Welcome! Impact of immigration on students' outcomes[*]

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Abstract

The humanitarian crisis triggered by Venezuela's political and socioeconomic situation in mid-2010s has led to the most significant movement of refugees and migrants in the recent history of Latin America and the Caribbean. We explore this episode as a natural experiment to investigate the effects of Venezuelan influx to Brazil on students' academic performance in grade 5. Using a difference-in-difference approach at school level, we found larger increases in average math test scores in schools that experienced larger increases in the share of Venezuelan students. No impact on average for language scores was found, but there was a positive impact on the median and a reduction in language test score inequality. The heterogeneity analysis shows a higher impact on schools presenting worse school quality indicators in the pre-immigration period.

Keywords: immigration; student performance; peer effect; Brazil.

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1. Introduction

Recent waves of migration due to wars, violence, and political and economic instability, especially to European countries, have raised concerns on the impact on local economies and how to integrate migrants into society better. For instance, according to the news, in March 2022 the Ministry of Education in Poland was expecting more than 700,000 new registries of students coming from Ukraine.[1] While there is some literature analysing the impact of migration on the labour market outcomes, much less is known about the impact of migration on educational outcomes. In addition, even less attention has been paid to migration when it involves developing countries. Hence, an interesting and important question is how migration impacts developing countries since they have fewer economic resources to integrate migrants into society. This is especially important when it comes to forced migration, as it generally starts suddenly and occurs in a short period of time.

This paper investigates the impact of Venezuelan students on student outcomes in grade 5 in Brazil. We explore the Venezuela's political and socioeconomic deterioration in the mid-2010s that triggered a massive migration to its neighbour countries as a natural experiment that exogenously increased the number of Venezuelan immigrants in Brazil, raising the share of Venezuelan students in Brazilian public schools.

The Venezuela humanitarian crisis has led to the largest movement of refugees and migrants in the recent history of Latin America and the Caribbean. As of November 2020, around 5.4 million people have left Venezuela, and 4.6 million currently reside in the region (R4V, 2021). Before closing its border due to the COVID-19 pandemic, Brazil had maintained an open-door policy to the influx of Venezuelan refugees and migrants who crossed borders primarily through the northern Brazilian state of Roraima. As discussed in more details in the next section, once in the country, Venezuelans went to other cities and states, especially the ones located in the North.

According to the Brazilian laws, the public administration is required to offer a spot in the education system for any person between 4 and 17 years old regardless of the person's nationality. Thus, the influx of Venezuelan migrants suddenly increased the number of foreign-born students in Brazilian schools. From less than 800 Venezuelan students in 2015, there were almost 20,500 in 2019. This context allows us to use a difference-in-differences

[1] The Washington Post, March 20, 2022. https://www.washingtonpost.com/world/2022/03/20/poland-schools-ukraine-refugees/ Accessed on April 8, 2022.

strategy at the school level to analyse whether schools experiencing larger increases in the share of Venezuelan students in the period are the ones in which school outcomes changed the most. The fast, sudden and massive influx of Venezuelan migrants reduce concerns on the two main empirical challenges in this context, i.e. non-random selection of schools by natives reacting to migrant influx and non-random assignment of immigrants to schools. We present evidence that the Venezuelan migration induced an exogenous change in Brazilian schools regarding the share of foreign students. In particular, we show that changes in students' composition, school resources and previous trends in both the presence of immigrants and test scores are not driving the results.

Results show positive impacts of Venezuelan students on math test scores. A one standard deviation increase in the share of Venezuelan students is associated with a test score increase higher by 0.09σ. Heterogeneity analyses show that schools presenting worse school quality indicators in 2015 – before the massive influx period – are the ones for which the impact is larger. This finding does not imply that low-performing students were the ones who benefited the most since quantile analysis showed that the impact was concentrated on students located at the median of test score distribution. Thus, immigration seems to have benefited average students in low-performing schools.

Results on language are null. Quantile estimations suggest that possible negative effects on high-achievers may have offset positive impacts on the median for this subject. Coefficients for high-achievers are not statistically significant, but they are for median-achievers. An additional exercise investigating the impact on test score dispersion shows a negative but week (10% level of significance) impact, suggesting a reduction in dispersion in language, which is consistent with results on the tails of test score distribution.

The impact of immigrants on native students is ambiguous and two main mechanisms – that would explain either result – have been proposed in the literature: Labour market expectations and peer effects. In the case of labour market, positive impacts would emerge because natives may feel threaten by immigrants in the extent to which immigrants are hired to perform low-skill jobs. Anticipating lower wages and fewer opportunities in the labour market, natives' reaction would be to start investing more in education (Tumen, 2021). However, the opposite effect is also possible (Llull, 2018): due to smaller returns to education, natives would reduce their effort and accumulate less human capital at school, leading to negative impacts on education outcomes.

In the case of peer effects, if foreign students possess higher skill levels in comparison to natives – including socioemotional skills, such as resilience–, natives may benefit from

social interaction and improve their performance (D. Figlio & Özek, 2019). On the other hand, negative impacts may arise due to changes in classroom to integrate immigrants. Additional resources might be required to assist immigrant students facing cultural and language barriers in fitting in. If schools change resource allocation away from native students, their performance may drop. For instance, teachers may slow the pace of instruction down to accommodate non–native speakers as they may possess a poorer command of the native language (Hunt, 2017) or may allocate more class time providing individualised attention to immigrants as well. Both cases suggests that foreign students take up teacher time in ways that are not useful to other students, affecting the whole classroom learning (Lazear, 2001).

In the context of this paper, the lack of negative impacts suggests that it seems not to be the case that the possible reallocation of school resources to integrate Venezuelan students adversely impacted native students. This is important since student achievement in public schools in Brazil is already low and could get worse due to efforts to integrate a relatively large number of newcomers. In addition, the labour market channel seems not to be operating here because (i) students are too young, enrolled in grade 5, and (ii) if that were the case, one would expect positive impacts on language as well. Unfortunately, we do not have data enough to provide hard evidence that the peer effect mechanism is the one through which immigrants impacted local students. Nevertheless, we present evidence consistent with the idea that foreign students come from better family background than natives: parents of Venezuelan students have higher educational attainment than Brazilian parents, which means that natives might have benefited from social interaction with higher ability students. This is consistent with results showing that impacts are larger in schools presenting worse school-quality indicators.

Empirical evidence on the impact of immigrant students on natives' outcomes is mixed. Regarding test scores – our main outcome –, Figlio et al. (2021) report positive impacts of cumulative exposure to immigrant students on math and language for 3rd-10th grade native students from Florida, and that the impact is twice as large for blacks and low socioeconomic status students. In Turkey, using two waves of PISA[2] data on 15 year-old students, Tumen (2021) report a positive effect on math, language, and science test scores following the Syrian refugee influx.

[2] Programme for International Student Assessment.

Brunello and Rocco (2013) found a small negative effect of the share of immigrants on school performance of 15-year-old natives in a cross country study using PISA data from 19 countries. Negative effects are also found in Denmark using PISA test scores, with stronger impacts on math in comparison to reading (Jensen & Rasmussen, 2011) and in Italy for 7-10 year-olds students on language and math (Ballatore et al., 2018; Virdia, 2018). However, for upper secondary schools in Italy, there is evidence that negative impacts happen only when there is a large – but rare – concentration of immigrants (Virdia, 2018).

Figlio and Özek (2019) found no impacts on Florida 3rd-10th graders after the massive influx of Haitians triggered by the earthquake that hit their country in 2010. Also, using data on grade 10 in Florida (USA) and grade 9 in Sweden, Conger (2015) and Brandén et al. (2019), respectively, found that the impact of foreign students on test scores is null. The same is observed for younger students in the Netherlands (grades 2 to 8) (Bossavie, 2020; Ohinata & van Ours, 2016; Ohinata & Van Ours, 2013) and England (Geay et al., 2013). Performance of native students in primary schools, measured by TIMSS[3] and PIRLS[4] in England and by a national exam measuring math and language skills in the Netherlands, was not found to be associated with the share of immigrant peers.

Regarding other outcomes, an adverse effect on natives was found in Israel: students exposure to immigrants in elementary school performed worse on the high school passing rate exam to attend college (Gould et al., 2009). In the USA, while there was a positive net effect on the high school attainment of natives (Hunt, 2017), no significant adverse effect on disciplinary incidents, high school graduation, or student mobility across schools was observed (D. Figlio & Özek, 2019). In addition, in primary schools in Austria, there was no impact on repetition and high track attendance (Schneeweis, 2015). In Italy, there is evidence that immigration led to an increase in both the percentage of individuals with low and high schooling levels, a phenomenon the authors called human capital polarisation (Brunello et al., 2020). This suggests that the labour market mechanisms operated in both directions.

As seen, there are two main gaps in the Economics literature about immigration and education outcomes: evidence on developing countries and on forced migration. A plausible explanation for the first case is that immigrants choose developed countries as a destination for obvious reasons, reducing possible study cases in developing countries. However, as of 2015, developing regions hosted 86% of refugees under mandates of the United Nations High

[3] Trends in International Mathematics and Science Study.
[4] Progress in International Reading Literacy Study.

Commissioner for Refugees and his Office (UNHCR, 2015) so we cannot discard that the limited research is associated with both less interest in these countries and data availability. In addition, most of literature does not relate to abrupt forced displacement as a result of conflict or human rights violations, as is the case of Venezuelans. In these cases, massive migration starts suddenly and occurs in a short period of time, reducing the time span the host country has to respond to the influx of foreign people. In fact, in the literature it is not uncommon that foreign students come from more than one country of origin, as in Figlio et al. (2021) in which 65% of immigrants comes from ten different countries. This implies that it is probably the case that there is a more continuous migration influx that has been occurring for a reasonable period of time.

This paper has five sections beyond this Introduction. Section 2 presents the context of Venezuelan immigration to Brazil. Section 3 presents the data and some descriptive statistics. Section 4 discusses the empirical strategy. Results are presented in section 5, while section 6 concludes the paper.

2. Venezuelan immigration to Brazil

Data on Venezuelan migrants are uncertain, but according to the Refugee and Migrant Response Plan 2021 (R4V, 2021)[5], 381,000 Venezuelans are currently hosted by Brazil, many in need of humanitarian assistance, – in health, shelter, food – as well as access to education, protection and integration. According to Brazilian authorities, more than 610 thousand Venezuelan influx to Brazil between 2017 and June 2021 and 260 thousand asked for migratory regulation.[6] The majority of Venezuelan influx is by land accessing the highway BR-174 in the border city of Pacaraima (state of Roraima) connecting Boa Vista (Roraima state capital) and Manaus (Amazonas state capital).

In 2017 the migratory flow of Venezuelans to the neighbouring Caribbean and Latin American countries intensified due to exacerbated levels of poverty, crime, hyperinflation and poor governance. Consequently, in 2018, the Brazilian government implemented a voluntary relocation programme to support refugees and migrants from Venezuela through its *Operação Acolhida* (Operation Welcome). Focusing on the northern states of Roraima and

[5] RMRP 2021 is the result of an intra-regional field-driven strategic planning process, bringing together 159 appealing organizations, in consultation with all host governments, local communities and authorities, United Nations agencies, civil society, including international and national non-governmental organizations (NGOs) and faith-based organizations, the Red Cross Movement, the donor community, as well as consultations with refugees and migrants from Venezuela.

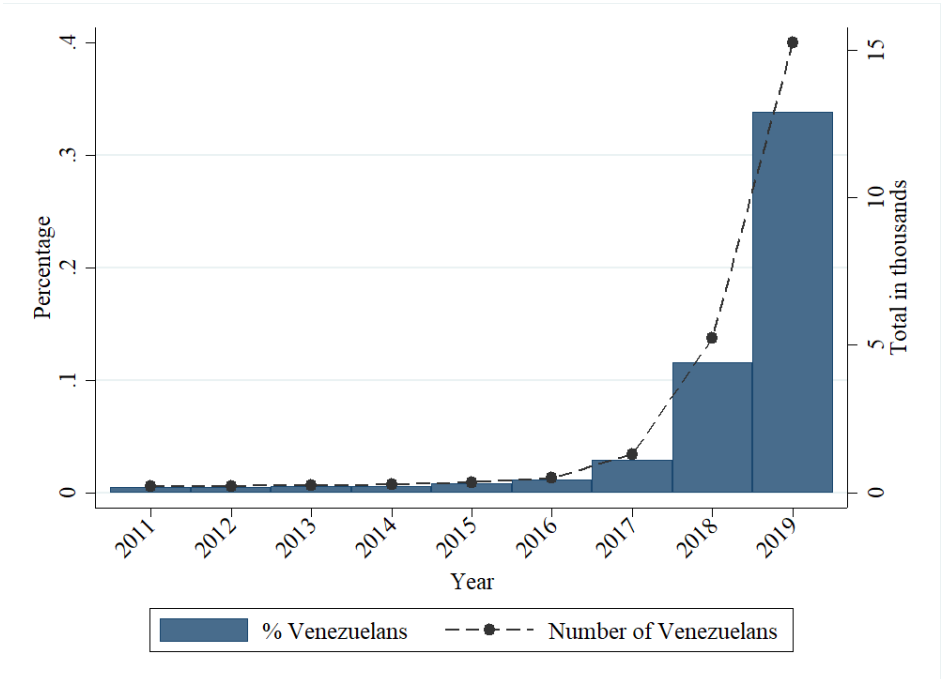
[6] https://www.gov.br/casacivil/pt-br/acolhida/sobre-a-operacao-acolhida-1 access on July 23, 2021.

Amazonas, it provides reception services, including registration, documentation, shelter, health and other services. An integration strategy of *Operação Acolhida* enables Venezuelans to move to other parts of the country safely. By June 2021, 50 thousand refugees and migrants from Venezuela have been relocated to 670 cities across the country.

As a result of Venezuelans influx, significant challenges arise both in terms of guaranteeing access to education and ensuring educational continuity for refugee and migrant pupils. In December 2019, 58% of refugee and migrant children aged 6-14 and 69% of the adolescents aged 15-17 were not enrolled in schools due to the lack of available slots in public schools associated with misinformation about education rights (R4V, 2021). Also, challenges with local language skills, validation of diplomas, and school transfers reduce the chances of refugees and migrants accessing the formal education system.

According to the Brazilian laws, the public administration is required to offer a spot in the education system for any person between 4 and 17 years old regardless of the person's nationality. Figure 1 shows the evolution of the absolute number of Venezuelan students as well as the percentage they represent among students enrolled in the seven states in the Northern region in Brazil. We focus on states in the Northern region due to the high concentration of Venezuelan students (75% of Venezuelan students in Brazil in 2019 were living in this region).

Figure 1 – Number and percentage of Venezuelan students enrolled in primary schools



Source: School Census. Authors' elaboration.

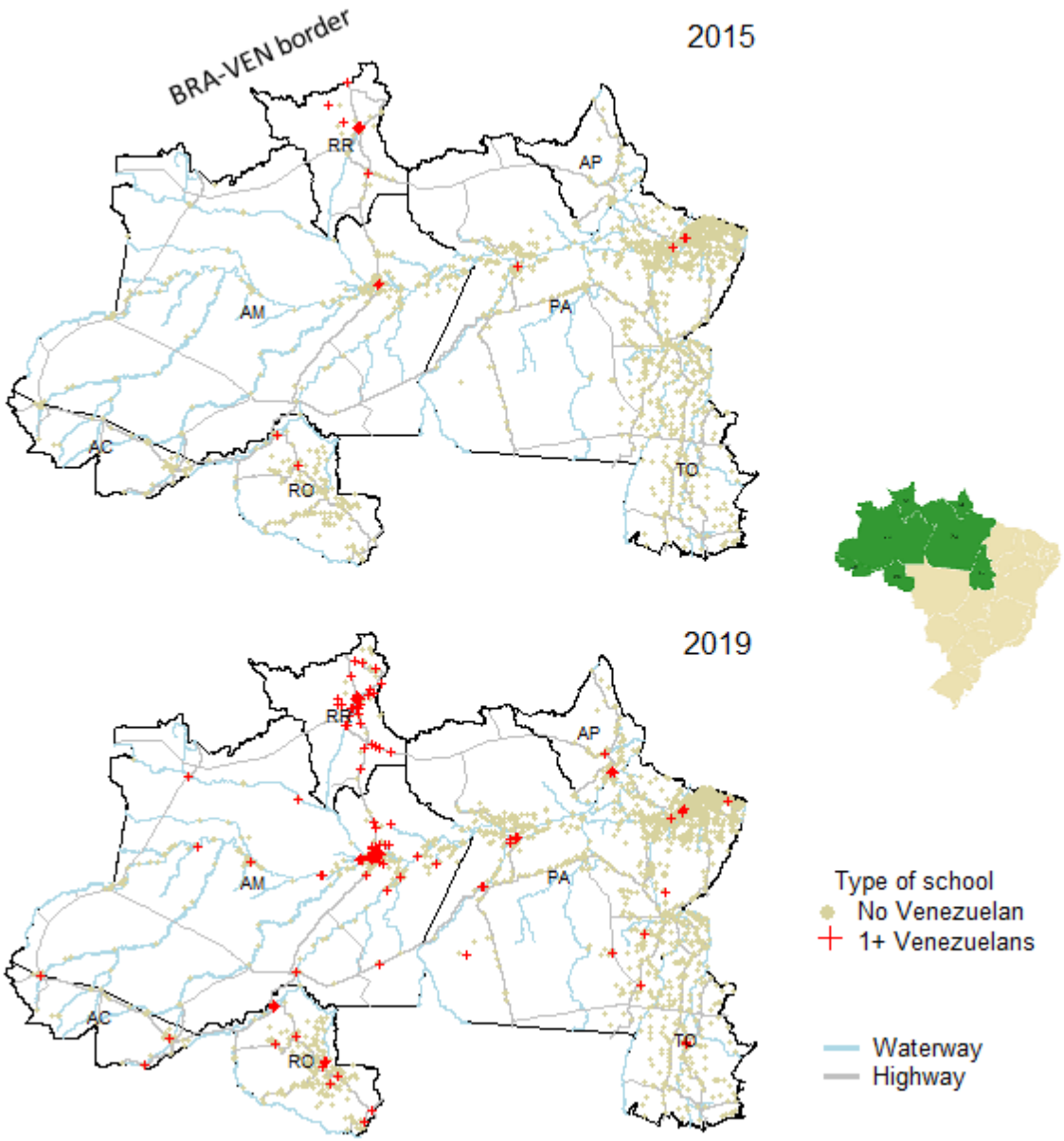
Between 2007, the first year for which we have data on student nationality, and 2015 the number of Venezuelans enrolled in Northern primary schools was very low and stable, barely reaching 400. After a slight increase in 2016 and 2017, we observe a sharp increase in 2018 and especially 2019, reaching more than 15,000 students in this last year, increasing the share of Venezuelans from practically zero to around 0.40%. This coincides with the timing of massive Venezuelan immigration, confirming that the Brazilian education system absorbed those students. As explained below, we have information on test scores for grade 5 only. Appendix Figure shows the percentage of immigrant students from Venezuela in grade 5 over time. As seen, the share of students from Venezuela increased abruptly after 2017, showing that immigration was neither age- nor grade-specific.

The unit of analysis in this paper is the school. Figure 2 shows the geographic distribution of primary schools (the ones offering grade 5) in the Northern region in 2015 and 2019. Despite the observed influx of migrants, a majority of schools admit no Venezuelan students (sand markers) in both years (next section explains how we compute these numbers).

In 2015, one can see that there were just a few schools in which Venezuelan students were enrolled (red markers). In 2019, the change is clear. Venezuelan students are found all over the region, mostly in state capitals, such as Manaus (Amazonas (AM) state capital) and Porto Velho (Rondônia (RO) state capital), but also in smaller cities located alongside roads and rivers. The most significant change is seen in Roraima (RR), as expected, since it is the only state with a highway connecting Brazil and Venezuela.[7] Some 5.5% of primary schools of our sample presented a change in the percentage of Venezuelan students between 2015 and 2019. Appendix Figure A.2 shows the distribution of schools according to this change excluding schools in which there was no change. We explore this variation across schools to identify the impact.

[7] Amazonas is the other state that shares border with Venezuela, but there is no connection between the countries by land in that state.

Figure 2 – Geographic distribution of schools according to Venezuelan enrolments, 2015 and 2019



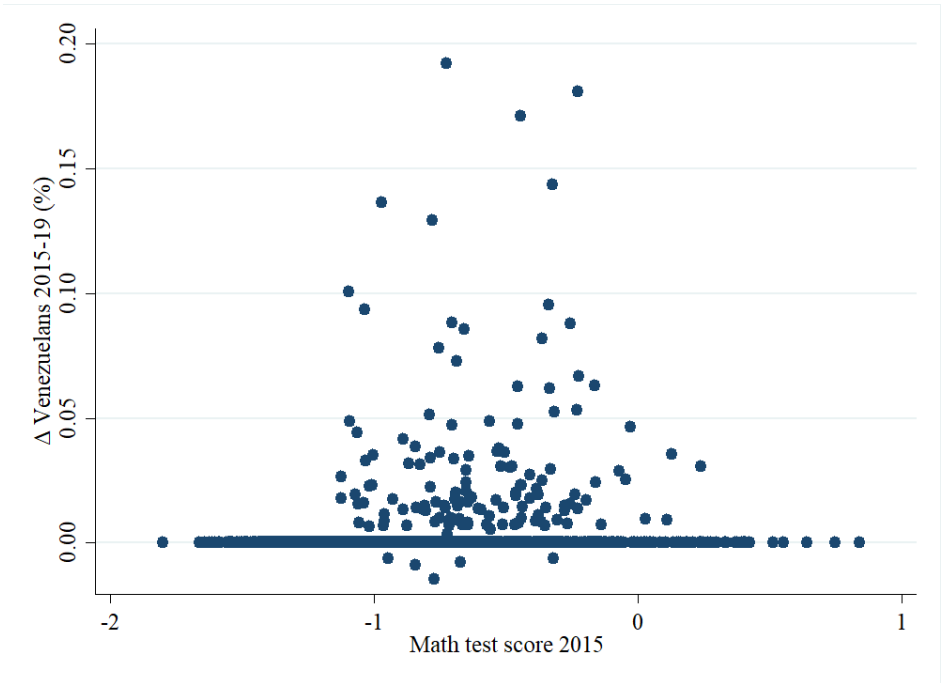
Source: School Census. Authors' elaboration.

The identification strategy relies on the exogeneity of Venezuelan immigration. We present additional pieces of evidence to argue that this is indeed the case. We already showed in Figure 1 and Appendix Figure that Venezuelan immigration was an unexpected shock to the Northern school system. Also, as there were less than 400 Venezuelan students in Northern Brazil in 2015 (in comparison to the 15,000 that came later), previous Venezuelan immigrants attracting newcomers and, consequently, biasing newcomers' choice of location

is not a concern. Moreover, Appendix Figure shows that the change in percentage of Venezuelans between 2015 and 2019 is not associated with the change in the percentage of other immigrants in the 2011-2015 period. This finding means that Venezuelan students did not necessarily enrol in the same schools in which other immigrants enrolled before the Venezuelan influx. In any case, previous change in other immigrant in Brazilian schools is tiny relative to the change in the percentage of Venezuelans we are analysing.

Although the Venezuelan immigration represented an unexpected event to the public education system in Brazil, another potential concern that may threaten our identification strategy is that immigrants might have enrolled in schools that had presented lower or higher average test scores. It could be the case that the best schools managed somehow to prevent enrolments of immigrants. However, Figure 3 shows that this is not the case. The figure plots the change in percentage of Venezuelan immigrants between 2015 and 2019 against the average math test score in 2015. As one can see, positive and negative changes occurred in a wide range of schools. Also, schools that experienced no change regarding Venezuelan immigrants are not concentrated in any specific point of test score distribution.

Figure 3 – Relationship between change in percentage of Venezuelan and pre-immigration math test score level



Source: School Census and Prova Brasil. Authors' elaboration.

In sum, the influx of Venezuelans to Brazil was large, sudden, unexpected, and concentrated in time. This provides a favourable context to address the research question related to the impact of immigration on the host country regarding educational outcomes. Still, we are going to present more formal tests about the exogeneity assumption to complement this section discussion.

3. Data and descriptive statistics

We use the School Census microdata to identify the nationality of each student enrolled in the basic education system in Northern Brazil. The School Census is assembled yearly by the National Institute for Educational Studies and Research (Inep), an agency linked to the Ministry of Education. The dataset also provides information on the school and grade the student is enrolled in. We use this dataset to compute the percentage of Venezuelans in each grade, school, and year (the school year in Brazil coincides with the calendar year). Unfortunately, we do not have information on how long the immigrant student has been living in the region but, as highlighted before, there were just about 400 Venezuelan students in 2015, so we know that most of migrants observed in 2019 are newcomers. In addition, we use this dataset to gather information on school infrastructure and equipment.

Student achievement derives from Brazil's National Examination (*Prova Brasil*), an assessment carried out every other year since 2005. Students attending public schools take Math and Portuguese Language tests if the school has at least 10 students enrolled in grade 5. The assessment consists of standardised tests that yield comparable test scores over time such that a one-point increase in, say, 2007 represents the same change of one-point increase in 2015. We are able to follow schools over time, but student identification is not provided so we do not have a panel data at student level. In the analysis, we use schools from 2011, 2015, and 2019 assessment waves.

In addition to test scores, the exam collects information on students' sociodemographic characteristics as well as schools' characteristics related to the teachers and administration. We keep in our sample schools with at least 10 students with complete information regarding their characteristics. It is important to note that in Prova Brasil there is no information on student nationality so average test scores include the performance of native and non-native students. Because the share of Venezuelans is small – less than 1% of schools have more than 5% of Venezuelan in 2019 according to the School Census –, their influence of average test scores is small. In any case, we do have information on the main language

spoken at home in 2019 (not in 2015). As a robustness exercise, we keep in our sample only students who speak Portuguese at home.

Table 1 presents descriptive statistics at student and school levels for 2015 and 2019. At the top of the table, one can see that the typical student in grade 5 in 2015 was non-white, enrolled in school for the first time in preschool, lived with both parents, and the mother graduated from high school. It is observed some changes four years later, when the share of students living with both parents and whose mother graduated from high school increased. As explained in the next section, we control for possible compositional effects related to student characteristics.

There are 2,509 primary schools in Northern states in the sample. One can see that school characteristics did not change much over time. The average number of students enrolled in grade 5 is 73, and local-run schools represent 77% of the sample.[8] The teacher qualification is measured as the percentage of teachers who have a college degree in the subject they teach: Pedagogy,[9] Mathematics or Portuguese Language. Some 62% of teachers had an appropriate degree in 2015, and the percentage increased up to 75% in 2019.

At the bottom of the table, it is seen that language and math average test scores (measured in standard deviation units) increased between 2015 and 2019. Test score dispersion, measured as the standard deviation of the mean test score, also increased over time.

The number of Venezuelans in Brazilian schools was so small in 2015 that its average is zero in the table even using two decimal cases (the exact values were 0.0033%). In 2019, though, the average share increased to 0.18% (or 54 times larger). Despite the large increase, the percentage is close to zero since most schools have no Venezuelan student enrolled. Students from other nationalities represent a small percentage as well. They were 0.6% in 2015 and went up to 0.10% in 2019.

[8] In Brazil, local governments (municipalities) are the main responsible for offering primary education. Despite that, there are local-, state-, and federal-run primary schools in the public system.

[9] Usually grade 5 has only one teacher per class with a college degree in Pedagogy.

Table 1 – Descriptive statistics – Student and school level characteristics by year

	2015		2019	
	mean	**s.d.**	**mean**	**s.d.**
Student level (proportions)				
White	0.23	0.42	0.21	0.41
Mother's schooling	0.50	0.50	0.65	0.48
Lives with parents				
none of them	0.07	0.26	0.09	0.29
one of them	0.38	0.49	0.25	0.43
both of them	0.55	0.50	0.66	0.47
Started school in				
nursery (<3 years-old)	0.36	0.48	0.32	0.47
preschool (4-5 years-old)	0.39	0.49	0.41	0.49
later (> 6 years-old)	0.25	0.43	0.26	0.44
Observations	108,971		101,418	
School level				
Enrolment (n^{o} of students)	73.0	40.7	73.6	40.8
local-run school (%)	77.1	42.0	77.1	42.0
Teacher qualification (%)	62.2	26.3	75.4	20.8
Infrastructure Index	0.87	0.50	0.78	0.54
Equipment Index	1.01	0.43	0.76	0.47
Mean math test score	-0.84	0.36	-0.63	0.40
Math test score dispersion (s.d.)	0.64	0.12	0.69	0.11
Mean language	-1.03	0.37	-0.85	0.39
Language test score dispersion (s.d.)	0.70	0.11	0.76	0.11
Venezuelans (%)	0.00	0.07	0.18	1.16
Other nationalities (%)	0.06	0.36	0.10	0.45
Observations	2,509			

Source: School Census and Prova Brasil. Authors' elaboration.

4. Empirical strategy

To estimate the impact of immigration on student outcomes, we run the following equation at school level:

$$y_j = \alpha + \beta immigration_j + \gamma X_j + \theta_r + \mu_s + \epsilon_j \quad (1)$$

where y_j is the change in average test score between 2015 and 2019 for school j, $immigration_j = \Delta log(1 + \lambda_j)$, such that λ_j is the proportion of Venezuelans enrolled in

grade 5 in school j, and Δ refers to the change between 2015 and 2019. X_j is a vector of time varying control variables related to school characteristics, θ_r is a dummy variable indicating local-run schools, and μ_s is a vector of state dummies. School characteristics include change in enrolments, infrastructure,[10] equipment,[11] teacher qualification, and percentage of immigrants from other nationalities. As we estimate the regression in differences, (i) we control for school fixed effects, and (ii) the dummy variables represent administrative- and state-specific time trends, controlling for changes in administrative- and state-level policies that may have affected schools differently. Standard errors are clustered at the municipal level.

We use dependent variables netted out of compositional effects in our main specifications to account for different changes in sociodemographic characteristics across schools over time. In order to net out the composition effects, we first run OLS regressions of test score on student characteristics using individual level data as follows:

$$w_{ijt} = Z'_{ijt}\rho + S'\delta_j + v_{ijt} \quad (2)$$

where w_{ijt} is the test score in Math or Language for student i in grade 5 in school j in year t, and Z is a vector of student characteristics including race (white and non-white), age started attending school, with whom the student lives (both parents, one of them or none), if the student's mother has graduated from high school, goods possession (number of TVs, vehicles, etc.), and home structure (number of bathrooms and bedrooms) to proxy for socioeconomic status. S is a vector of school dummies in which the coefficients (δ_j) capture the year-grade-specific math and language average test scores. Then, we use these coefficients to compute the outcome y_j used in equation (1). Equation (1) is weighted by the precision of this first step estimates, i.e., the inverse of the standard error of each school coefficient.

While our main outcomes are math and language test scores, we also estimate the impact of immigration on different points of the test score distribution and on test score dispersion (measured as the standard deviation of school's average test score). As these

[10] Indicators of kitchen, science lab, computer lab, electricity power, water supply, sewerage, covered playground, refectory, sports court built the infrastructure index through an Item Response Theory approach.

[11] The equipment index uses binary items indicating the presence of satellite dish, DVD player, copy machine, sound system, TV, multimedia equipment. The index was built using IRT approach also.

outcomes are school level measurements, there is no first step as in equation (2). In these cases, to control for possible composition effects, we include in equation (1) school level variables capturing changes in average student characteristics over time. Observations in these specifications are weighted by the mean number of students in each school over time.

5. Results

Table 2 reports the impacts of immigration on Math (columns 1-3) and Language (columns 4-6) test scores. The three specifications, for each subject, control (cumulatively) for state and local-run time trends, change in student characteristics, and change in school characteristics.

Overall, we found positive impacts on Math and no impact on Language. Also, results barely change after controlling for student and school characteristics, which is consistent with the assumption that Venezuelan immigration to Brazil was an exogenous event that hit local schools.

Table 2 – Impact of immigration on student math and language test scores, grades 5 and 9

	Math			**Language**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Immigration	1.195***	1.328***	1.277***	0.733	0.850	0.800
	(0.390)	(0.403)	(0.420)	(0.518)	(0.538)	(0.567)
Observations	2,509	2,509	2,509	2,509	2,509	2,509
Adjusted R2	0.0291	0.0301	0.0308	0.0290	0.0374	0.0385
Sociodemographic controls		✓	✓		✓	✓
School characteristics			✓			✓
Local-run time trend	✓	✓	✓	✓	✓	✓
State-specific time trends	✓	✓	✓	✓	✓	✓

Standard errors in parentheses adjusted for 389 municipality clusters. *** p<0.01, ** p<0.05, * p<0.1. Unit of analysis: schools. OLS regressions of change in average test score between 2015 and 2019 on the change in percentage of Venezuelans. Dep. vars. measured in standard deviation units. Indep. vars.: Column (1) controls for local-run and state dummies; Column (2) adds sociodemographic controls using dependent variables netted out of composition effects estimated using a first stage (eq. 2); Column (3) adds time-varying school characteristics. Observations weighted by the inverse of the standard error of the dependent variable.

As seen in column (1), there is a positive and statistically significant relationship between the change in percentage of Venezuelan students in grade 5 and the change in Math test scores between 2015 and 2019 in that grade. Compared to column (1), coefficients in columns (2) and (3) that control for student and school characteristics, respectively, are slightly larger, remaining significant at 1% level.

On the other hand, the impact on language, although positive, is not statistically significant. The coefficient in column (6), for instance, is smaller and less precisely estimated than its analogous for math (column 3).

To have an idea about the magnitude of the immigration effect on Brazilian schools, considering the specification in column (3), an increase in Venezuelan students higher by 0.18 percentage points (the average increase in the period) is associated with a relative increase of 0.23 of a standard deviation in math test score. Alternatively, a one standard deviation increase in the percentage of Venezuelan students (0.07 p.p.) is associated with an increase of 0.09σ in test scores. This impact represents about half of the test score change in the period (0.18σ) or about one-fourth of test score variation between schools in 2005 (0.36σ). This 0.09σ impact is smaller than what Tumen (2021) found for Turkey using PISA data (0.22σ). On the other hand, it is higher than previous findings for developed countries. For instance, Figlio et al. (2021) report that a cumulative change in exposure to immigrants from 1% to 13% (10^{th} and 90^{th} percentiles, respectively) increases US-born math test scores by 2.8% of a standard deviation.

The positive effects on math and the lack of negative impacts on language suggest that two mechanisms are not operating (or at least are not prevailing) in the present case of immigration effects. First, it seems not to be the case that school resources were taken away from students to better integrate Venezuelans. Resources can be understood in broader sense, from financial ones to time instruction. One would have expected a negative impact to emerge in such a case. Second, if the influx of Venezuelans decreased labour market expectations, it did not affect students to a large extent in such a way as to make students reduce effort.

Conversely, two mechanisms would result in positive impacts. In the first one, immigration would stimulate students to increase effort due to a possible future competition with Venezuelans in the labour market that would reduce wages and opportunities for low-educated individuals. However, if that were the case, one would expect positive impacts not only on math, but also on language since there is no particular reason for increasing effort in single subject.

Thus, the prevailing mechanism seems to be the one related to peer effects. If immigrant students are better educated or harder working than their native peers, they will promote positive spill-over effects (Hunt, 2017). Although we do not have data on soft skills, there is some evidence that Venezuelan immigrants possess a better family background than

the Northern students. A survey conducted in 2017 with a stratified probabilistic sampling design that interviewed 650 Venezuelans in Boa Vista (capital of Roraima) reports that 78% have completed at least the high school and 32% have an undergraduate or graduate degree (Simões, 2017). Using data from a National Household Survey,[12] Appendix Table A.2 shows that Brazilians living in Boa Vista have worse educational attainment indicators: Some 40% have not graduated from primary school and only 18% have a college degree. In addition, the lack of impact on Portuguese language is consistent with this peer effect channel. Due to language barriers, it is not unexpected that the impact occurred only on math. This difference suggests that the peer effect did not come necessarily through attitudes and behaviors, as discussed by Figlio et al. (2021) in the case of the U.S.; it is more likely that the family background of Venezuelans played a major role in impacting Brazilian students.[13]

5.1 Outcomes related to test score distribution

To complement the analysis of the impact of immigration on student performance, this section presents results for other outcomes. We begin analysing the effect on other points of the test score distribution and then move to test score dispersion within schools. As all variables are measured at the school level, there is no first stage in these estimations. To control for student composition, we first compute the mean values for each school and year, and then compute changes in the mean values over time. After implementing this procedure for each student characteristic, we include the created variables in the X vector in equation (1).

5.1.1 Quantiles

We estimate the impact of the change in percentage of Venezuelan students on three different percentiles of the test score distribution: 10, 50 and 90. For each school and year, we take the test score values of students located in those percentiles and then compute the change between 2015 and 2019 to create the dependent variables. Table 3 present the coefficients of the change in percentage of Venezuelan students on these outcomes. Columns 1-3 refer to math test scores while columns 4-6 refer to language.

[12] Continuous National Household Sample Survey (PNADC) is similar to the Current Population Survey in the US.

[13] Different impacts of immigration across subjects were previously found in the literature. Bossavie (2020), for instance, found that the presence of immigrants reduced the verbal scores of Dutch students in the Netherlands but had no impact on math scores. In this case, though, it is more likely that natives have a better family background than immigrants.

Firstly, results on the median are larger and more significant than on average. In fact, the impact on language at the median is statistically significant at 5% level (the coefficient is larger, but the precision is also higher). So possible outliers affecting average test scores are actually preventing us from finding significant impacts on average.

Table 3 – Impact of immigration on change in test score at different percentiles of test score distribution

	Math			Language		
	Median	**P10**	**P90**	**Median**	**P10**	**P90**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Immigration	1.503***	0.569	0.774	1.259**	1.146*	-0.651
	(0.551)	(0.493)	(0.476)	(0.489)	(0.623)	(0.722)
Observations	2,509	2,509	2,509	2,509	2,509	2,509
R-squared	0.069	0.069	0.045	0.078	0.075	0.057

Standard errors in parentheses adjusted for 389 municipality clusters. *** p<0.01, ** p<0.05, * p<0.1. Unit of analysis: schools. OLS regressions of change in test score at given quantiles between 2015 and 2019 on the change in percentage of Venezuelans. Dep. vars. measured in standard deviation units. Indep. vars.: local-run and state dummies, and time-varying student and school characteristics. Observations weighted by number of students.

Secondly, results at the tails point that the impact changes over the test score distribution. For math, P10 and P90 coefficients, although statistically non-significant, are positive but smaller than that at the median. So neither low- nor high-achievers seems to have benefited from immigration. On language, on the other hand, impacts on P10 and P50 are close, but the impact on P10 is significant at 10% only. Also, the estimated coefficient on the right tail is negative and non-significant, which may have contributed to the lack of impact on average.

Finally, the quantile results partially support the mechanism related to peer effects based on family background. High-performing students were not affected by their peers because they probably have a better family background than the average student, making them less susceptible to such influence. Under this mechanism, a possible explanation for the lack of impact on low-performing students is that the peer effect was not strong enough to improve their performance since they do not have more basic skills. However, family background-based peer effect does not fully explain why median-performing students were benefited in language, unless one argues that Portuguese language domain by natives was so low that better-prepared foreign students were able to help them even in their mother tongue. Although unlikely, there is evidence supporting this conclusion. Language mean test score at

municipal level of Northern municipalities is almost 0.9σ smaller than the average observed for the other Brazilian municipalities. We will further discuss mechanist in section 5.3.

5.1.2 Dispersion

This section complements the quantile analysis by using as outcome an aggregate measure of test score dispersion at school level: the standard deviation of the mean. Table 4 reports the results of equation (1), in which the outcome variable is the change in the standard deviation between 2015 and 2019. We use the same specification of column (3) in
Table 2, including the full set of control variables. In addition, as there is no first stage in this case, we include in equation (1) changes in individual student characteristics between 2015 and 2019 averaged at school level.

Table 4 – Impact of immigration on math and language test score dispersion. Dep. Var.: change in the standard deviation of mean test scores

	Math	**Language**
	(1)	**(2)**
Immigration	0.172	-0.405*
	(0.204)	(0.197)
Observations	2,509	2,509
R-squared	0.044	0.044

Standard errors in parentheses adjusted for 389 municipality clusters. *** p<0.01, ** p<0.05, * p<0.1. Unit of analysis: schools. OLS regressions of change in test score standard deviation between 2015 and 2019 on the change in percentage of Venezuelans. Dep. vars. measured in standard deviation units. Indep. vars.: local-run and state dummies, and time-varying student and school characteristics. Observations weighted by number of students.

Math test score dispersion did not change as a result of Venezuelan immigration. Estimated coefficients are positive but not statistically significant (column 1). Therefore, immigration impacted average test score positively without increasing differences between students.

In language, we have a negative estimated coefficient in Column 2, indicating a possible reduction in dispersion. However, it is significant at 10% only, being consistent with the weak impact on percentile 10 discussed in the previous section. The coefficient means that an increase higher by one standard deviation in the percentage of Venezuelans leads to a decrease of 0.028 in dispersion, representing a 4% reduction of initial dispersion. All in all,

we do not have evidence that immigration increased differences in test scores among students.

This section showed that the additional positive impacts of immigration on student performance are consistent with our main results. As with test scores and their dispersion, results are modest at most. Nevertheless, it is interesting to observe that international migration can contribute to improve education outcomes in the host country when the host country is a developing country that already struggles to improve its education system.

5.2 Robustness

5.2.1 Sample

Our test score data do not allow us to separate natives from immigrants since there is no information on student nationality for students assessed in Prova Brasil (remember that the share of Venezuelans comes from the School Census, which does not have information on test scores). Thus, test score averages we use to compute dependent variables include the performance of Venezuelan students, which means that the impact we found could be a result of change in composition not controlled for instead of an impact caused by the presence of Venezuelan students in the classroom.

The percentage of Venezuelan students is small in most schools, as Appendix Figure A.1 shows, which reduces concerns about their influence on average test scores. Also, impacts on the median of the test score distribution tend to be larger than the impacts on the average, as discussed in section 5.1.1. So even if some Venezuelan students are outliers, it does not seem to be the case that they are driving our results.

Still, it is possible that a few schools with larger shares of Venezuelans are playing a bigger role in the results. To test the robustness of the results, we use a piece of information that allows us to indirectly separate immigrants from natives. Students are asked what language is spoken most of the time at home: Portuguese, Spanish or other. Thus, in the exercise carried out in this section, we keep in the sample only Portuguese speakers. However, this information is available only in 2019 so we cannot do the same in 2015. Because less than 0.7% of students enrolled in Brazilian Northern schools were foreign students in 2015, their influence on test score average is even less concerning in that year.

Table 5 presents the results. Specifications are the same as in Table 2, columns 3 and 6, our preferred specifications. As seen, the results are very close to the main ones: coefficient sizes are similar and present the same direction.

Table 5 – Impact of immigration on Math and Language test score – Excluding non-Portuguese speakers from the 2019 sample

	Math	**Language**
	(1)	**(2)**
Immigration	1.216***	0.882
	(0.410)	(0.568)
Observations	2,502	2,502
R-squared	0.035	0.045

Standard errors in parentheses adjusted for 389 municipality clusters. *** p<0.01, ** p<0.05, * p<0.1. Unit of analysis: schools. OLS regressions of change in average test score between 2015 and 2019 on change in percentage of Venezuelans. Dep. vars. measured in standard deviation units. Indep. vars.: local-run and state dummies, and time-varying student and school characteristics. Observations weighted by the inverse of the standard error of the dependent variable.

Thus, in spite of this data limitation preventing us to argue that we are estimating the impact on natives only, there is evidence that we are very close to do it. The next two sections present additional evidence regarding the robustness of our results.

5.2.2 Pre-trend

In this section we show that previous trend in test scores is not driving our results. It could be the case that Venezuelan students enrolled in schools that were already improving before immigration started. Then we would be incorrectly attributing the positive impact to migration when it actually came from other factors. A visual inspection of the relationship between test score change in 2011-15 and Venezuelan influx in 2015-19 in Appendix Figure A.4 shows that this seems not to be the case. Before immigration, the test score change of schools receiving Venezuelan students varies considerably.

Table 6 presents the results of a formal test. Specifications reported in the table includes previous trend as an additional control variable in our preferred specification (Table 2, Columns 3 and 6). As one can see, results on average barely changed, reinforcing that immigration and previous trend are approximately orthogonal. Estimated coefficients for

math and language increased a little as well as the standard errors, but statistical significance remained the same: significant at 1% for math e non-significant for language.[14]

Table 6 – Impact of immigration on Math and Language test score – Including pre-trend

	Math	**Language**
	(1)	**(2)**
Immigration	1.369***	0.908
	(0.499)	(0.659)
Δ (test score) 2011-15	-0.242***	-0.292***
	(0.0293)	(0.0239)
Observations	2,509	2,509
R-squared	0.095	0.128

Standard errors in parentheses adjusted for 389 municipality clusters. *** p<0.01, ** p<0.05, * p<0.1. Unit of analysis: schools. OLS regressions of change in average test score between 2015 and 2019 on the change in percentage of Venezuelans. Dep. vars. measured in standard deviation units. Indep. vars.: local-run and state dummies, and time-varying student and school characteristics, and previous trend in test scores. Observations weighted by the inverse of the standard error of the dependent variable.

5.2.3 Falsification

We conclude our robustness check exercises by performing a falsification test. If our measure of Venezuelan immigration is exogenous, by running a regression of the previous trend on the change in percentage of Venezuelan students between 2015 and 2019, one would expect no relationship between them. Despite the null results for Language, we wanted to be sure that the immigration episode is, in fact, exogenous.

Table 8 presents the results. Except for the dependent variables, the specifications in the table are identical to our main specification in Table 2 (Columns 3 and 6). It is seen that there is no evidence that the change in test scores in the 2011-15 period is associated with future Venezuelan immigration in the 2015-19 period. The estimated coefficients are positive but smaller than the respective standard errors.

[14] Notice that there is mechanical correlation between the dependent variable and the pre-trend variable since 2015 test score is used in the construction of both. The point here is that immigration coefficients do not change when pre-trend is included in the regression.

Table 7 – Falsification tests. Dep. Var.: change in test score between 2011 and 2015

	Math	**Lang**
	(1)	**(2)**
Immigration	0.377	0.368
	(0.567)	(0.464)
Observations	2,509	2,509
R-squared	0.075	0.100

Standard errors in parentheses adjusted for 389 municipality clusters. *** p<0.01, ** p<0.05, * p<0.1. Unit of analysis: schools. OLS regressions of change in average test score between 2011 and 2015 on the change in percentage of Venezuelans between 2015 and 2019. Dep. vars. measured in standard deviation units. Indep. vars.: local-run school and state dummies, and time-varying student and school characteristics. Observations weighted by the inverse of the standard error of the dependent variable.

The exercises presented in this section showed that the positive impacts on math would not have happened in the absence of the influx of Venezuelan students into the Brazilian schools. In the next section, we use heterogeneity analysis to further discuss possible mechanisms behind the results.

5.3 Heterogeneity

This section performs heterogeneity exercises to shed some light on the mechanisms behind the main results. Specifically, we analyse how initial school and student characteristics – measured in 2015, before the immigration process started – conditioned the change in Venezuelan immigration. To make coefficients comparable, we standardised the heterogeneity variables to have mean zero and standard deviation one. We add the standardised variables (one at a time) to equation (1) interacted with the change in the percentage of Venezuelan immigrants. Other control variables are the same as in our main specification (Table 2, column 3 or 6). As we run equation (1) in differences, we do not include the heterogeneity variable in levels. We have three variables related to school characteristics and one variable related to student characteristics. The outcome is the change in test score between 2015 and 2019.

Table 8 report the results for math. The impact on math test scores varies according to the initial test score. As seen in column (1), an average test score of one standard deviation above the mean in 2015 is associated with a smaller effect of immigration on test scores that is about 48% smaller than that observed at the average test score level. So, low-performing

schools benefited from Venezuelan immigration more than high-performing ones. Consistent with this first result, it is observed in column (2) that schools with initially lower pass rates benefited more from immigration. Assuming that pass rate is a proxy for school quality, this result complements findings regarding test scores. Column (3) shows that the interaction coefficient between Venezuelan immigration and school teacher qualification is also negative, which means that the impact tends to be larger in schools having a smaller percentage of teachers who teach the subject they were trained to teach. Although this coefficient is not statistically significant, its sign is consistent with the previous two regarding school characteristics.

Table 8 – Heterogeneity of the impact of Venezuelan immigration on math test scores

	Initial average test score	**Initial pass rate**	**Initial teacher qualification**	**Initial level of mother's schooling**
	(1)	**(2)**	**(3)**	**(4)**
Immigration	2.084***	1.872***	1.754**	1.565**
	(0.543)	(0.709)	(0.753)	(0.727)
Immigration x heterogeneity	-1.080**	-0.995*	-0.676	-0.700*
	(0.444)	(0.523)	(0.646)	(0.410)
Observations	2,509	2,509	2,509	2,509
R-squared	0.065	0.064	0.064	0.064

Standard errors in parentheses adjusted for 389 municipality clusters. *** p<0.01, ** p<0.05, * p<0.1. Unit of analysis: schools. OLS regressions of change in average test score between 2015 and 2019 on the change in percentage of Venezuelans and the interaction between this change and heterogeneity variables. Dep. vars. measured in standard deviation units. Indep. vars.: local-run and state dummies, and time-varying student and school characteristics. Observations weighted by the inverse of the standard error of the dependent variable. Immigration x heterogeneity is the coefficient of the interaction between change in percentage of Venezuelans and each heterogeneity variable measured in 2015. Heterogeneity variables are standardized to mean zero and s.d. equal 1. Teacher qualification is the percentage of teachers who have a college degree in the subject they teach. Mother`s schooling is the percentage of mothers who completed high school.

In terms of student characteristics, we found a marginally significant effect according to the mother's schooling. The interaction coefficient shows that schools presenting a smaller share of students born to mothers who graduated from high school tend to benefit more from immigration. So, bringing the evidence together, it is clear that the Venezuelan immigration has benefited more schools that had worse indicators before the immigration.

Combining these heterogeneity findings with the ones discussed in quantile analysis (section 5.1.1 Quantiles), one can argue that average-achievers from relatively worse schools were the students who benefited the most from immigration. Again, this evidence is

consistent the hypothesis that the impact on grade 5 is mainly coming from peer effects based on family background.[15] Schools experiencing higher positive impacts are below the mean test score of schools in the Northern region. We assume that low-performing students from low-performing schools were not able to take advantage from interactions with higher-achieving peers.[16]

6. Conclusion

This paper analysed the impact of Venezuelan students on student outcomes in Brazilian schools. We explored the episode of Venezuelan political and economic crises in mid-2010s that triggered a massive immigration to other countries as a natural experiment that generated an exogenous influx of immigrants to Brazil starting in 2017 and suddenly increased the share of Venezuelan students in the Brazilian education system.

Using a difference-in-differences strategy at the school level, we found that, between 2015 and 2019, average math test scores increased more in schools that experienced more significant increases in the share of Venezuelan students. In turn, there was no impact on language test scores. The results are robust to changes in student composition and school resources. In addition, we present evidence that the results seem to be unrelated to the previous trend in test scores.

On the one hand, positive effects in math and null effect in language associated with larger impacts in low-performing schools suggest that Brazilian students benefited from peer effects in the subject immigrants could contribute the most given the language barrier. We presented suggestive evidence that Venezuelan students who came to Brazil have better family background than Brazilian students in public schools in the Northern region, so peer effects based on family background seems to be the main mechanism behind our findings. On the other hand, it seems not to be the case that native students suffered from fewer resources caused by the demand for integration of foreign students that could drag school resources out. This is important since Brazilian student achievement in public schools is low and could worsen due to efforts to integrate a relatively large number of newcomers.

[15] Appendix Table A.3 shows the results regarding language. We do not see any differential impact in most specifications.

[16] An alternative explanation would be that teachers paced down class rhythm to better support foreign students due language barriers. In that case, one would expect low-achievers to improve their performance and high-achievers to be negatively impacted. We do not have evidence on this in math.

Concerns regarding massive immigration recently gained a new chapter due to war in Ukraine. This paper contributes to the Economics literature by improving our understanding on how migrants may impact local education systems when the country of destiny is a developing country. Lack of human and financial resources can be a serious issue in that context since these countries already struggle to improve student performance. Nevertheless, our findings show that hosting foreign students do not necessarily harm local student and can be positive in such contexts.

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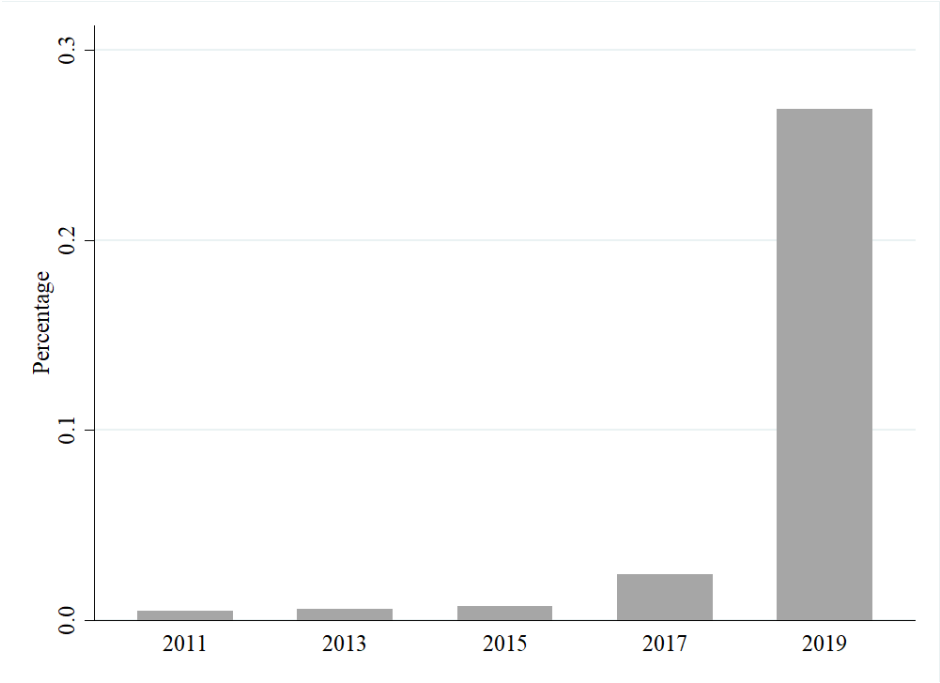
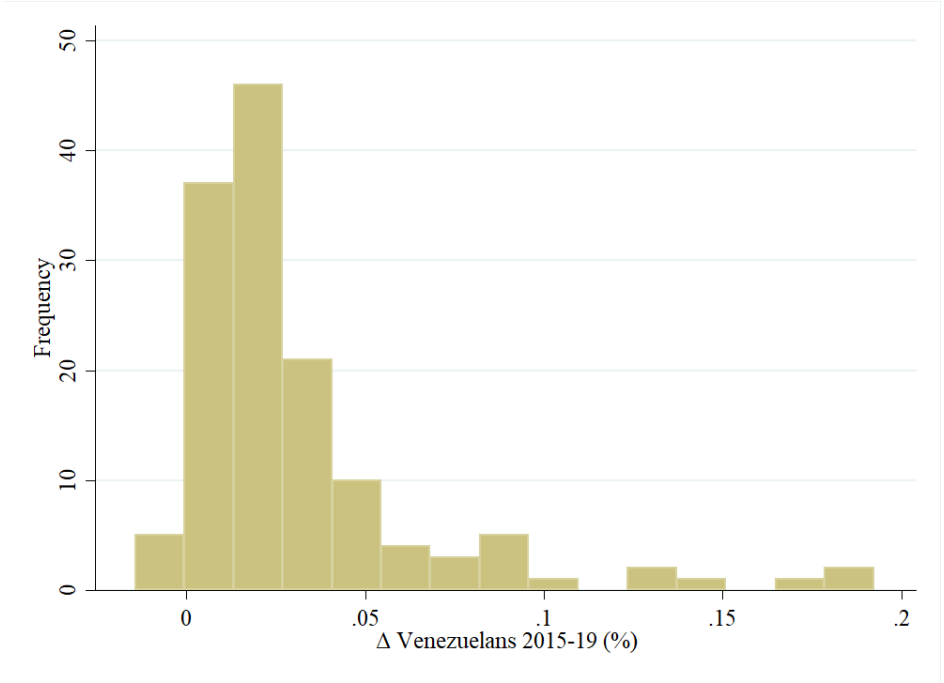
Appendix

Figure A.1 – Percentage of Venezuelans students enrolled in grade 5



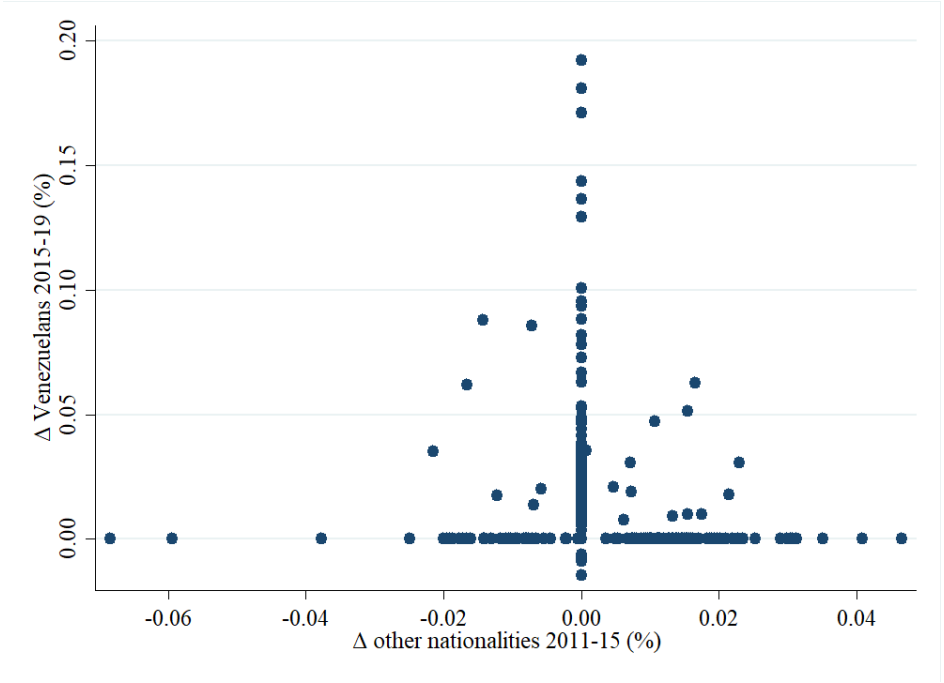
Source: School Census. Authors' elaboration.

Figure A.2 – Distribution of schools according to the change in percentage of Venezuelan students between 2015 and 2019



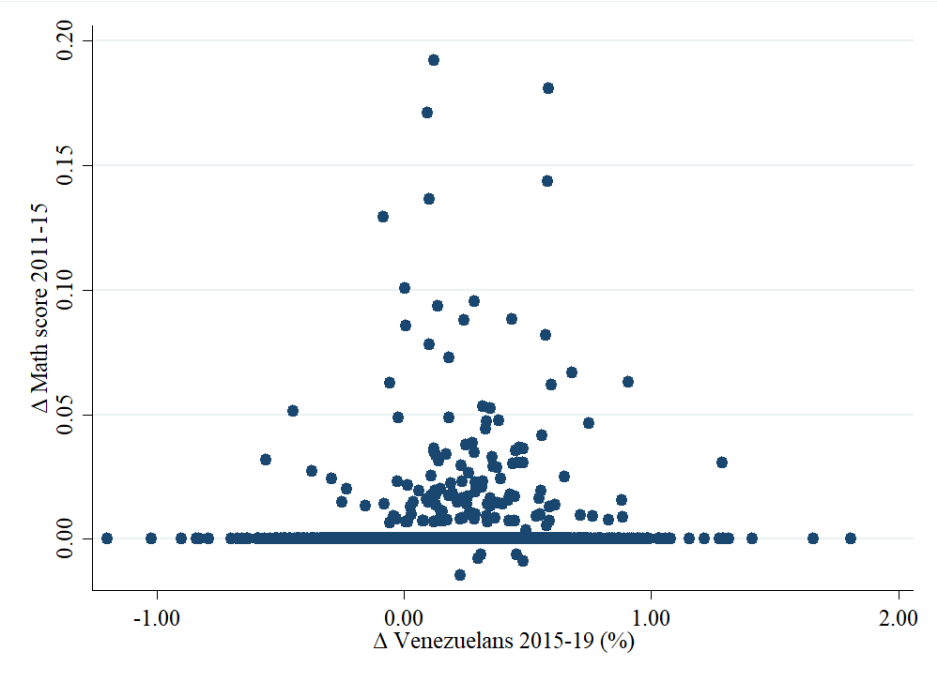
Note: There are 2,371 schools with none variation in the share of Venezuelan students in grade 5.

Figure A.3 – Relationship between change in percentage of Venezuelan and previous change in other immigrants



Source: School Census and Prova Brasil. Authors' elaboration.

Figure A.4 – Relationship between change in percentage of Venezuelan students and previous trend in test score



Source: School Census and Prova Brasil. Authors' elaboration.

Table A.1 – Descriptive statistics

	2015		2019	
	mean	**s.d.**	**mean**	**s.d.**
Goods possession				
Refrigerator				
None	0.04	0.20	0.03	0.17
One	0.79	0.41	0.79	0.41
Two or more	0.17	0.38	0.18	0.38
Computer (yes/no)	0.44	0.50	0.42	0.49
Car				
None	0.69	0.46	0.65	0.48
One	0.24	0.43	0.27	0.45
Two	0.05	0.21	0.06	0.23
Three or more	0.02	0.14	0.02	0.15
TV				
None	0.09	0.28	0.04	0.19
One	0.46	0.50	0.52	0.50
Two	0.29	0.46	0.31	0.46
Three or more	0.15	0.36	0.13	0.34
Home structure				
Bathroom				
None	0.03	0.17	0.02	0.13
One	0.68	0.47	0.64	0.48
Two	0.23	0.42	0.27	0.44
Three or more	0.06	0.24	0.08	0.27
Bedroom				
None	0.03	0.16	0.03	0.16
One	0.16	0.37	0.14	0.34
Two	0.40	0.49	0.43	0.50
Three or more	0.42	0.49	0.41	0.49

Source: Prova Brasil. Authors' elaboration.

Table A.2 – Percentage of population by school degree

Schooling	Venezuelans immigrants	Boa Vista population
Illiterate	0,9	5,41
Incomplete Primary	2,3	18,4
Complete Primary	4,8	6,34
Incomplete High School	14,0	7,41
Complete High School	30,5	35,86
Incomplete College	15,6	8,69
Complete College	31,9	17,9

Source: PNADC 2017 (IBGE) and Simões (2017).

Table A.3 – Heterogeneity of the impact of Venezuelan immigration on language test scores

	Initial average test score	**Initial pass rate**	**Initial teachers qualification**	**Initial level of mother's schooling**
	(1)	**(2)**	**(3)**	**(4)**
Immigration	1.018*	0.629	1.008	1.092
	(0.536)	(0.805)	(0.789)	(0.860)
Immigration x heterogeneity	-0.512	0.0461	-0.350	-0.630
	(0.392)	(0.553)	(0.489)	(0.481)
Observations	2,509	2,509	2,509	2,509
R-squared	0.067	0.067	0.067	0.067

Standard errors in parentheses adjusted for 389 municipality clusters. *** p<0.01, ** p<0.05, * p<0.1. Unit of analysis: schools. OLS regressions of change in average test score between 2015 and 2019 on the change in percentage of Venezuelans. Dep. vars. measured in standard deviation units. Indep. vars.: local-run school fixed effect, state fixed effects, and time-varying student and school characteristics including change in percentage of other nationality students. Observations weighted by the inverse of the standard error of the dependent variable. Immigration x heterogeneity is the coefficient of the interaction between change in percentage of Venezuelans and each heterogeneity variable measured in 2015. Heterogeneity variable are standardized to mean zero and S.D. equal 1. Teacher qualification is the percentage of teachers who have a college degree in the subject they teach. Mother`s schooling is the percentage of mothers who completed high school.