively proportional to the total number of Venezuelans in Roraima.

The increase in sales is consistent across all of our models. In summary, Table 11 suggests that labor demand increased during the crisis, at least in the formal labor market, possibly contributing to the wage increase.

8   Conclusion

In this paper, we conducted a comprehensive analysis of the labor market impacts of the Venezuelan crisis in Brazil, focusing on the state of Roraima, where the crisis had a direct impact. The state's geographical isolation helps us use the immigration shock as a natural experiment, allowing us to gauge the effects on the local labor market. Using a difference-in-differences model, we explored the potential differences in effects based on market diversity in terms of the economic sector and worker occupation.

Our findings revealed that the average monthly wages in Roraima increased by approximately 3 percent in the early stages of the crisis. By analyzing the presence of Venezuelan formal workers by firm's economic sectors and occupation type, we found that Brazilians involved in economic sectors and occupations with a high penetration of Venezuelans had no significant effects on their wages, while the overall wage effect was positive that was driven by those involved in economic sectors and occupations with little to no involvement of Venezuelan immigrants. Using survey data, our analysis of the informal labor market revealed that these workers experienced a significant wage drop. From this, we can conclude that immigrants in the informal labor market acted as complements to the formal labor market, allowing the overall wage to increase and offsetting any substitution effect of foreign workers in the formal labor market.

Our analysis of job displacement and occupation changes further supports these findings. We observed no significant changes in formal employment displacement of Brazil-

ians in Roraima but did find evidence of them moving from high-immigrant occupations to low-immigrant occupations in the post-treatment years. Additionally, we found no effect on the wages in the border municipality, where the economy is less diverse and more than 90 percent of the occupations are manual.

In summary, our study emphasized the need to consider the various factors that can influence the impacts of refugees on the labor market. While our research suggested that refugees can bring benefits, it also highlighted the potential drawbacks of large-scale immigration in regions with a significant informal economy. Moving forward, policymakers should prioritize policies that improve the welfare of refugees and promote their active participation in the economy while also being mindful of the potential negative effects on those working informally. Future research should further explore the impacts of the population boom in Roraima, including improving the understanding of the effects on consumption. It should also seek to untangle the complex situation in Roraima that arose after 2017.

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Appendix

A Tables

Table A.1: Venezuelans Reported Crossing the Border in Roraima

Year	Entry	Exit	Stayed
2015	32294	28979	3315
2016	57106	47429	9677
2017	70757	29002	41755

Table A.2: Economic activities defined by the IBGE

First 2-digit code	Definition
01...03	Agriculture, livestock, hunting, and fishing related activities.
05...09	Extraction industry.
10...33	Transformation industry.
35	Gas and Electricity.
36...39	Water distribution and waste
41...43	Construction.
45...47	Commerce (retail and wholesale. We call retail and commerce interchangeably in this paper).
49...53	Transportation.
55...56	Restaurants and hotels.
58...63	Information and communication.
64...66	Financial activities, insurance.
68	Real state.
69...75	Research related activities.
77...82	Administrative services.
84	Public administration, defense and social security.
85	Education.
86...88	Human health and social services.
90...93	Arts, culture and sports.
94...96	Other economic activities.
97	Domestic services.
99	International organizations and other foreign institutions.

[1] Each digit in the coding system represents an additional level of detail for the economic activity variable. For example, 01 stands for agriculture, livestock, forestry, and aquaculture. 01.5 stands for livestock. If we go even further, 01.51-2 represents bovine livestock. 01.51-2/02 is the highest level, representing bovine milk producers. For the purposes of this study, we used the first two digits of the code to categorize a broader but still detailed economic activity.

B   Foreign Presence Outside RAIS

Even though RAIS provides a good picture of Venezuelans entering Brazil and exclusively staying in Roraima, it only counts Venezuelans in the formal labor market. Venezuelans may be crossing the border and going through, staying in other states outside the formal labor market, in refugee camps, or working informally. Table A.1 shows that around 41 thousand individuals crossed Roraima and did not return to Venezuela. However, we do not observe either in RAIS or the Federal Police data whether they stayed in Roraima or moved around.

It would jeopardize our identification strategy if the control states hosted many Venezuelan refugees outside the formal labor market. To show that it is not the case, we rely on the refugee application data from the Brazilian National Committee for Refugees (CONARE).

Foreigners in Brazil can be registered as refugees to get benefits such as obtaining the individual taxpayer registration number (CPF), accessing health and education services, and opening a bank account, among others. A potential refugee must submit its recognition to, and then analyzed by, CONARE. The committee then decides whether they are recognized as a refugee. If rejected, they can appeal. Since refugee applications only exist conditional on the presence of a forcibly displaced population, we believe the data is an adequate proxy for Venezuelans not observed in the formal labor market.

Variables included in CONARE are the nationality of the applicants, the reason for leaving their country, the date when the application was submitted, the municipality and the state where the application was submitted, and the date when CONARE made the decision.

Table B.1 shows the cumulative number of refugee applications by treatment status and year between 2011 and 2020. There were 56,984 refugee requests in Roraima in 10 years, with the first application submitted in 2015. If we consider our period of interest, 2014-2017, more than 10 thousand individuals requested refugee status, with virtually zero

applications found in control states. If immigrants are moving across treated and control states, the likelihood of a Venezuelan applying for refugee status in another location rather than Roraima would significantly increase. Accordingly, we do not see this behavior in the data.
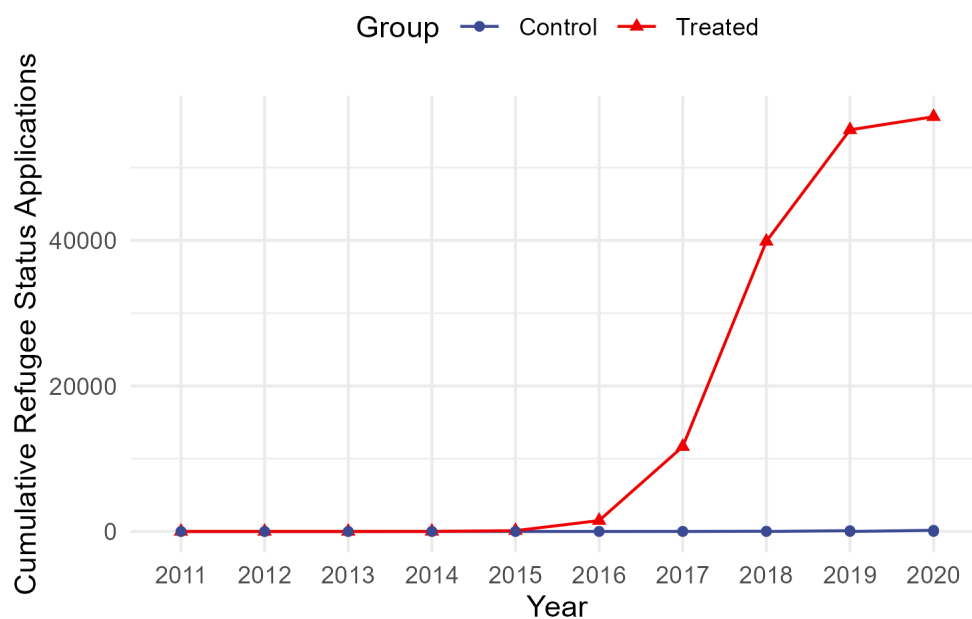

Figure B.1: Cumulative refugee requests by year and treatment status

Another consideration when combining Figure B.1 and Table A.1 is that only a quarter of those who entered Roraima and stayed in 2017 applied for refugee status. If we combine RAIS, around ten percent of these applicants found a job in the formal labor market. Suppose we assume an individual seeks refugee status to apply for employment and proper residence. In that case, it is a safe inference that a significant fraction of Venezuelans were actively in seek of employment, not necessarily in the formal labor market, with some of these accepting offers in the informal labor market.

C Effects in the Border Municipality

So far we have explored the labor market effects of the Venezuelan refugee crisis at the state level and the capital municipality level. In this section, we examine the impact on the formal labor market of Pacaraima, the border municipality in Roraima located adjacent to Venezuela. Besides the capital, Boa Vista, Pacaraima was the municipality most affected by the crisis. Unlike Boa Vista, which has a more diverse local market, Pacaraima's labor market is dominated by retail, with a considerable percentage of the population working in this economic sector. We employ the difference-in-differences specification explained in equation 1 to analyze whether the wage effects are different from our main results focused on the state capitals, given the difference in market size and diversity. We take the border municipalities in the control states, Acre and Amapa, as control units for comparison.

Table C.1 displays the analysis results. Columns (1) to (3) include data from all 11 years used in the previous regression samples. The model with covariates and individual and year fixed effects shows that the Venezuelan crisis led to a nearly 5 percent decrease in wages for Brazilians in the border municipality. Figure C.1 plots the coefficients from the equivalent event study using equation 2.

The event study figure shows that the parallel trends assumption is only weakly satisfied. To address this issue, we ran an alternative regression using a sample limited to 2010 and beyond. Columns 4 and 5 show the results of this restricted sample. The estimates are now smaller and have lost their significance. When using the balanced dataset, there is a 1.4 percent decrease in wages for Brazilians in Pacaraima compared to control state border municipalities.

Contrasting our results for the capital, the border municipality results showed no significant effect on the aggregate market, suggesting that the labor market was unable to benefit from labor complementarity. This may be due to the lack of diversity in occupations available in Pacaraima, as it is a smaller market. Therefore, we also show evidence

that market diversity plays a role in determining the extent of labor complementarity in the face of an immigration supply shock, which future research should focus on.

Table C.1: Effects in the Border Municipality

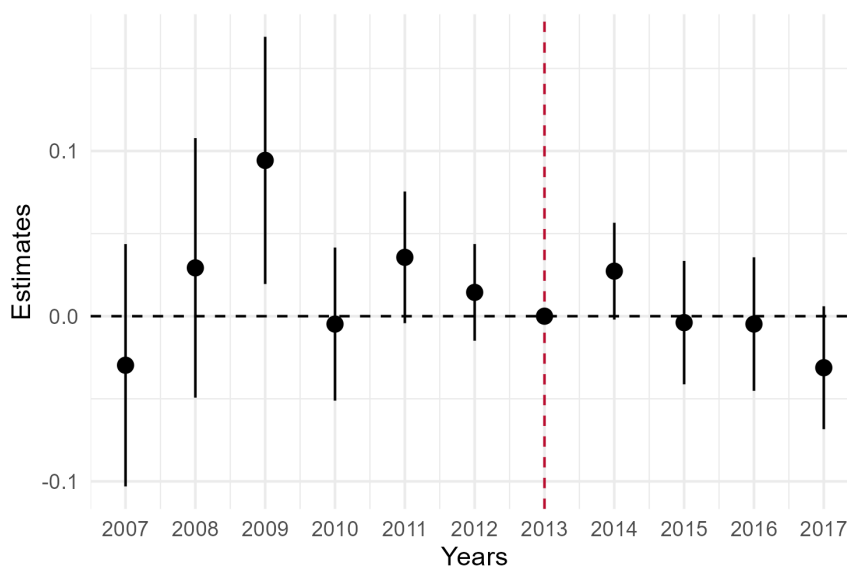|	Log Wage				
	(1)	(2)	(3)	(4)	(5)
Treated	−0.050*	−0.050**	−0.049**	−0.038	−0.014
	(0.025)	(0.024)	(0.024)	(0.027)	(0.019)
Individual FE	X	X		X	X
Individual x Municipality FE			X		
Year FE	X	X	X	X	X
Covariates		X	X	X	X
Balanced Panel Data					X
Restricted Pre-Treatment Period				X	X
N	40 398	40 398	40 398	32 736	18 154

[1] Standard-errors are clustered by municipality.
[2] Covariates are individual's race, age, age-squared, gender, and education level.
[3] Restricted Pre-Treatment Period excludes 2007, 2008 and 2009
[4] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure C.1: Border Analysis Event Study

D Placebo Test: Comparision between the Control States

Table D.1: Placebo between Control States

	Log Wage			
	Placebo State Capital			
	(1)	(2)	(3)	(4)
Treated	0.003	0.003	0.003	0.003
	(0.010)	(0.008)	(0.008)	(0.006)
Individual FE	X	X		X
Individual x Municipality FE			X	
Year FE	X	X	X	X
Covariates		X	X	X
Balanced Panel Data				X
N	1 154 407	1 154 407	1 154 407	790 269

[1] Standard-errors are clustered by municipality.

[2] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.001$