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Internal migration and crime in Brazil

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Abstract: Empirical evidence suggests that the social effects of internal migration may be substantially different from those associated with the arrival of international migrants. In this paper, I provide the first evidence of the effect of internal migration on crime with longitudinal data from Brazilian *microregiões*. Using local labour demand shocks in the manufacturing sector as an instrument for migratory flows, I find that a 10 per cent increase in the in-migration rate translates into a 6 per cent increase in the homicide rate in destinations. Exploring possible channels, I do not find that crime-prone migrants drive the results. The effect is only significant in locations with high past crime rates, indicating crime inertia, and in places with a small informal sector, suggesting that the impact of internal migration is conditioned by the ability of local labour markets to accommodate migrants.

Keywords: Brazil, crime, internal migration

JEL classification: J61, K42, R23

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1 Introduction

Does the arrival of migrants result in more crime? This question is popular in the public debate, especially with regards to international migration into developed countries. However, the existing literature finds no or only very small effects of international migration on crime (and only for specific groups of migrants) (Bell et al. 2013; Bianchi et al. 2012; Chalfin 2015; Özden et al. 2017; Spenkuch 2011). The question is potentially more relevant in the case of internal migration: internal migrants are much closer substitutes for residents in the destination labour markets than their international counterparts. They do not face language barriers or legal restrictions to their participation and they can often move at much lower costs as internal mobility is mostly unregulated. Consequently, an influx of internal migrants may result in unemployment either of residents or of migrants. The labour market effects of migration have been a particular concern in the literature on rural–urban migration (Harris and Todaro 1970; Todaro 1971), and recent empirical evidence confirms that migration into urban areas does indeed give rise to unemployment and lower wages (Kleemans and Magruder 2017). In turn, these labour market effects may lead to higher levels of crime, an association that has also been independently confirmed in the context of the USA (Gould et al. 2002; Grogger and Willis 1998) as well as Brazil (Dix-Carneiro et al. 2017).

In this paper, I provide the first evidence for the effect of internal mobility on local crime rates, focusing on violent crimes (homicides) in Brazil. Crime rates in Brazil are among the highest in the world (UNODC 2013). High crime, especially homicides, comes with a high economic cost. Aside from public safety expenditures, violent crime is shown to have a negative impact on human capital (Monteiro and Rocha 2016) and health (Manacorda and Koppensteiner 2015). According to the Annual Brazilian Public Safety Report 2014, violent crime alone cost Brazil an equivalent of 5.4 per cent of the country's gross domestic product (GDP) (de Seguranca Publica 2014). In addition, rates of internal mobility in Brazil are high, comparable to those in the USA, making it important to establish the relationship between migration and crime.[1]

I estimate the effect of internal migration on homicides in a panel of Brazilian *microregiões* from 2005 to 2010 using the nationally representative Brazilian Census of 2010. The advantage of these data is that they allow analysis at a fine geographic level, and of annual dynamics. Assessing the impact of internal migration on crime at destinations is complicated by issues of reverse causality and omitted variable bias. To overcome this endogeneity, I apply an instrumental variable (IV) approach that has been previously used to study the effects of migration on labour market outcomes. The exogenous variation in the migration rate over time comes from local labour demand shocks in the manufacturing sector in migrants' places of origin (Bound and Holzer 2000; Diamond 2016; Monras 2015; Morten and Oliveira 2016; Notowidigdo 2013).

I find an elasticity of 0.6 per cent between the in-migration rate and the homicide rate. The elasticity can be interpreted as the lower bound of the effect on overall crime rates, because homicides are the most extreme act of crime and are highly correlated with other types of crime in Brazil (Dix-Carneiro et al. 2017). Exploring the channels through which migration might increase crime, I find that less-educated individuals are the most likely to migrate in response to the local labour market shocks. Thus, labour market competition among low-educated workers is expected to rise at migrants' destinations. Yet, those usually associated with high crime—young, uneducated men—are not more likely to migrate than their female or older counterparts, which suggests that it is not necessarily the migrants themselves who commit crimes at the destination. Furthermore, I find that migration increases homicide rates significantly in locations where the informal sector is relatively small and past crime is high, whereas in locations with the opposite setting there does not seem to be an impact of in-migration on homicides. These variables

[1] Approximately 20 per cent of Brazilians had moved to another *microregião*, according to the 2010 Census.

have been shown to be significantly related to high crime levels and it appears that in such locations their effects become exacerbated as labour market competition increases through migration.

This paper is structured as follows. An overview of the literature on crime and migration in Section 2 is followed by setting the context of crime in Brazil in Section 3. Next I describe the data and define the variables used in the analysis (Section 4). Section 5 explains the empirical methodology. Thereafter, results are presented and discussed in Section 6. Section 7 discusses possible mechanisms. Section 8 presents robustness checks and sensitivity tests, before I conclude in Section 9.

2 Literature review

In the economic model of crime (Becker 1968), unemployment and low wages both reduce the opportunity costs of crime. The empirical literature confirms this for property crime in the USA (Gould et al. 2002; Grogger and Willis 1998). Kelly (2000) emphasizes that only inequality matters significantly for violent crimes in the USA. Evidence for developing countries is thinner, despite the high prevalence of crime and inequality in some regions, such as Latin America. Fajnzylber et al. (2002) present cross-country evidence for the positive effect of inequality on crime, including developing countries. They also document that crime is countercyclical in occurrence and that past crime is a strong predictor of current crime levels. Demombynes and Özler (2005) find that in South Africa higher inequality is related to higher property crime. Evidence for Latin America comes mainly from Mexico, where homicide rates have increased severely in the past decade. Inequality significantly predicts drug-related homicides (Enamorado et al. 2016). For Brazil, there is evidence that inequality, urbanization, and unemployment are determinants of federal homicide rates (Sachsida 2013; Sachsida et al. 2010), but income, male population, drug use, firearm ownership, incarceration rate, and police effectiveness are also strongly correlated with crime (Cerqueira 2014b). A recent study by Dix-Carneiro et al. (2017) is the first to identify the causal effect of local economic shocks on crime in a developing country by exploiting the trade liberalization in Brazil as an exogenous shock. Their findings confirm that worse employment rates increase crime in the medium term.

Migrant inflows arguably constitute a different kind of economic shock, but one that can also impact the local labour market in the migrant destination. In the US context, the literature has found that the arrival of internal migrants has no effect on local wages in the destination cities in the USA, but reduced the hours worked and induced out-migration among residents (Boustan et al. 2010). The only evidence on this topic in a developing country context comes from Kleemans and Magruder (2017). They study the effect of internal migration on local labour markets in Indonesia and find that in-migration increases unemployment and lowers wages for residents in the destination areas. Furthermore, they demonstrate how the impact differs for formal and informal sector workers. The formal sector is affected in terms of employment, whereas incomes are only affected in the informal sector. These findings point to a negative impact of internal migration on destination labour markets. This negative effect could further lead to an increase in crime rates.

The impact of migration on crime has been studied only in the context of international migration (Bianchi et al. (2012) for Italy, Bell et al. (2013) for the UK, Spenkuch (2011) and Chalfin (2014, 2015) across US counties, and Özden et al. (2017) for Malaysia). These studies conclude that immigration has no effect, or only a weak positive effect, on property crime, but all emphasize that there is heterogeneity in the group of immigrants. Immigrants with few labour market prospects, such as unskilled Mexican immigrants in the USA or asylum-seekers in the UK, increase property crime rates, whereas those immigrants with qualifications and legal access to the labour market, such as Polish immigrants in the UK, have no effect on property crime, or they are even associated with lower crime rates relative to residents.

This paper contributes to the literature by analysing a possible determinant of crime that has not been considered so far: internal migration. The literature on migration and crime has focused so far only on international migration, even though internal migration occurs at much higher rates and differs in its dynamics and the migrants' characteristics. By focusing on Brazil, this paper enriches the literature on internal migration and its consequences in developing countries.

3 Homicides in Brazil

The literature on migration and crime tends to focus on property crime because it can be seen as an economic activity with economic benefits and opportunity costs (Becker 1968). Furthermore, in most cases, empirical studies in developed countries do not find any significant effect of international immigration on violent crimes (Bell et al. 2013; Bianchi et al. 2012). In those countries, violent crime is comparatively low in contrast to Brazil, which ranks as one of the most violent countries in the world in terms of homicides. Many Latin American countries have high homicide rates, driven either by civil war-like struggles (Colombia) or wars between the state and drug gangs (Mexico) (Fernandes and de Sousa Nascimento 2007).

In Brazil, violence is not easily traced to any one factor. In some areas of the country, such as large metropolitan cities or the Amazon, illegal markets have emerged over the past few decades. The drug trade or trade of tropical woods are markets outside the legal order, and agents use violence to enforce their rules (Chimeli and Soares 2011). Violence between drug gangs in Rio de Janeiro has regularly featured in the global news and is often accompanied by crime unrelated to drugs in areas adjacent to drug-trade areas in the city (Fernandes and de Sousa Nascimento 2007). Other sources of conflict are those concerning land, dating back to the colonization of Brazil; such conflicts are often encountered in the context of indigenous or landless populations of Brazil (Hidalgo et al. 2010). All these points of conflict contribute to high homicide rates. Those who are mainly involved in committing homicides and those mostly victimized are young non-white men, reflecting the underlying socio-economic issues of violence in Brazil (Reichenheim et al. 2011).

Additionally, many weapons found their way into the country during the dictatorship from the 1960s to the 1980s, and thus unreported firearm ownership is common. Small crimes such as street robbery can easily end with violent and often deadly results. In the words of Fernandes and de Sousa Nascimento (2007: 228), 'Brazil is a society with rates of firearm victimization that surpass some countries at war.' Despite the introduction of a disarmament law in 2003, crime does not appear to have reduced. The state of São Paulo was the only one successful in the reduction of death due to firearms (De Castro Cerqueira and Pinho De Mello 2012).

In most studies, crime rates are a combination of property crime, such as burglary and theft, and violent crime, with homicide as the most extreme case. In contrast to the USA, for example, there is little reliable Brazilian data on property and other crimes, aside from homicides. Dix-Carneiro et al. (2017), who investigate impacts of local employment shocks on homicide rates, show highly significant correlations of homicides and various other crimes for *microregiões* in the two most populous states of Brazil for which such data are available. Homicide rates are therefore a strong indicator of general crime rates in Brazil, and any effect found on homicide rates can be seen as a lower-bound estimate for the impact on overall crime.

4 Data, variables, and definitions

The sample of analysis is an annual panel of destination *microregiões* spanning the period 2001–10. *Microregiões* are geographic and administrative agglomerations of municipalities sharing a labour market and economic activities, a bit larger than counties in the USA. The hypothesized effect of migration on crime is expected to be channelled through the labour market. Thus, local labour markets provide the best unit of observation. The data for the dependent, independent, and instrumental variables come from different sources and require aggregation in the case of migration rates.

4.1 Migration

The migration data come from the Brazilian Population Census of 2010. Every 10 years, the Brazilian National Institute for Geography and Statistics (IBGE) conducts a nationally representative household survey (*Censo Demográfico* 2010, IBGE 2012). This survey comprises approximately 20 million individuals in all *microregiões* of Brazil, covering 10 per cent of the whole population. It contains information on household composition, living conditions, the labour market, education, geographic location, and migration. I construct a panel of annual migration between *microregiões* from retrospective migration questions. Each individual is asked about their former *microregião* of residence and of work and the time since migration in years. For each year from 2001 to 2010, based on which year the individual stated as being the year of her or his move, I aggregate the in- and out-migration rates at the *microregião* level. The sample of migrants is restricted to working-age male and female Brazilians,[2] because the interest lies in labour market dynamics. For the aggregation from the individual to the *microregião* level, I apply population survey weights. I restrict the definition to people who move at least 252 km. This is the median distance that migrants in the data move. I do this to avoid capturing people who just move to their neighbouring town. The definition of migration between *microregiões* ensures that migrants move between local labour markets and not within them. This definition also reduces the concern of spatial correlation between the instrument measured at origins and the dependent variable observed at destinations. In the robustness checks (Section 8.1), I change the distance cut-off to test whether such potential spatial spill-overs affect the results.

The in-migration rate $\mathrm{M}_{m,t}$ is the number of migrants in *microregião m* in year t relative to the local population in the previous year per 100,000 inhabitants:

$$\mathrm{M}_{m,t} = \mathrm{Immigrants}_{m,t} * 100,000/\mathrm{Population}_{m,t-1} \tag{1}$$

I use the rate of migration relative to population and not the absolute number of migrants, because I expect the effect of migration to be different if 10 migrants arrive in a *microregião* of 100 people compared to one with 100,000 people. It is also the same unit as the dependent variable, homicides per 100,000 inhabitants, which allows for an easier interpretation of the estimates.

4.2 Homicides

Homicide rates—that is, the number of homicides per 100,000 persons living in a *microregião*—come from the Brazilian System of Death Registration (SIM) maintained by the Brazilian Ministry of Health (Ministério da Saúde). Data were extracted from the Department of Public Health Information (DATASUS), which is regarded as the most reliable information source on homicides in Brazil (Cerqueira 2012). Homicides are those deaths registered with the codes X85 to Y09 according to the international coding of violent deaths in the Global Burden of Disease 2004 Update by the World Health Organization (Murray et al. 2013).

[2] The legal working age in Brazil is 16 years, and the retirement age for men is 65 years. All individuals in the sample are currently not in school.

Even though homicide is the most extreme type of crime and, as such, is more likely to be reported than other crimes, there are known issues of under- and non-reporting in Brazil (Cerqueira 2014a). However, at the level of the *microregião*, there are only 34 *microregião*–year observations with missing values.

4.3 Instrumental variable

Data on employment and wages in the manufacturing sector at the *microregião* and national level come from the RAIS (Annual Social Information Report),[3] a national employment registry.[4]

4.4 Additional variables

Data on municipal population size are obtained from *Ipeadata*.[5] These are projections based on the 2000 and 2010 Censuses.

4.5 Summary statistics

In Table 1 I present the summary statistics of the two main variables, homicide and in-migration rates in the 558 *microregiões* from 2005 to 2010. The number of observations is only 3,316 due to 34 *microregião*–year observations with missing homicide rates. The in-migration rate is, on average, 350 migrants per 100,000 inhabitants. An average of 19 out of 100,000 people in a *microregião* were murdered each year in the study period. This rate is very high in international comparison, where the average homicide rate was approximately 7 in 2010 (UNODC 2011).

Table 1: Descriptive statistics of main variables, destination *microregião*–year observations

	N	Mean	Std dev.
Homicide rate	3,316	18.5	14.5
In-migration rate	3,316	324.6	384.04

Source: author's compilation based on data sources discussed in the text.

The standard deviations of the main variables presented in Table 1 indicate a large variation across *microregiões*. Figures A2 and A3 in the Appendix show the distribution of the two main variables across the country, pointing at some hot-spots for crime and some major migration destinations and indicating some overlap. The variation within the greater regions of Brazil emphasizes the value of studying the relationship between internal migration flows and crime at the sub-regional level. The overlap in the maps is confirmed by a simple plotting of the correlation between homicide and in-migration rates in Figure A1. Higher in-migration rates are associated with higher homicide rates. To establish a causal relationship, however, an IV approach will be used.

[3] The Annual Social Information Report (RAIS, *Relação Anual de Informações Sociais*) is collected by the Ministry of Labour and Employment and comprises approximately 97 per cent of Brazilian formal enterprises.

[4] The manufacturing sector is used as a broad term for the processing industry. It is category 'C' in the updated national code of economic activities (CNAE) by the IBGE, and it includes the two-digit level from 10 ('Production of food products') to 33 ('Maintenance, reparation and installation of machinery and equipment') (IBGE 2012).

[5] Ipeadata is an online data pool provided by Ipea (Instituto de Pesquisa Econômica Aplicada), a Brazilian public research institute that collects the data from several ministries and other public sources.

5 Methodology

5.1 Empirical strategy

This paper estimates the effect of internal migration on crime rates at the local level. I estimate a log–log first-difference model of crime on in-migration:

$$\delta \ln(\mathrm{H})_{m,t} = \beta_1 \delta \ln(\mathrm{M})_{m,t} + \beta_2 \delta \ln(\mathrm{Pop})_{m,t} + T_t + \varepsilon_{m,t} \tag{2}$$

The change in the homicide rate H in *microregião m* from year $t-1$ to year t is a function of the yearly change in the rate of in-migration M into *microregião m*. By taking the first difference, any time-invariant unobservable characteristics of each locality are captured. The year dummy T_t controls for year-specific events that affect all *microregiões*, such as the global economic crisis that hit Brazil in 2009–10. ε is an idiosyncratic error term. Standard errors will be clustered at the state level as, in Brazil, public safety and the homicide reporting system fall under state legislation.

Population is included to control for the natural population growth in each location. All regressions are also weighted by *microregião* population following the health literature, which shows that mortality realization is an estimator of the underlying mortality probability (Dix-Carneiro et al. 2017). Other applications are seen, for example, in Bell et al. (2013).

The estimated coefficient β_1 measures the percentage change in homicide rates associated with a 1 per cent change in the migration rates.

Two econometric issues arise in the context of estimating β_1. First, there might be unobservable factors that affect homicide rates and immigration rates, such as labour market institutions or police effectiveness. Assuming that such unobserved variables do not vary over the study period, the first-difference model eliminates their effect.[6] Second, there is the problem of reverse causality between crime and migration. The lower crime rates are, the more attractive a location might be for migrants. This would bias the estimate downwards. Alternatively, the higher the crime rates are, the larger the illegal market will be, which could attract specific types of migrants. In this case, one would overestimate the impact. To identify the causal effect of immigration on crime, I apply an IV strategy.

5.2 Instrument for migration rates

The IV has to be a strong predictor of migration but independent of crime rates at the destination of migrants. It has to predict that migrants leave their origin and that they choose one destination over another (Card 2001). To estimate a fixed-effect panel model, the instrument for this analysis also needs to predict variation in migration over time.

I adopt an IV strategy that has been used in the literature to study local labour market dynamics. The recent applications by Bound and Holzer (2000) Notowidigdo (2013), Monras (2015), Diamond (2016), and Morten and Oliveira (2016) showed that if a sector experiences a slump at the national level, then wages or employment will fall in locations where this sector usually employs a large share of workers. This crisis affects workers' decisions regarding whether to stay in or leave these locations. I employ such local labour demand shocks in the manufacturing sector to create exogenous variation in the migration rate.

The intuition behind the first stage is the following. Consider a *microregião m* hosts immigrants from a specific origin o. If origin o is affected by a local labour demand shock S, I expect this to change the

[6] I do not include additional time-varying control variables, such as unemployment rate, because they are likely to be endogenous.

rate of migrants arriving in *microregião m* from origin o in the following period. The sector-specific local labour demand shock in year t, $S_{o,t}$ is an interaction of the employment share in a specific sector in location o in the pre-study year 2003, $\mathrm{e}_{o,2003}$, and the national employment growth of that sector, $\bar{E}_t^S$, in each year t of the analysis.

$$\mathrm{S}_{o,t} = \mathrm{e}_{o,2003} * \bar{E}_t^S \tag{3}$$

If employment falls at the national level in sector S, demand for workers in this sector is lower and people might lose their jobs. Employment or other economic shocks in one *microregião* cannot change this national trend.[7] This is why I can assume the national employment growth to be exogenous. Instead of the national wage growth, Monras (2015) used a dummy indicating whether the year was before or after the financial crisis hit the USA. Bound and Holzer (2000) used hours worked in a specific sector. I will use national employment growth, like Bartik (1991), but in the robustness checks I will use sector wage growth, as in Diamond (2016).

If the employment share of the sector in a specific *microregião*, e_o, is large, this location will be affected more strongly by the changes in national trends. The mobility of workers is likely to be affected by this variation. The out-migration of workers would change the employment share. I therefore use the employment share in 2003 preceding the study period. This provides variation across origins, and the national employment growth creates annual variation.

Many origins can be affected by such a shock, and destination *microregiões* receive migrants from all origins, not just one. Thus, the term $\mathrm{p}_{o,m}$ is used to weigh each origin o according to its importance as a migrant sender to each specific destination *microregião m*. The weight is based on migration patterns pre-dating the study period, and it follows the literature exploiting the variation of historical migration flows between origin–destination pairs (Bell et al. 2013; Bianchi et al. 2012; Chalfin 2014, 2015; Jaitman and Machin 2013; Özden et al. 2017; Spenkuch 2011). The idea is that the destination choice of migrants follows certain patterns that were established in the past and evolved over time due to networks (Munshi 2003). A migrant from origin A is more likely to go to destination B than to C if, in the past, more people moved from A to B than from A to C.

First, I aggregate all migrants that moved out of an origin *microregião* during the years 2001–04. Next, I compute how many of these migrants moved to each specific destination *microregião m*. Then, $\mathrm{p}_{o,m}$ is the share of the origin–destination-specific migrants over all migrants that left origin o. One can think of it as the probability of migrants leaving origin o to move to destination m. The probability that migrants who move in response to a local labour demand shock S will arrive in *microregião m* is therefore the sum over the shocks in all origins O weighted by the destination-specific migration probabilities of each origin $\mathrm{p}_{o,m}$.

The first stage of the 2SLS IV estimation can thus be written as follows:

$$\ln(\mathrm{M})_{m,t} = \mathrm{b}_1 \sum_{o=1(m\neq o)}^{O} (\mathrm{p}_{o,m} * \mathrm{S}_{o,t-1}) + \mathrm{b}_2 \mathrm{S}_{m,t-1} + \alpha_m + \delta_t + \gamma_s \mathrm{t} + u_{m,t} \tag{4}$$

The in-migration rate in *microregião m* in year t, $\ln(\mathrm{M})_{m,t}$, depends on a lagged local labour demand shock in the origins of migrants, $\mathrm{S}_{o,t-1}$, and on such a shock in destination *microregião m*, $\mathrm{S}_{m,t-1}$.

Finally, the first and second stages also include a control of the lagged local labour demand shock in the destination *microregiões*, $\mathrm{S}_{m,t-1}$, to capture the potential correlation of these shocks across origin and destination *microregiões*. This is to ensure that the demand shock is only related to crime through the migration rate, as required by the exclusion restriction.

[7] In my sample of origin *microregiões*, the local sector employment share is on average lower than that in destinations (10 per cent compared to 18 per cent, respectively). I am therefore not concerned that any of these locations could be the driver of national trends in the sector. Furthermore, each *microregião* is excluded when computing its local instrument.

In the second stage, homicide rates are regressed on the predicted in-migration rate, $\hat{M}$:

$$\ln(\mathrm{H})_{m,t} = \beta_1 \widehat{\ln(\mathrm{M})}_{m,t} + \beta_2 \mathrm{S}_{m,t-1} + \alpha_m + \delta_t + \gamma_s \mathrm{t} + \varepsilon_{m,t} \tag{5}$$

With a valid instrument, the estimation of equation 5 gives a consistent estimate of β, the impact of internal migration on crime. The estimation is performed as a first-difference model as this is more efficient in the presence of auto-correlation.

6 Results

6.1 Reduced form and first-stage results

Table 2 shows the reduced form and first stage of the two-stage least squares (2SlS) estimation. The instrument, the sum of weighted labour demand shocks in migrants' origins, is a significant predictor of crime at destinations (column 1). Column 2 confirms that the first stage is significant. In the third column, a control of the lagged local labour demand shock in the destination *microregiões* is included to capture the potential correlation of these shocks across origin and destination *microregiões*. If they were correlated, their inclusion in the regression should change the size of the coefficient of the in-migration rate. It seems that the destination labour demand variation has to be controlled for as a potential pull factor in this analysis.

Table 2: Reduced form and first stage of the 2SLS regression

Dependent variable:	ln(Homicide rate)	ln(In-migration rate)	
	(1)	(2)	(3)
IV: Origin labour	0.193***	0.295***	0.306***
demand shock in $t-1$	(0.032)	(0.064)	(0.069)
Destination labour	0.951		–3.658***
demand shock in $t-1$	(1.081)		(1.037)
Log(Population)	0.556	–0.421**	–0.442**
	(0.394)	(0.184)	(0.176)
Year dummies	Yes	Yes	Yes
N	2,742	2,742	2,742
F-test / Kleibergen–Paap test	13.8	21.3	19.6

Notes: significance levels * 10, ** 5, and *** 1 per cent. Standard errors are clustered at the state level and all estimations are weighted by the *microregião* population.

Source: author's compilation based on data.

The Kleibergen–Paap test for weak identification is in both cases well above the rule-of-thumb value of 10, which confirms the relevance of the instrument for the first stage. The positive coefficient on the instrument means that if, at the national level, employment in the manufacturing sector grows faster than in the previous year, more people will migrate out from *microregiões* with a relatively larger share of the manufacturing sector. The opposite applies for slower employment growth.

To interpret the first-stage regression of the 2SLS estimation, it is important to understand how the local demand shocks affect local economies and, consequently, out-migration from the origins. Table 3 shows the coefficients of a fixed-effects regression of local GDP, wages, and formal sector employment in origin *microregiões* on the first lag of the instrument, the manufacturing sector labour demand shock. The estimates show a positive significant relationship for the study period in the origin *microregiões* for GDP, employment, and wages. If national employment in the manufacturing sector grows slower than in the previous year, local economies of locations with high manufacturing employment suffer. If there is a boom, meaning higher employment growth, these locations benefit. These variations in local economic conditions affect migrants' moving decisions, as Monras (2015) has shown.

Table 3: Ordinary least squares (OLS) regression of the local economy on the instrument in origin *microregiões*, 2005–10

	ln(GDP)	ln(Wages)	ln(Employment rate)
Manufacturing labour	0.414*	0.203***	0.117*
demand shock in $t-1$	(0.206)	(0.051)	(0.057)
Log(population)	0.097	0.005	0.327***
	(0.096)	(0.068)	(0.089)
Year fixed effects	Yes	Yes	Yes
Microregião fixed effects	Yes	Yes	Yes
N	2790	2780	2780
R^2	0.197	0.846	0.334

Notes: significance levels * 10, ** 5, and *** 1 per cent. Standard errors are clustered at the state level. Wages and employment rate are only for the formal sector.

Source: author's compilation based on data.

In some contexts, out-migration can be less likely in response to negative shocks compared to positive local shocks due to the presence of migration costs and credit constraints (e.g. Notowidigdo 2013). Morten and Oliveira (2016) find for Brazil that '37% of the total incidence of a [local] shock falls on residents [if migration is costly], compared to 1% in a model where migration is costless'.[8] Guriev and Vakulenko (2015) show that internal out-migration is restricted by migration costs, credit constraints, and poverty. The out-migration rate from less-developed locations in Russia increases with an increase in income and declines in credit constraints in these areas. Hirvonen (2016) finds that Tanzanians exposed to negative income shocks are less likely to migrate at the individual and household level.

In the context of this paper, the majority of migrants are low-skilled. Therefore, I expect the majority of workers to be in the lower quantiles of the income distribution so that migration costs matter and migration flows depend on income levels. A positive shock increases incomes at origins so that workers can afford to move. This explains why the first-stage result shows a positive correlation between local labour demand shocks at the origin and in-migration at the destination.

6.2 Second-stage results

The results of the second stage are presented in Table 4. The first column shows the results of a simple fixed-effect estimation that does not account for the endogeneity of migration and crime. In this regression, there is no significant relationship between migration and crime. Once I instrument for the in-migration rate in column 2, there is a strongly significant impact of the in-migration rate on crime, with an elasticity of approximately 0.6 per cent. As expected, reverse causality leads to an underestimation of the relationship, such that the IV-2SLS result is larger than the OLS result.

I find that, on average, a 1 per cent increase in the in-migration rate into *microregiões* in Brazil in the period 2005–10 is associated with a significant increase in homicide rates of 0.63 per cent. This effect is comparable to the magnitudes other studies have found for the impact of migration on crime when looking at international immigrants. Özden et al. (2017) find a negative elasticity of –1.8 per cent of international immigration on violent crime in Malaysia. Bianchi et al. (2012) find no effect on most crime but an elasticity of 1 per cent of immigration on robbery in Italy.

The average migration rate over the study period is 325 per 100,000 inhabitants, while that of homicide rates is 18. Thus, if the migration rate increases by 10 per cent to 358, homicides are expected to increase to 18.6, which is, on average, approximately six more homicides per year in a *microregião*.

[8] Cited from the abstract of Morten and Oliveira (2016).

Table 4: 2SLS estimation: homicide rates on in-migration rates 2005–10, second-stage results

	ln(Homicide rate)	
	OLS	IV-2SLS
	(1)	(2)
ln(In-migration rate)	–0.007	0.630***
	(0.029)	(0.213)
Destination labour	1.120	3.259***
demand shock $t-1$	(1.125)	(1.225)
Log(population)	0.536	0.831*
	(0.403)	(0.446)
Year dummies	Yes	Yes
N	2,735	2,735
Kleibergen–Paap F-test		19.6

Notes: significance levels * 10, ** 5, and *** 1 per cent. Standard errors are clustered at the state level. Each regression is weighted by *microregião* population.

Source: author's compilation based on data.

7 Discussion of possible channels

7.1 Channels at the individual level

The results suggest that an increase in migration into destination *microregiões* is associated with a small but significant rise in homicide rates in these locations. The literature on migration and crime suggests different channels to explain this result. Migrants could be criminals and thus increase the crime rates upon their arrival. Another explanation in the context of international migration is that hate crimes against immigrants increase with higher immigration. These channels cannot be tested with the data, because incarceration or victim data do not record previous residences if people moved within Brazil. Furthermore, for internal migration, hate crimes against migrants are less likely. The literature also suggests that immigrants with restricted access to the labour market might be more prone to committing crime due to lower opportunity costs. Internal migrants, however, do not face legal or language barriers to participation in the destination labour market.

Studies investigating the impact of internal migration on local labour markets found negative effects of migration on wages and employment of residents at destinations (Boustan et al. 2010; Kleemans and Magruder 2017). This could lead to higher rates of crime committed by residents who lose their jobs or receive lower wages. For Brazil, the only panel data available on labour market variables with national coverage concern formal sector employment (RAIS). This is not very informative for the Brazilian case, because the informal labour market is very large. Kleemans and Magruder (2017) document that in a developing country with a large informal sector, the impact of rural to urban migration is different for formal and informal sector workers.

Those who are statistically most likely to be involved in crime in Brazil are young, unskilled men (Reichenheim et al. 2011). I thus look further into the characteristics of workers who migrate in response to the sector-specific demand shocks. I run a regression at the individual level predicting the probability of a migrant being either low-educated, female, and young, or a young, low-skilled man on the sector-specific shocks. The marginal effects in Table 5 show that the migrant workers who move in response to a local manufacturing labour demand shock in origin *microregiões* are significantly more likely to be low-educated or to be aged above 25 years. There are no significant differences between the sexes. Consequently, the young, male, and low-skilled workers are significantly less likely to move in response to the instrument. It should be noted that the migration responses to local labour demand shocks in 2009

were different from the other years. Women are significantly more likely to migrate, and the effects are much larger for all groups. This could be a response to the global economic crisis that briefly hit Brazil in that year triggering different responses than in 'normal' years.

Table 5: Migrants' characteristics in response to local labour demand shocks at origin, by year

Year	Probability to be				*N*
	Low-skilled	Female	Young (16–25 years)	Young, male, low-skilled	
2009	2.696	18.008***	–29.524***	–12.098***	178,296
	(3.932)	(4.064)	(3.891)	(2.662)	
2008	4.330***	–0.230	–1.413**	–1.074***	135,486
	(0.471)	(0.472)	(0.438)	(0.283)	
2007	1.723***	–0.080	–0.987***	–0.277*	138,280
	(0.197)	(0.197)	(0.179)	(0.110)	
2006	2.118***	–0.017	–0.888***	–0.412**	123,029
	(0.248)	(0.249)	(0.220)	(0.132)	
2005	5.061***	0.405	–1.803***	–0.741*	105,273
	(0.572)	(0.573)	(0.497)	(0.296)	
2004	1.079***	–0.051	–0.521**	–0.218*	71,576
	(0.196)	(0.197)	(0.167)	(0.098)	

Notes: significance levels * 10, ** 5, and *** 1 per cent. These are the marginal effects from separate probit estimations of the probability of a migrant to be either low-educated, female, young, or young/male/unskilled in response to the local labour demand shock in a migrant's origin in $t-1$ by year of migration. Standard errors are robust. All regressions include dummies for the state of origin.

Source: author's compilation based on data.

The characteristics of migrants in response to local labour market shocks change somewhat across distances of migrants moved (see Table A1 in the Appendix). Young men are significantly more likely to migrate short distances (up to 100 km), whereas longer distances reveal the same patterns as mentioned above. The effect of migration on crime at different distance cut-offs (see Figure 1) does not show any significant difference between shorter and longer distances, so this selection of migrants does not seem to be the driver of the results.

While the results are not driven by the migration of a crime-prone population, they can partly be explained by the fact that relatively more low-skilled workers move in response to a manufacturing demand shock. These workers add to the unskilled workforce at destinations, increasing the competition for low-skilled jobs and, thereby, the crime rate.

7.2 Labour market structure: informal and criminal sector

The economic model of crime by Becker (1968) argues that individuals are more likely to participate in criminal activities if the opportunity costs and deterrence are very low. Lower deterrence implies a lower probability of getting caught and being punished. Hence, the costs of participating in crime are lower. This depends on sentences in response to crime and on the probability of being caught based on policing measures. Fajnzylber et al. (2002) documented in a cross-country panel comparison that past crime is a significant predictor of higher current crime. If criminal markets are very large and long-established, then this is often associated with less successful policing activities and low deterrence. It is therefore to be expected that the impact of internal migration on crime is greater in areas where there is a large and long-established criminal sector.

Another factor is whether there are enough outside options to the criminal market to increase the opportunity costs of crime. If in-migrants indeed increase the competition in the labour market, this reduces the opportunities to find a job, and hence crime becomes an option. In line with the traditional view by Fields (1975), large shares of informal work contracts in Brazil are due to the strict labour market regu-

lations that make firing difficult and expensive, require payment of minimum wages, contribute to social protection and low working hours, and relax the role of trade unions (Barros and Corseuil 2001; Mariano Bosch 2007). This incentivizes employers to hire informally. Most recent evidence suggests that formally registered firms hire approximately 40–50 per cent of their workforce informally, depending on firm size. The wage differential between formal and informal workers is zero within firms, conditional on individual characteristics (Ulyssea 2010). Thus, the traditional view of informality as a way to keep labour costs low seems valid in the Brazilian context.

If the informal sector is very large, immigrants as well as natives will find many opportunities in this sector, whereas the formal sector will be less easily accessible. The results of Kleemans and Magruder (2017) reflect this. Informal wages are affected by migration, but not informal employment, while formal employment is directly affected by the increase in labour supply. If the informal sector is small, low-skilled workers will be confronted with a very rigid formal labour market and higher chances of staying unemployed. This reduces the opportunity costs for crime for these workers.

These two hypotheses are tested in the data. In Table 6, I present the results of the main regression for specific sub-samples. The first column shows the impact of migration inflows on crime in *microregiões* where the homicide rate has been above the median in the past (in 2000). The effect is 0.6 close to the main result. In those *microregiões* where the past homicide rate was below the median, the effect is insignificant (see column 2).

In the third and fourth columns, I conduct the same exercise with locations where the informal sector is above or below the median size based on the 2010 data.[9] As suggested, in *microregiões* where the informal sector is relatively small, the arrival of more workers is associated with a significantly higher homicide rate. The elasticity is now 0.5. Where the informal sector is large, the IV does not appear to pass the first-stage test, so it is not possible to show a conclusive result for this sub-sample. These results suggest that the prevalence of crime in combination with low availability of outside options to the restrictive formal labour market is associated with a stronger impact of in-migration on local crime rates.

[9] Using the informal sector size of 2010 could imply that the sector size is itself a result of migration. It is not possible to match exactly the *microregiões* from the 2000 Census to the *microregiões* in 2010 due to changes in administrative codes. However, because I do not use the informal sector size within the regression but purely to define the sub-sample, I am less concerned that this should affect the results. Furthermore, recent analysis showed that the informal sector has been shrinking in the past few years (Haanwinckel and Soares 2016), which would work against my result.

Table 6: IV-2SLS regressions, sub-samples

Sub-samples:	ln(Homicide rate)			
	Homicides in 2000		Informal sector size	
	High	Low	Large	Small
	(1)	(2)	(3)	(4)
ln(In-migration rate)	0.560**	0.263	0.144	0.550**
	(0.230)	(0.517)	(0.223)	(0.266)
Destination shock	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Observations	1,340	1,395	1,365	1,370
Kleibergen–Paap F-test	24.4	3.9	4.2	25.0

Notes: significance levels * 10, ** 5, and *** 1 per cent. Standard errors are clustered at the state level and all regressions weighted by *microregião* population. Destination shock indicates that the regression includes the local labour demand shock variable at the destination. Sub-samples are divided into those above and below the median homicide rate in 2000 (18.3), the median share of workers in the informal sector in 2010 (50.6 per cent) in destination *microregiões*.

Source: author's compilation based on data.

8 Robustness and sensitivity of results

8.1 Spill-over effects

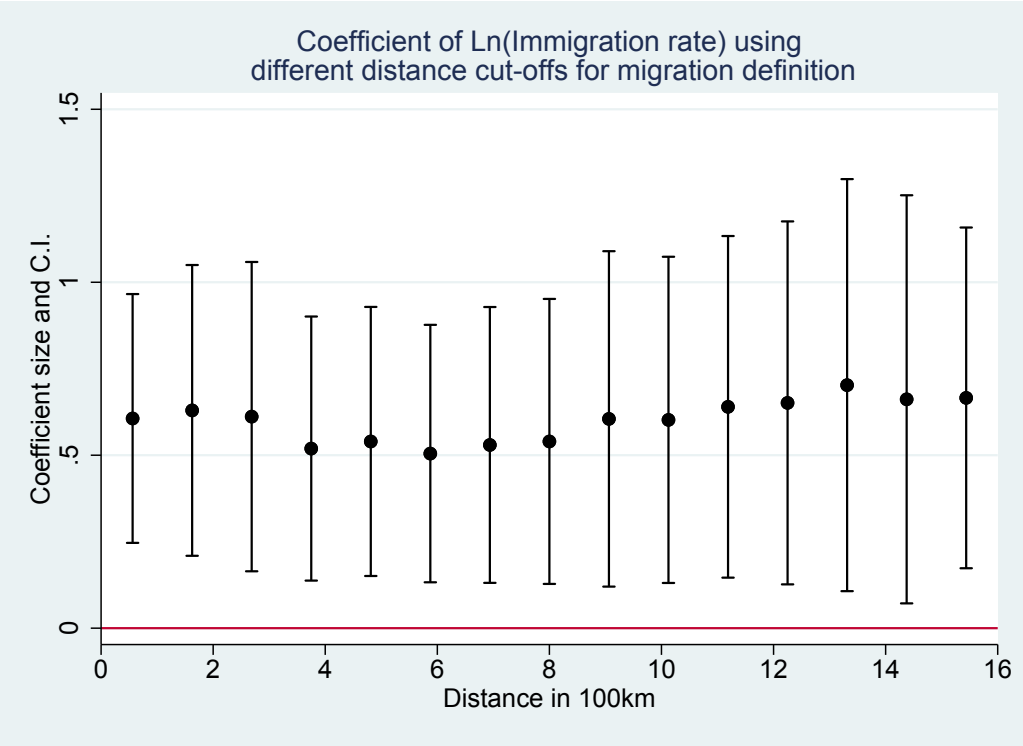
One potential threat to identification is posed by the possibility that manufacturing sector labour demand shocks at origins predict not only out-migration but also other economic activities that may spill over to the migrant destinations.

For example, a negative shock in one origin might cause fewer workers to leave this location and, at the same time, might cause changes in prices of goods produced and their trade. The firms affected will lower the prices of their goods in order to be able to compete in the national market. Their goods will become cheaper relative to the goods produced in another *microregião*. Thus, internal trade from the *microregião* hit by the shock to an unaffected location should increase. This would put pressure on the firms in that destination, and it could imply negative consequences for the local labour market there. Such negative spill-overs could, in turn, lead to more crime in destinations. Such spill-overs would thus work against the estimated effect.

Because data on inter-municipal trade are not available, I conduct the same estimation with different samples for which migration is defined through a minimum distance. I start with 100 km and move up to 1600 km in steps of 100. Trade and labour market spill-overs from the local labour demand shock at origins to the destinations are much more likely under this scenario when distances are shorter. If my main results were driven by inter-*microregião* trade and labour demand spill-overs, I would expect the effect to be strongest for locations that are closer.

The estimated coefficients of in-migration on crime from each of these separate regressions are plotted in Figure 1. The effect is fairly robust to changes in the distance cut-off. Figure 2 plots the corresponding statistics of the Kleibergen–Paap test for weak identification. All results are above the critical value of 10. The main results should not be affected by such spill-overs.

Figure 1: Results for different distance cut-offs in the migration definition



Source: author's elaboration.

Figure 2: Kleibergen–Paap tests for different distance cut-offs in the migration definition

Source: author's elaboration.

8.2 Other sensitivity tests

The computation of the weights that are interacted with the instrument (term $p_{o,m}$ in Equation 4) is based on migration rates from 2001 to 2004. Hence, one concern could be that this short period yields migration patterns specific to these years but not to the study period, and that these migration rates are measured with error due to recall bias. As a robustness check, the weights are computed using the full period for which migration data are available (2001–10) and using the study period from 2005 to 2010. The results of these estimations are presented in Table 7 in columns 1 and 2, respectively. Neither estimate differs from the original estimate of 1.2 per cent.

The third column of Table 7 presents the results of a further sensitivity test using national employment growth in the manufacturing sector instead of wage growth. The effect becomes smaller, indicating again that the instrument used triggers a specific group of migrants to move and captures a local average treatment effect. It is, however, still close to the initial result.

Table 7: IV-2SLS regression: sensitivity analysis

	Ln(Homicide rate)		
	Altering periods for weights		Regional-level employment growth
	2001–10	2005–10	
	(1)	(2)	(3)
ln(migration rate)	0.638***	0.643***	0.598***
	(0.218)	(0.221)	(0.211)
Destination shock	Yes	Yes	Yes
Population	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
N	2,735	2,735	2,725
Kleibergen–Paap Test	19.7	19.8	21

Notes: significance levels * 10, ** 5, and *** 1 per cent. Standard errors are clustered at the state level. Each regression controls for the log of local population and is weighted by *microregião* population. Destination shock indicates that the regression includes the local labour demand shock variable at the destination. Columns 1 and 2 present the results of the main estimation, changing the period used to compute the migration probability weights used to construct the instrument. In column 1, the full period of data available was used (2001–10); in column 2 only the most recent years (2005–10) were used. Column 3 presents the result of the main estimation, but using regional- instead of national-level employment growth to construct the instrument.

Source: author's compilation based on data.

Further sensitivity tests were conducted regarding the level of clustering, including tests for instrument redundancy and under-identification. These are presented in the Appendix, in Table A2. The coefficient of interest does not change, and at all clustering levels the test of instrument redundancy is rejected at the 1 per cent level. Moreover, the test statistic of the Kleibergen-Paap F-test for under-identification is above the rule-of-thumb value of 10.

9 Conclusion

This paper provides the first evidence for the effect of internal migration on crime rates, using data from Brazil. To overcome the endogeneity of migration, local labour demand shocks in the manufacturing sector were used as an instrument.

The results indicate a significant and positive effect of internal migration flows on homicides at migrants' destinations. A 10 per cent increase in in-migrants relative to the local population leads, on average, to

an increase of 6 per cent in the homicide rate in a Brazilian *microregião* in the period 2005–10. A limitation of the analysis is that data availability dictates a focus on homicides. Given that this is the most extreme form of crime, one may expect that the effects are even larger for overall crime rates, given that violent and other crimes are highly correlated in Brazil.

I show that the estimated effect applies to low-skilled migrants. The local labour demand shock in the manufacturing sector used as an instrument strongly predicts the migration of this group of workers. There is no indication that these migrants are more likely to commit crimes based on their demographics, but there are no data available to tell us more about who commits more crime—migrants or residents.

The hypothesis of this paper was that internal migration has an impact on destination labour markets and, through these, affects crime. I therefore investigated heterogeneous effects with respect to labour market structures. The effect is significant and even larger in the sub-sample of *microregiões* with a small informal sector and a larger criminal sector. I suggest that a larger informal sector acts as a buffer that absorbs low-skilled workers in destination labour markets when labour supply increases due to the arrival of migrants. In contrast, in locations with fewer informal work opportunities, crime increases. The effect is also larger and significant if the destination has a historically larger criminal sector. The criminal inertia indicates that deterrence measures are unsuccessful in these locations and that *'crime' is an economically important activity or 'industry'* (Becker 1968: 170).

This study is consistent with the findings of Kleemans and Magruder (2017), who showed that the impact of immigration on local labour markets in developing countries with high informality is different from that of previous model predictions and from empirical analyses that did not include the informal sector (Borjas 2003; Card and Lemieux 2001). In many developing economies, such as Brazil, it is hence important to account for the role of the informal sector.

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Appendix

Table A1: Migrants' characteristic in response to local labour demand shocks at origin in 2008, by maximum distance moved

Distance moved (up to)	Probability to be				*N*
	Low-skilled	Female	Young (16 to 25 years)	Young, male, low-skilled	
100 km	4.604***	–2.838**	0.975	0.965*	33,821
	(0.882)	(0.880)	(0.785)	(0.475)	
500 km	4.224***	0.004	–1.269	–0.714	60,064
	(0.735)	(0.744)	(0.683)	(0.430)	
1000 km	3.882***	0.232	–2.158***	–1.355***	76,231
	(0.659)	(0.667)	(0.617)	(0.398)	
1500 km	4.089***	0.157	–1.896**	–1.294***	85,204
	(0.633)	(0.641)	(0.596)	(0.387)	

Notes: significance levels * 10, ** 5, and *** 1 per cent. These are the marginal effects from separate probit estimations of the probability of a migrant to be either low-educated, female, young, or young/male/unskilled in response to the local labour demand shock in a migrant's origin in $t-1$ by year of migration and distance cut-off moved. Standard errors are robust. All regressions include dummies for the state of origin.

Source: author's compilation based on data.

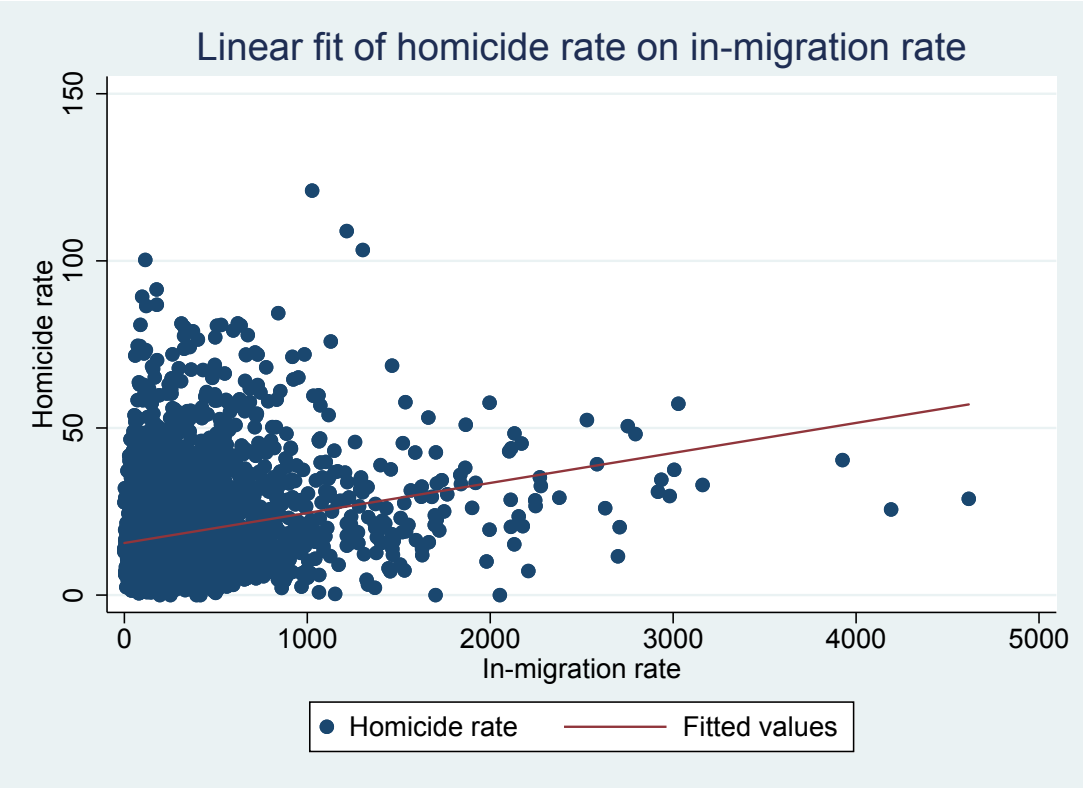
Table A2: Sensitivity tests: 2SLS estimation—homicide rates on in-migration rates 2005–10, second-stage results

	Ln(Homicide rate)	
Level of clustering	*Microregião* (1)	State (2)
ln(In-migration rate)	0.629***	0.629***
	(0.154)	(0.213)
Destination shock	Yes	Yes
Year fixed effects	Yes	Yes
Population	Yes	Yes
Observations	2,735	2,735
F-test of joint significance (second stage)	5.3	5.7
Kleibergen–Paap F-test of under-identification	24.2	19.6
AR test for instrument redundancy (*p*-value)	0.000	0.000
Number of clusters	556	27

Notes: significance levels * 10, ** 5, and *** 1 per cent. The regression is weighted by *microregião* population. Destination shock indicates that the regression includes the local labour demand shock variable at the destination. The estimation presented in column 1 is clustered at the level of *microregião*, in column 2 the federal state.

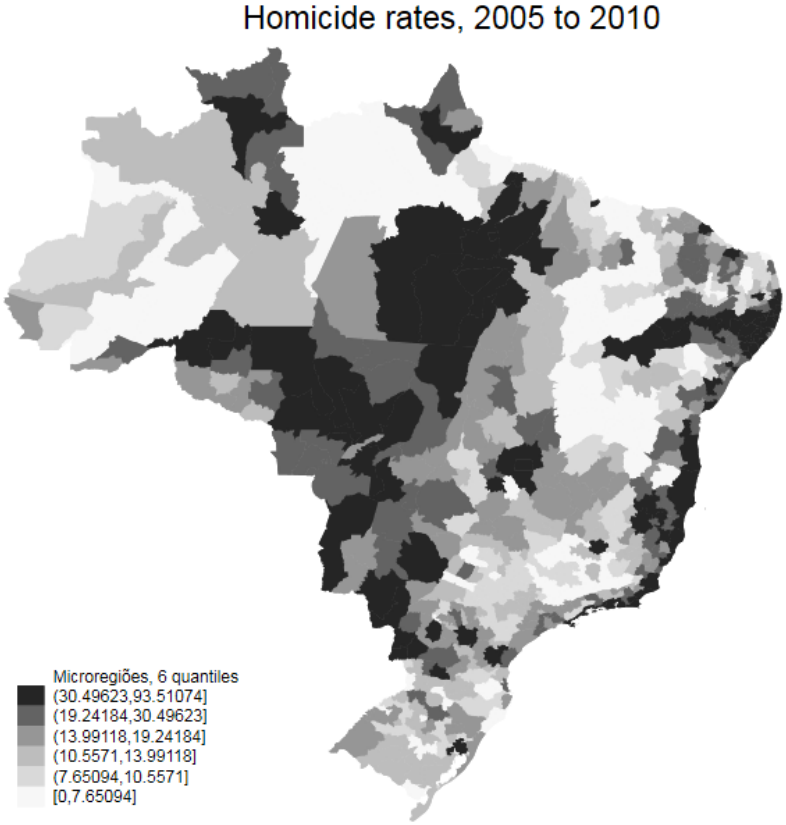
Source: author's compilation based on data.

Figure A1: Correlation of homicide and in-migration rates, 2005–10



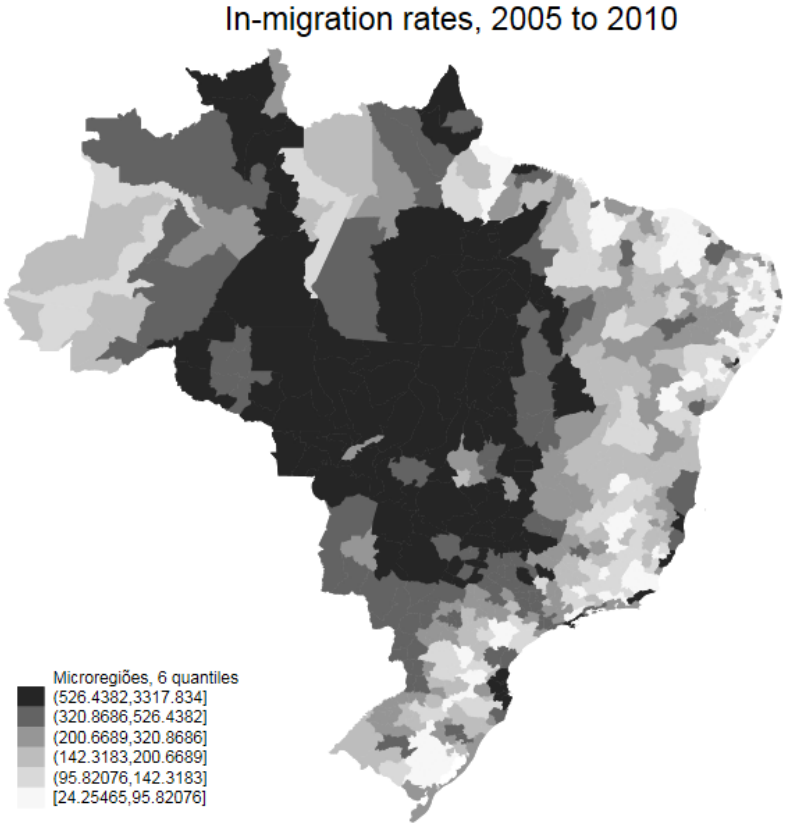
Source: author's elaboration.

Figure A2: Map of average homicide rates, 2005–10



Source: author's elaboration.

Figure A3: Map of in-migration rates, 2005–10



Source: author's elaboration.