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Effect of Actual and Perceived Violence on Internal Migration: Evidence from Mexico's Drug War

Abstract

According to the Organisation for Economic Co-operation and Development (OECD), violence should be considered by examining both actual and perceived crime. However, the studies related to violence and internal migration under the Mexican drug war episode focus only on one aspect of violence (perception or actual), so their conclusions rely mostly on limited evidence. This article complements previous work by examining the effects of both perceived and actual violence on interstate migration through estimation of a gravity model along three 5-year periods spanning from 2000 to 2015. Using the methods of generalized maximum entropy (to account for endogeneity) and the Blinder–Oaxaca decomposition, the results show that actual violence (measured by homicide rates) does affect migration, but perceived violence explains a greater proportion of higher average migration after 2005. Since this proportion increased after 2010 and actual violence, the results suggest that there was some adaptation to the new levels of violence in the period 2010–2015.

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1 Introduction

In 2006, former president Felipe Calderon began the "war against drugs" in Mexico, a starting point for a considerable increase in the levels of violence in the country (Rios Contreras, 2014; Ybañez Zepeda and Alarcon, 2014). The sharp rise in several types of crime, such as homicides, extortion, and kidnapping, during this war provides a valuable opportunity to enrich the understanding about the link between violence and migration, since interest on forced migration at the international level began to rise recently (Fitzgerald, 2015; Engel and Ibañez, 2007).

Previous empirical work on the effects of violence on migration has not been conclusive, but it exposes some important considerations. Various international studies reinforce the argument that violence on certain location promote emigration (Bohra-Mishra and Massey, 2011; Ibañez and Velez, 2005; Engel and Ibañez, 2007; Morrison, 1993; Rios Contreras, 2014). However, estimation of the effects of violence may be sensible to different ways of controlling endogeneity (Basu and Pearlman, 2017) and other determinants of migration such as social and political conditions (Alvarado and Massey, 2010). Furthermore, sensibility of the effect of violence on migration may depend on the level of violence; for example, Bohra-Mishra and Massey (2011) and Morrison (1993) found that this relationship is not linear, i.e., when violence levels in a society are small their effect on emigration is negative, and the effect becomes positive when violence levels increment beyond a certain point. In their study, Ibañez and Velez (2005) found that in the presence of violence, other migration determinants produce opposite effects.

Violence may affect migration decisions depending on individuals' socioeconomic (Arceo-Gomez, 2012) or psychological (Becker and Rubinstein, 2011) conditions. In this regard, Becker and Rubinstein (2011) argued that fear affects emotions, which in turn affect beliefs and behavior; however, individuals adjust the latter, i.e., individuals may control their emotions, so violence may have a null effect on their behavior. Finally, migration analysis may depend whether movements are interstate or international (Chiquiar and Hanson, 2005), so findings by Bohra-Mishra and Massey (2011) suggested that the effect of violence on both types of migration should be analyzed distinctively.

Studies that examine the effect of violence on migration decisions and flows of Mexican population have taken different approaches to deal with some issues mentioned earlier, also reaching inconsistent conclusions that need further analysis. For instance, Rios Contreras (2014) found that drug-related homicides caused migration, and Arceo-Gomez (2012) found that the drug war increased college-educated migration to the USA. Ybañez Zepeda and Alarcon (2014) mentioned that Mexican drug war increased homicides in the northern states of the country, which had an impact on migration patterns. However, the authors based their conclusion merely on descriptive analysis, so their assertion of causality may be considered unjustifiable. Quintana and Salgado (2016) suggested that Mexican drug war reduced immigration to the northern states but increased it to the south and center states of the country, though they do not provide empirical evidence. Moreover, the authors suggested that the effect of violence on migration could be extracted from the fixed effect of a longitudinal econometric model; however, since this effect is particular to each unit of observation—and may include information of other characteristics of such unit of observation—it is difficult to isolate or generalize the effect of violence on migration from these fixed effects. In addition, Robles et al. (2013) and Quiroz Felix et al. (2015) argued that violence in Mexico has caused forced migration,

but they do not provide empirical evidence to support their argument. Nevertheless, these authors showed other negative socioeconomic effects—resumed in increments of crime and a reduced economic activity—caused by Mexican drug war. On the other hand, Alvarado and Massey (2010) found that homicides in Mexico reduced the probability to migrate to the USA, and Basu and Pearlman (2017) found little evidence that Mexican drug war caused interstate migration.

This article proceeds from three important features highlighted in the literature which allow a suitable estimation of violence effects on Mexican interstate migration flows. First, the estimation strategy emphasizes the possible differences in the effects of actual and perceived violence on interstate migration. Since violent actions also affect non-victims (Organisation for Economic Co-operation and Development [OECD], 2011), perceived violence effects may add up to the effects that actual violence has on migration decisions. Thus, the present article departs from other approaches that use only homicide data as an indicator of violence (Ramirez de Garay, 2014; Quiroz Felix et al., 2015; Robles et al., 2013; Quintana and Salgado, 2016; Ceron Monroy and Silva Urrutia, 2017; Meseguer et al., 2017; Ybañez Zepeda and Alarcon, 2014; Feldmeyer et al., 2018) or consider actual violence as a proxy of perceived violence (Basu and Pearlman, 2017).

Second, the estimation strategy aims to comprise a comprehensive set of migration determinants. In this regard, recent studies regarding internal migration in Mexico have departed from the traditional neoclassical economic approach that examines rural–urban migration (Todaro, 1980) by considering determinants related to more than one theoretical approach. Referring to this, Fitzgerald (2015) stated that the theoretical framework regarding economic determinants of migration comprises wage differentials (Bartel, 1979; Harris and Todaro, 1970; Borjas, 1987), diversification strategies of household economic portfolios (Stark and Bloom, 1985; Anam and Chiang, 2007), credit market failures, structural demand of immigrants in modern economies, and liquidity constraints of migration financing. Other group of migration theories take an economic and sociological approach, which include the study of skilled versus unskilled labor migration, localized temporary migration programs (Piore, 1979), and the world systems theory (Bean and Brown, 2015), or a social approach that includes the theory of networks (Bean and Brown, 2015), the role of the State and migration policy (Massey, 2015), and forced migration (primarily refugee policy). Based on these theories, determinants of migration used in recent literature include wage differences (Quintana and Salgado, 2016), gross domestic product (GDP) levels (Soloaga et al., 2010), unemployment rates (Villarreal and Hamilton, 2012), foreign direct investment (FDI) levels (Flores et al., 2013), dummy variables for a common border with the USA (Soloaga et al., 2010; Peeters, 2012), maquiladora employment (Varela Llamas et al., 2017), proportion of previous migrants and distance (Peeters, 2012), education levels (Aguallo-Tellez and Martinez-Navarro, 2013), and population levels (Peeters, 2012; Villarreal and Hamilton, 2012).

Third, Basu and Pearlman (2017) highlighted a potential problem of endogeneity caused by state-characteristic omitted variables that jointly determine migration flows and violence, i.e., there may be factors such as institutions or effectiveness of drug-related organizations that simultaneously determine violence levels and migration flows. To obtain an exogenous variation of the effect of violence, Basu and Pearlman (2017) followed an instrumental variables approach. However, this methodology has two shortcomings: although a valid instrument

provides consistent estimates of the effect of regressors on interstate migration flows, it comes with a loss of precision that increases with weaker instruments (Cameron and Trivedi, 2005). Furthermore, endogeneity may be caused by other spatial–structural factors (Peeters, 2012) that include state-characteristic omitted variables that jointly influence interstate migration and its determinants. Therefore, instead of following the instrumental variables approach, Peeters's (2012) three-way fixed effects method is recommended.

The remainder of this article is organized as follows. Section 2 presents the data, the gravity model, and econometric methods proposed to estimate the effects of perceived and actual violence on interstate migration within Mexico. Section 3 discusses the main results, and Section 4 provides some conclusions.

2 Method

2.1 Estimation strategy

Mexican drug war initiated in the first year of ex-president Felipe Calderon's mandate, i.e., 2006. To appropriately capture changes on the violence structure associated with Mexican drug war and its effects on migration, the empirical analysis considers data from 2000 to 2015. Due to the availability of information on interstate migration in Mexico, the period is divided into three 5-year subperiods that separate the data before and after the beginning of the drug war: the first period covers the years 2000–2005 (before the drug war), the second period covers the years 2005–2010 (beginning of the drug war), and the third period covers the years 2010–2015 (extension and "inertia" of the drug war).

To estimate the influence of violence on internal migration in Mexico, the present study takes the personal security approach referred by the OECD (2011), i.e., the influence of both actual and perceived violence on internal migration. Thus, at first a descriptive and comparative analysis of interstate migration and actual violence—measured by the annual average of state homicide rates—in the three periods examined will be provided. Subsequently, the gravity model expressed in equation (1) will be estimated.

$$lm_{ijt} = c + c_t'\beta + lthomave_t'\gamma + u_{ijt} \tag{1}$$

In this model, the natural logarithm of migrant individuals going from state j (origin state) to state i (destination state) in period t (lm_{ijt}) is a function of $lthomave_t$, a vector of variables referring to the annual average homicide rates (in logarithms) of *destination* and *origin* states, and c_t, a vector of control variables—determinants alluded by the theories mentioned in Section 1 of the present article. Specifically, this vector includes logs of origin's and destination's real GDPs, unemployment rates, education levels (years of schooling), FDI, and populations (15 years and older); also the vector includes the log of the distance between origin and destination (main cities), the difference between destination's and origin's birthrates, the difference between destination's and origin's average daily wages, the log of the proportion of the population from origin living in destination at the beginning of period t (previous immigrant proportion), and a dummy equal to 1 if destination shares a border with the USA. β and γ are parameter vectors to be estimated, c is a constant parameter, and u_{ijt} is the idiosyncratic error.

To deal with endogeneity in model (1), estimation of β and γ entails controlling the individual characteristics of each state for each migration situation—whether it is origin or

destination—in addition to each migration path relation (Peeters, 2012). In other words, estimation requires to control for fixed effects in three directions: origin state, destination state, and origin–destination path.[1] Therefore, following the suggestion of Peeters (2012), the gravity model is estimated using the method of generalized maximum entropy (GME) with three-way fixed effects (3FE). To compare the results with previous work, two-way fixed effects (2FE) estimations by GME—as well as traditional ordinary least squares (OLS) and Poisson pseudo maximum likelihood (PPML)—are also presented.

Subsequently, the effect of violence perception on interstate migration will be estimated by applying the Blinder–Oaxaca decomposition to the GME outcome. By means of this decomposition, equation (1) is divided into equation (2), the predicted migration in the period before the beginning of the drug war (2000–2005)—the reference category for comparison—and equation (3), the predicted migration in period 2 (beginning of the drug war) or period 3 (continuation of the war and the levels of violence), to decompose the difference through equation (4). Although the subscripts shown in equations (2) and (4) denote only for period 2, comparisons are also made between periods 1 and 3.

$$\overline{lm}_2 = X'_2 \alpha_2 \tag{2}$$

$$\overline{lm}_1 = X'_1 \alpha_1 \tag{3}$$

$$\overline{lm}_2 - \overline{lm}_1 = (\overline{X}_2 - \overline{X}_1)'\hat{\alpha}_2 + \overline{X}_1'(\hat{\alpha}_2 - \hat{\alpha}_1) \tag{4}$$

In equations (2) and (3), $\overline{lm_1}$ and $\overline{lm_2}$ represent migration mean predictions in periods 1 and 2, respectively, and $\overline{X}_1$ and $\overline{X}_2$ are vectors of migration determinants in periods 1 and 2, respectively. Equation (4) shows that the difference between migration mean predictions in periods 1 and 2—$\overline{lm_2} - \overline{lm_1}$—can be attributed (decomposed) into differences in migration—determinants conditions (also known as endowments) between periods 2 and 1—$\overline{X}_1'(\hat{\alpha}_2 - \hat{\alpha}_2)$—and differences aside from migration determinant conditions, i.e., unexplained factors related to those determinants—$(\overline{X}_1'(\hat{\alpha}_2 - \hat{\alpha}_1)$. From equations (1) and (4), it is clear that this unexplained component provides information regarding changes in elasticities—expected migration to migration determinants—from period 1 to period 2. Therefore, if a determinant's coefficients difference is not zero, it means that holding constant the level (condition) of that determinant from period 1 to period 2, expected migration changes nonetheless because of a greater elasticity on that determinant.

An important concern in estimating violence perception effects on migration is that interpretation of the unexplained component may include more than changes in perceptions (Barrera-Osorio et al., 2011). Thus, the perception interpretation of the unexplained component relies on two main assumptions: the model includes sufficient determinants that explain internal migration from a theoretical–empirical base, and Becker and Rubinstein (2011) hypothesized that individuals adjust their behavior when they cope with fear holds. The first assumption considers that the Blinder–Oaxaca unexplained component subsumes the effects of group differences in unobserved predictors (Jann, 2008), so its interpretation depends on the

1 The inclusion of the fixed effects presents an econometric problem since the resulting parameters to be estimated surpass the number of observations. For instance, for 32 states, the inclusion of origin–destination path-fixed effects requires the estimation of 992 dummies. According to Corral and Terbish (2015), GME allows the consistent estimation of this model. Besides, Corral and Terbish (2015) mentioned other advantages of GME regarding efficiency.

assumption that there are no relevant unobserved predictors (Jann, 2008)—i.e., an omitted-variables condition (Stanley and Jarrell, 1998)—and the set of observable regressors is sufficiently rich, theoretically derived (Neumark, 1988) to remove all migration differences between the groups, so that any unexplained differences represent ability-type effects (Elder et al., 2009), such as discrimination, favoritism, or perception.

The second assumption considers that, after detailed Blinder–Oaxaca decomposition, the homicide-related components show differences in migration flows in two periods due to different homicide levels (explained component) or different homicide effects (unexplained component). For instance, where homicide levels were equal in two periods, a significant homicide-related unexplained component may indicate migration due to changes in homicides composition (people regard differently drug and nondrug-related homicide types) or violence perception (people may adapt to drug-related homicides according to Becker and Rubinstein, 2011). Since homicide composition changed significantly after the beginning of the drug war, homicide-related unexplained component in periods 1 and 2 may reflect changes in migration flows (mainly) due to changes in homicides composition. However, since homicide composition was similar in periods 2 and 3, a different homicide-related unexplained component of periods 1 and 3 decomposition may reflect changes in violence perception. This way, since decomposition is made on time groups, the homicide-related unexplained component relates to general homicide–violence adaptation.

2.2 **Data**

Following previous work (Basu and Pearlman, 2017; Peeters, 2012; Chiquiar and Hanson, 2005), data on interstate migration flows were compiled using the National Institute of Statistics and Geography (INEGI) information of people's past residence—instead of birthplace—from the 2005 Census of Population and Housing, the 2010 Census of Population and Housing Units, and the 2015 Intercensal Survey. Thus, migration refers to the population who declared residing in a different state 5 years prior to the date of interview, i.e., October 2000, June 2005, and March 2010. A concern using this data is that census information does not provide the timing of migration, so it does not capture information on short-run migration,[2] i.e., individuals who moved more than once within a 5-year period, or close to the beginning or end of each period. Nevertheless, Table 1 shows that this long-run migration data capture the particular characteristic of migration flow increments after the drug war. For instance, net migration flows increased by 15% from period 1 to period 2 and remained high in period 3.

Figure 1 shows that in the period 2000–2005, there were three regions with positive net migration (see Appendix A for a map of Mexico's administrative division): a group of states on the US border,[3] another group in the center—*Bajio*-pacific region of the country, and the group in the Peninsula of Yucatan. On the other hand, during the three periods analyzed the net migration ejectors included states considered as the poorest in the country (Michoacan, Guerrero, Oaxaca and Chiapas), and the northern states that do not share a border with the

2 Basu and Pearlman (2017) showed that short-run migration data from the National Survey of Occupation and Employment (ENOE) is highly correlated to the long-run migration data from the Census.

3 Although Baja California Sur is not on the US border, it is usually considered in this group (see Peeters, 2012).

Table 1 Descriptive statistics on migration data

	Immigration			Emigration			Net migration variation		
	P1	P2	P3	P1	P2	P3	P1–P2	P2–P3	P1–P3
Mean	59,994	82,708	81,905	59,994	82,708	81,905	0.15	0.02	0.55
Standard deviation	59,465	81,641	78,422	75,865	105,981	89,873	1.09	1.46	1.28
Min	16,628	23,417	20,077	8,562	14,236	16,064	–3.36	–5.35	–1.58
Max	323,378	464,284	403,100	382,622	588,895	444,875	2.44	2.96	3.90

Notes: P1 denotes period 1: 2000–2005. P2 denotes period 2: 2005–2010. P3 denotes period 3: 2010–2015.

USA (Sinaloa, Durango and Zacatecas). Thus, it is evident that before the drug war net migration was primarily related to socioeconomic conditions.

Figure 1 shows that after the period 2000–2005, there were slight changes regarding each state's net migration status, though there were interesting changes in migration flows mainly in states that border the USA. For instance, Chihuahua, Coahuila, Tamaulipas and Baja California experienced a net migration drop in the period 2005–2010, but Sonora, Nuevo Leon, and Baja California Sur experienced a net migration increase. The case of Sinaloa (state of origin of the remarkable Sinaloa cartel) is interesting, despite of remaining a net expelling state of migrants the difference between the emigrant and immigrant population decreased over time. Also, Michoacan (another state with significant involvement in the drug war) presented a greater relative expulsion of migrants in each period. Finally, Figure 1 also shows that other non-border states with positive net migration in the period 2000–2005 also presented increases in net migration in the following periods.

State-level homicide rates data[4] in each period were calculated as the ratio of average annual homicides per 1,000 people (15 years or older)[5] from INEGI's state-mortality statistics. Table 2 shows significant differences in average state homicide rates (and standard deviation) across the three periods analyzed, which indicate the overall violence increments after the beginning of the drug war.

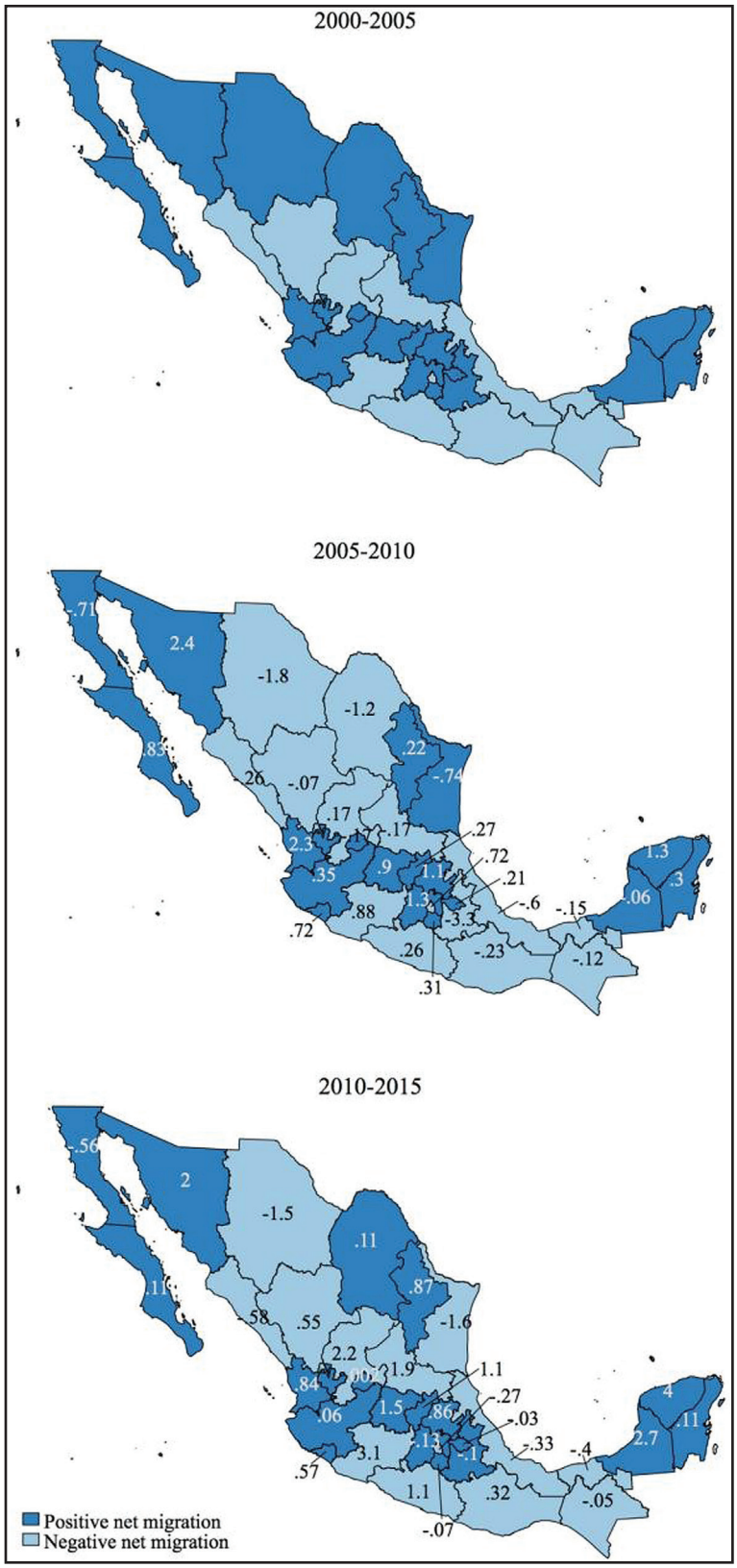
Figure 2 shows that homicide rates in Mexico exhibited spatial (across states) and temporary (across time) disparities along the three periods examined. For instance, there was a clear longitudinal inequality in homicide rates distribution: some states (e.g., Chihuahua) surpassed 0.5 homicides per 1,000 people, while others (e.g., Yucatan) did not exceed the 0.1 rate in any period. Even within the same region there are differences, such as in the case of Chiapas (less than a 0.15 rate in the three periods) and Guerrero (increased from a 0.34 rate in period 1 to more than 1.0 in period 3).

Figure 2 shows that most states (68%) had the lowest annual homicide rate during the period 2000–2005. In the beginning of drug war, most of the substantial increases (as much as 700%) in homicide rates occurred in northern states, where generally homicide rates were

4 A concern is that state-level drug-related violence may be too vague since this type of violence may occur in defined municipalities within a state. However, Figure 1 given by Basu and Pearlman (2017) shows that homicide increment variation within states occurred mostly in more than one municipality.

5 To test if results are sensible to this specification of the homicide variable, since crime and migration may commove and differ across groups, homicide rates were also defined for males (15 years or older) and young males (15–39 years old). However, the results did not vary significantly, so discussion was mainly referred to the original specification. Blinder–Oaxaca decompositions for males and young male homicide rates are shown in Appendices E and F, respectively.

Figure 1 Classification of Mexican states by (internal) net migration condition and period.



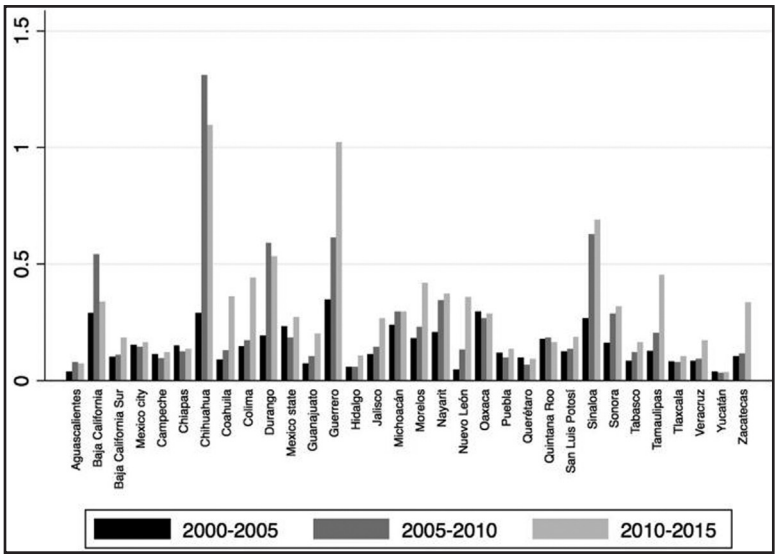
Notes: Positive net migration refers to a greater inflow of migrants (compared with the outflow) into a state. The number expresses the relative change in net migration (compared with the period 2000–2005). Data of this figure are provided in Appendix B.

Table 2 Descriptive statistics on homicide data

	Average homicides			AHR			AHR variation		
	P1	P2	P3	P1	P2	P3	P1–P2	P2–P3	P1–P3
Mean	313	493	731	0.150	0.241	0.309	0.472	0.506	1.158
Standard deviation	371.6	578.9	720.3	0.083	0.256	0.245	0.808	0.604	1.395
Min	23	38	50	0.037	0.034	0.036	−0.311	−0.374	−0.099
Max	1,926	2,774	2,889	0.348	1.311	1.094	3.519	1.955	6.920

Notes: P1 denotes period 1: 2000–2005. P2 denotes period 2: 2005–2010. P3 denotes period 3: 2010–2015. AHR, Average homicide rate.

Figure 2 Homicide rate (per 1,000 people), by state and period.



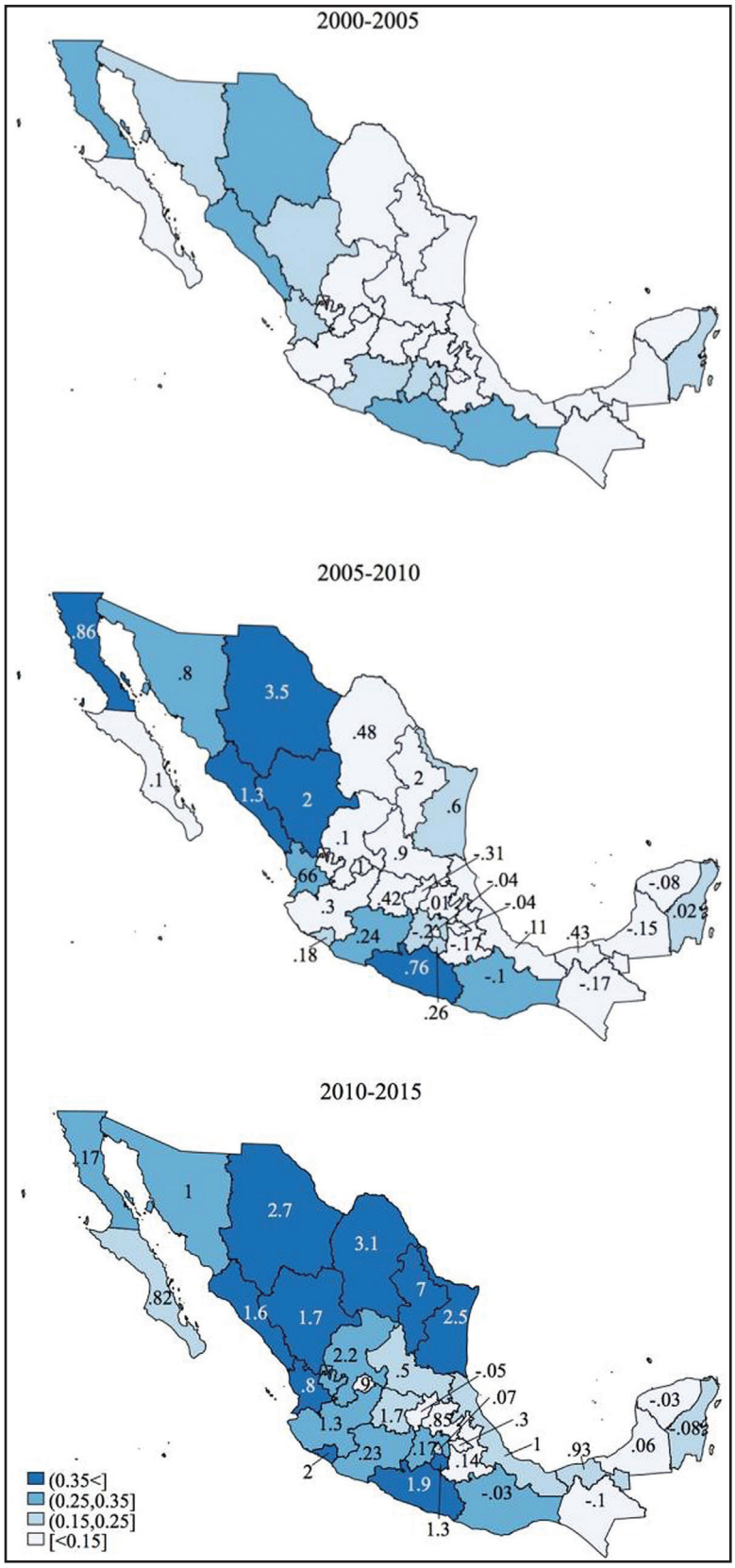
already high. Nevertheless, violence augmented in other regions that presented low homicide rates in the period 2000–2005, increasing more than 100% in some states. Figure 2 also shows that violence persisted across the country in the period 2010–2015, though the most relevant increments were concentrated in the northern region (Figure 3).

Data of other variables used as controls in the analysis—yearly averages of real GDP, unemployment, education, FDI, birthrate difference, population (15 years and older), and wage difference—were generated from INEGI's state information. Distance data were defined as road distance between main cities, i.e., the socioeconomic poles of attraction in each state; the data were taken from the Communication and Transportation Secretariat "Trace your route" application. The descriptive statistics and correlation of explanatory variables are provided in Appendix D.

3 Results and discussion

The geographic location of states that experienced the largest increases in homicide rates during the periods 2005–2010 and 2010–2015 suggests a relationship with net migration changes. However, this relationship is not very clear just by examining Figures 1 and 3 as some states that exhibited an increase in homicide rates became net expellers of migrants (such as

Figure 3 Homicides rate (per 1,000 people) in Mexican states (yearly average), by period.



Note: Numbers in map refer to relative change in homicide rate (compared with the period 2000–2005). Data of this figure are provided in Appendix C.

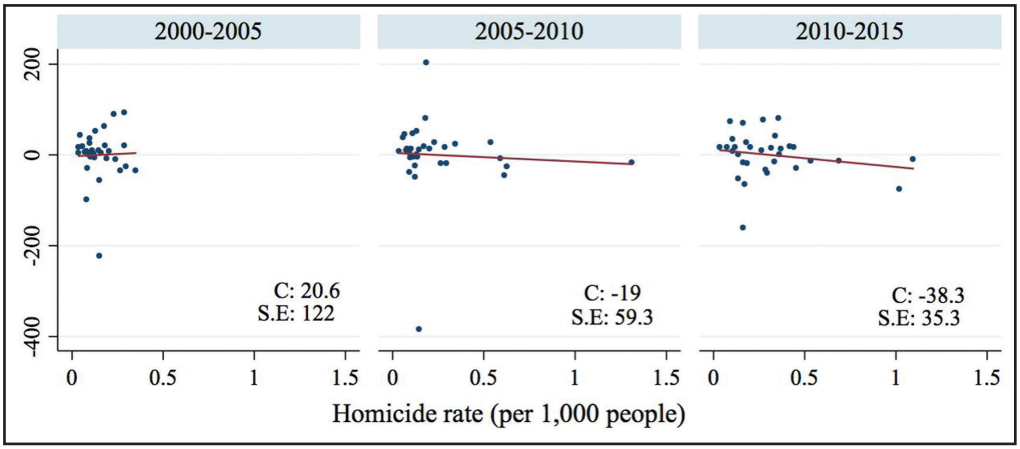
Chihuahua, Coahuila, and Tamaulipas) and others remained net recipients of migrants (such as Baja California and Nuevo Leon).

Figure 4 suggests two aspects regarding the relationship between homicide rates and net migration. On the one hand, in the period 2000–2005 there is no apparent relationship between the two indicators. However, in the period 2005–2010 there is a slight negative relationship, which becomes clearer in the period 2010–2015. Although the negative relationship is not statistically significant, it is evident that the states with the highest annual homicide rates (more than a 0.5 rate) show a negative net migration.

Considering state immigration information, an insignificant, positive correlation with homicide rates during the period 2000–2005 is shown in Figure 5. However, the figure suggests a slight inverse relationship for the following periods, similarly to what was observed with net migration. Therefore, besides insinuating that actual violence may influence interstate migration, temporal changes suggest that there may be a threshold after which migration overreacts to high levels of actual violence (Bohra-Mishra and Massey, 2011; Morrison, 1993), which could be related to perceived violence since overreaction implies changes in the migration–violence elasticity.

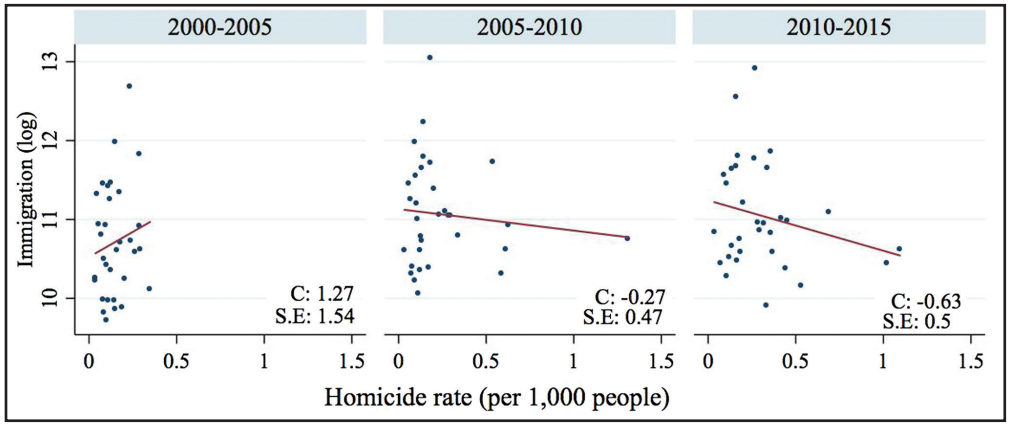
To support a causal relationship between internal migration and actual violence—measured by homicide rates—it is appropriate to realize the formal analysis via econometric

Figure 4 Net migration (in thousands) and homicide rates in Mexican states by period.



Note: C stands for slope coefficient and S.E. for standard error of fitting curve.

Figure 5 Immigration and homicide rates (per 1,000 people) in Mexican states, by period.



Note: C stands for slope coefficient and S.E. for standard error of fitting curve.

modeling and estimation explained in Section 2.1. Table 3 shows estimation of equation (1) considering all periods by the methods explained in Section 2.1: OLS and PPML controlling by fixed effects in two directions (OLS 2FE and PPML 2FE columns, respectively), and GME controlling by fixed effects in two and three directions (GME 2FE and GME 3FE columns, respectively). Since there are structural changes across periods, temporal dummies are included for the periods 2005–2010 and 2010–2015 (periods 2 and 3 dummies, respectively). The results in Table 3 present another advantage of GME 3FE estimates besides controlling endogeneity: most of the OLS and PPML coefficients are not significant at a 95% level despite there is no high multicollinearity among regressors (the correlation matrix is shown in Appendix D). Nevertheless, Peeters (2012) explained that OLS and PPML (even GME 2FE) coefficients are not reliable since path-specific fixed effects are omitted, so GME 3FE results should be considered for interpretation.

GME 3FE estimates in Table 3 show that on average migration increases (decreases) if homicide rates in origin (destination) increase. Likewise, a greater distance between origin and destination reduces migration, but a greater proportion of previous immigrants living in destination increases migration. On average, an increase in real GDP (either in origin or destination) or FDI (in origin) increases migration, and greater unemployment rates in destination (origin) have a negative (positive) effect on migration. Also, if average wage in destination increases relative to that in origin, migration increases, and increments in education levels or population in destination increases migration. Finally, on average states that share border with the USA present greater immigration, as expected. It is noteworthy that the border and education at destination coefficients are the greatest in magnitude.

Additionally, the period 2 dummy indicates that, on average, migration was greater in 2005–2010 than in 2000–2005. Therefore, holding constant other covariates, i.e., other socioeconomic conditions that determine migration, there was an influence of unexplained factors—including the perception of greater violence due to the drug war—that caused an increase in average migration between periods 1 and 2. On the other hand, the period 3 dummy coefficient resulted insignificant, so there is no statistical difference between periods 1 and 3 average migration levels when holding other covariates constant.

The results in Table 3 support that homicide rates do have an impact on migration—on average, homicide rates in destination deter migration while homicide rates in origin increase it. Moreover, they show that on average homicide rates in destination have a slightly greater effect on migration. However, the results in Table 4 show that the effect of violence presents slight differences whether homicides occur in origin or destination, or a different period, after controlling for other covariates. For instance, the negative effect of homicide rates in destination on migration holds only for periods 1 and 2, but in period 3 the effect changed direction, i.e., in the period 2010–2015 an increase in homicide rates—whether in origin or destination—reduced migration.

Since the estimation in Table 4 controls all covariates specified in equation (1) except structural changes captured by dummy estimation of period 3 given in Table 3, the negative effect of origin's homicide rates on emigration in period 3 is explained by other specific characteristic of this period. For instance, violence (homicides) may have different effects on migration decisions in period 3 because there were greater levels of violence (Bohra-Mishra and Massey, 2011;

Table 3 Gravity equation estimates (OLS, PPML, and GME)

	OLS 2FE	PPML 2FE	GME 2FE	GME 3FE
Log homicide rate (destination)	−0.125	−0.019	−0.122	−0.117
	(2.45)*	(2.52)*	(4.68)**	(6.13)**
Log homicide rate (origin)	0.065	0.012	0.066	0.092
	(2.70)*	(3.35)**	(2.56)*	(4.81)**
Log distance	−0.15	−0.014	−0.152	−0.913
	(4.90)**	(2.44)*	(8.40)**	(19.53)**
Log GDP (destination)	0.37	0.033	0.367	0.465
	(1.63)	(0.84)	(3.06)**	(5.28)**
Log GDP (origin)	0.342	0.067	0.357	0.266
	(1.75)	(2.02)*	(2.99)**	(3.02)**
Log unemployment (destination)	−0.2	−0.031	−0.212	−0.35
	(1.59)	(1.77)	(3.94)**	(8.80)**
Log unemployment (origin)	0.01	−0.001	0.012	0.106
	(0.15)	(0.16)	(0.23)	(2.67)**
Log education (destination)	0.07	0.084	0.14	2.256
	(0.06)	(0.46)	(0.25)	(5.33)**
Log education (origin)	1.478	0.18	1.552	−0.023
	(2.83)**	(2.36)*	(2.75)**	(0.06)
Log FDI (destination)	−0.06	−0.009	−0.057	−0.028
	(0.87)	(0.85)	(2.13)*	(1.42)
Log FDI (origin)	0.147	0.027	0.144	0.069
	(4.09)**	(4.89)**	(5.36)**	(3.47)**
Birthrate difference (destination−origin)	−0.258	−0.032	−0.254	0.093
	(0.85)	(0.7)	(1.6)	(0.8)
Log population (destination)	−0.256	−0.005	−0.184	0.62
	(0.51)	(0.07)	(0.91)	(4.12)**
Log population (origin)	−0.332	−0.017	−0.315	0.137
	(1.69)	(0.56)	(1.56)	(0.91)
Wage difference (destination−origin)	0.002	0.00	0.002	0.002
	(1.01)	(0.78)	(2.17)*	(4.09)**
Log immigrant proportion	0.884	0.132	0.883	0.232
	(48.01)**	(47.85)**	(88.99)**	(9.71)**
Border with USA	−0.939	−0.12	1.96	6.183
	(1.1)	(0.97)	(6.15)**	(11.23)**
Period 2 dummy	0.573	0.079	0.548	0.149
	(5.21)**	(4.84)**	(6.06)**	(2.18)*
Period 3 dummy	0.268	0.022	0.218	−0.219
	(1.32)	(0.75)	(1.41)	(1.89)
Constant	9.726	1.231	5.39	−12
	(1.0)	(0.88)	(1.19)	(3.41)**

(*Continued*)

Table 3 Continued

	OLS 2FE	PPML 2FE	GME 2FE	GME 3FE
Origin FE	Yes	Yes	Yes	Yes
Destination FE	Yes	Yes	Yes	Yes
Pair-specific FE	No	No	No	Yes
Model entropy			3,346.8	4,371.1
Pseudo-R^2			0.0001	0.0004
R^2	0.95	0.94		
N	2976	2976	2976	2976

Notes: $^{**}p < 0.01$, $^{*}p < 0.05$. Standard errors in parenthesis. Total sample (2000–2015).
OLS, ordinary least squares; PPML, Poisson pseudo maximum likelihood; GME, generalized maximum entropy; 2FE, two-way fixed effects; 3FE, three-way fixed effects.

Table 4 Estimation of gravity model (GME 3FE) per period

	GME P1	GME P2	GME P3
Log homicide rate (destination)	−0.169	−0.125	−0.292
	(7.36)**	(12.45)**	(8.90)**
Log homicide rate (origin)	0.118	0.054	−0.395
	(5.87)**	(3.44)**	(15.93)**
Other control covariates	Yes	Yes	Yes
Origin FE	Yes	Yes	Yes
Destination FE	Yes	Yes	Yes
Pair-specific FE	Yes	Yes	Yes
Model entropy	2,179.6	2,179.6	2,179.6
Pseudo-R^2	0.00	0.00	0.00
N	992	992	992

Notes: $^{**}p < 0.01$. Standard errors in parenthesis. Other control covariates refer to variables specified in equation (1).
P1 denotes period 1: 2000–2005. P2 denotes period 2: 2005–2010. P3 denotes period 3: 2010–2015.
GME, generalized maximum entropy; 3FE, three-way fixed effects.

Morrison, 1993)[6] or different sociopolitical conditions (Alvarado and Massey, 2010). In this regard, Mexico suffered considerable political changes brought by the regime transition since 2010 and the modified strategy on the drug war when former president Enrique Pena Nieto took mandate in 2012. Despite the federal government reduced the intensity of the war against drug cartels and established structural reforms in important areas such as education, energy, labor, and economics, homicide levels increased.

In addition, the negative effect of origin's homicide rates on emigration in period 3 could be associated with changes in migration trends or costs. For instance, the period 2010–2015 exhibited the greatest homicide rates, but it had similar migration flows than the period

6 These authors found that violence affects migration differently at different levels of intensity, so a nonlinear relationship may be more appropriate to estimate. Unfortunately, quadratic terms for homicide variables could not be included in regressions explained in Table 4 because GME estimation encountered perfect collinearity in the linear terms.

2005–2010. Therefore, the negative relationship may indicate people who emigrated in period 2, despite of the higher levels of crime returned to their origin states in period 3 (temporary migrants), or may be reflecting new barriers to emigration in states with high homicide rates.

Another reason is that the beliefs and behavior of individuals regarding crime were adjusted (Becker and Rubinstein, 2011) by period 3, i.e., individuals did not migrate as much because they controlled their emotions and adjusted their beliefs (perceptions) of safety despite higher homicide levels in period 3. Under adaptation theory and evolutionary psychology (see, e.g., Buss, 2012; Chapman et al., 2010), it can be argued that after a phase of high levels in actual violence people may get familiarized (adaptive fear), so they stop reacting (emigrating) to high levels of violence as they did before, i.e., emigration to homicide-rate-at-origin elasticity became less elastic. Duntley (2015) implied that people may expose themselves to risk and danger-related experiences as an evolutionary mechanism of defense. Becker and Rubinstein (2011) found evidence from Israel that supports this hypothesis of behavior adaptation toward crime. More insight regarding this possible explanation is discussed from a detailed decomposition of estimates in Table 4.

Decomposition of the difference between periods 1 and 2 migration mean predictions is displayed in detail (columns under "Decomposition P1–P2" in Table 5) to examine the individual contribution—explained and unexplained—of each migration determinant to the difference. As described in Section 2.1, explained–decomposed coefficients indicate how condition differences in regressors between periods 1 and 2 contribute to the overall difference in migration mean predictions; also, unexplained–decomposed coefficients indicate the contribution to the difference due to factors related to each regressor but distinct from its condition, so this unexplained component is assumed to be mostly related to regressor-related perceptions in each period. Explicitly, the explained–decomposed coefficient (−0.265) indicates that compared with period 1, average migration in period 2 was smaller due to changes in migration determinant conditions. For instance, immigrant proportion average—a significant determinant of migration—was more than 30% smaller in period 2 than in period 1, and some potential migrant receptor states (such as border states) suffered changes (such as increments in homicide rates) in period 2 that deterred migration according to theory. Still, the unexplained component presented a sufficiently large effect (0.661) to turn the overall outcome into a positive difference, i.e., a greater average migration in period 2.

The first detailed decomposition (column "Explained of Decomposition P1–P2" in Table 5) shows that the regressors whose (changed) conditions explain a greater average migration in period 2 compared with period 1 include origin's homicide rate (0.033) and unemployment (0.029), and destination's real GDP (0.017) and population (0.052). On the other hand, immigrant proportion and destination's homicide rate explain a smaller average migration difference. As expected, coefficients of constant determinants (distance and the border dummy) do not contribute to differences in average migration between both periods. Again, this evidence supports the argument that increments of crime levels after the beginning of the drug war increased interstate migration flows in period 2.

The second detailed decomposition (column "Unexplained of Decomposition P1–P2" in Table 5) shows that the unexplained reasons (mostly related to perception changes) that increased the average migration difference between periods 2 and 1 were related to distance, origin's GDP, origin's FDI, and destination's population. On the other hand, unexplained

Table 5 Decomposition of mean predictions differences between periods 1 and 2, and periods 1 and 3

	Decomposition P1–P2		Decomposition P1–P3	
	Explained	**Unexplained**	**Explained**	**Unexplained**
Total	−0.265	0.661	0.121	0.244
	(0.069)**	(0.02)**	(0.073)	(0.036)**
Log distance	0	0.253	0	−1.09
	(0.000)	(0.045)**	(0.000)	(0.053)**
Log GDP (destination)	0.017	−6.36	0.037	−20.7
	(0.006)**	(0.362)**	(0.007)**	(0.818)**
Log GDP (origin)	−0.001	4.1	−0.003	6.36
	(0.002)	(0.377)**	(0.004)	(0.633)**
Log unemployment (destination)	0.008	−0.298	0.018	−2.29
	(0.009)	(0.074)**	(0.022)	(0.106)**
Log unemployment (origin)	0.029	−0.048	0.066	−2.14
	(0.005)**	(0.041)	(0.011)**	(0.068)**
Log FDI (destination)	0.006	0.338	0.017	2.11
	(0.005)	(0.195)	(0.015)	(0.238)**
Log FDI (origin)	−0.001	0.545	−0.005	6.98
	(0.004)	(0.134)**	(0.011)	(0.29)**
Log homicide rate (destination)	−0.047	−0.383	−0.104	1.02
	(0.008)**	(0.218)	(0.015)**	(0.334)**
Log homicide rate (origin)	0.033	0.560	0.073	4.28
	(0.006)**	(0.221)*	(0.013)**	(0.267)**
Log population (destination)	0.052	5.82	0.126	14.79
	(0.018)**	(0.492)**	(0.019)**	(0.72)**
Log population (origin)	0.001	−1.89	0.003	−10.76
	(0.002)	(0.437)**	(0.004)	(0.653)**
Log immigrant proportion	−0.317	−0.282	−0.089	0.13
	(0.059)**	(0.027)**	(0.058)	(0.033)**
Border with USA	0	−0.082	0	−0.022
	(0.003)	(0.011)**	(0.003)	(0.017)

Notes: **$p < 0.01$, *$p < 0.05$. Origin, destination, and path-specific fixed effects coefficients are omitted to save space. Birthrate difference and wage difference are omitted since all their coefficients were insignificant.

P1 denotes period 1: 2000–2005. P2 denotes period 2: 2005–2010. P3 denotes period 3: 2010–2015. Linear decompositions take P1's coefficients as reference. Mean predictions are 6.326 (2000–2005), 6.723 (2005–2010), and 6.693 (2010–2015).

GDP, gross domestic product; FDI, foreign direct investment.

reasons related to destination's GDP and unemployment, origin's population, and immigrant proportion reduced the average migration difference between these periods. In this case, destination's homicide rate unexplained coefficient was not significant, but origin's homicide rate was at a 95% level indicating that the unexplained feature of this regressor increased the average migration difference. As argued on Section 2.1, since drug-related homicides increased considerably in period 2, homicide unexplained coefficients may imply migration due to changes in

homicides composition rather than violence perception. However, since destination's homicide rate unexplained coefficient was not statistically significant, this argument does not hold. Therefore, the origin's homicide unexplained coefficient may reflect changes mostly in violence perception.[7]

An important aspect to note is that most unexplained coefficients present greater magnitudes than explained coefficients, so migration in period 2 changed primarily due to perceptions rather than factual conditions of migration determinants. This is in accordance with the argument that migration decisions imply rather significant uncertainty and incomplete information regarding their true costs and benefits and may explain why some studies have found little evidence of the migration response to violence (e.g., Basu and Pearlman, 2017). Since homicide rates unexplained coefficients are greater than explained coefficients, and despite the significant increases in violence in period 2 the average migration difference between periods 1 and 2 could be attributed primarily to violence perception rather than actual violence.

In addition, Table 5 displays a greater migration mean in period 3 than in period 1,[8] though smaller than in period 2. In contrast with the decomposition of the difference between periods 1 and 2 migration mean predictions, the decomposition between periods 1 and 3 shows that average migration was higher in period 3 due to both explained and unexplained factors. Still, the unexplained part accounts for a greater (approximately 67%) portion of the difference, and only five regressors present a significant explained contribution, i.e., destination's GDP, population, and homicide rate, and origin's unemployment and homicide rate. The explained decomposition shows similar results, regarding the sign of coefficients, to those found between periods 1 and 2 explained decomposition. For instance, condition changes of population in destination, homicide rate in origin, and unemployment in origin (coefficients of 0.126, 0.073, and 0.066, respectively) increased the average migration difference between periods 3 and 1. Again, the homicide rate in destination presents a negative sign, so homicide conditions in destination explained a smaller expected migration in period 3 compared with period 1. Also, constant regressors (distance and the border dummy) do not contribute to differences between migration predictions of periods 1 and 3 as expected.

However, compared with the unexplained decomposition between periods 1 and 2, the unexplained coefficients of periods 1 and 3 decomposition shows some changes regarding the sign and significance for some regressors. For instance, distance has a negative contribution on the average migration difference, perhaps due to the perception that a larger distance was related to greater risk, and homicide rate in destination and immigrant proportion have a positive contribution on the average migration difference. Also coefficients of destination's population, origin's FDI, and origin's GDP have a greater contribution (14.79, 6.98, and 6.36, respectively), but destination's GDP and origin's population have a negative contribution on the average migration difference (coefficients of −20.7 and −10.76, respectively).

Finally, both homicide rates unexplained coefficients are positive and significant, suggesting that violence perception influenced a greater average migration in period 3 compared with period 1. Despite periods 2 and 3 presented a similar homicide-type composition, the

7 Appendices E and F show that this argument applies for young male homicide rates, but not for male homicide rates since both coefficients were statistically significant.

8 Although it is evident from Table 3 that average migration of period 3 is statistically the same as that of period 1, this can be attributed to the fact explained in Table 3 which restricts the same covariate coefficients to all periods, but estimation explained in Table 5 allowed for differences.

proportion of the homicide rates unexplained coefficients with respect to explained is greater than the difference in decomposition between periods 1 and 2. For instance, Table 5 shows that, in the decomposition between periods 1 and 2 the unexplained coefficient of origin's homicide rate (0.56) is nearly 17 times the explained coefficient (0.033), but in the decomposition between periods 1 and 3 it is more than 50 times greater (4.28–0.073). Again, these results reinforce the argument that certain adaptation to high levels of violence was present in period 3, since interstate migration reacted relatively more to perceived violence than to an increased actual violence.

4 Conclusions

This article examined the effects of actual and perceived violence on internal migration at the rise of Mexican drug war. Data on homicide rates and interstate migration were used for three 5-year periods: period 1 from 2000 to 2005, period 2 from 2005 to 2010, and period 3 from 2010 to 2015. A gravity model to the whole sample and each subperiod separately was estimated, controlling for other covariates regarded important in the literature and theory, including real GDP, distance, population, unemployment rates, education, FDI, birthrates, and wage differences. Finally, the Blinder–Oaxaca decomposition to the gravity model estimations was performed to obtain information regarding unexplained factors that explain migration, including the perception of violence.

The results of the gravity model show that homicide rates do have an effect on internal migration. Considering migration as the flow of people from origin to destination, during 2000–2015 a higher homicide rate in origin fostered migration while a higher homicide rate in destination deterred it. However, only in the period 2010–2015 homicide rates in origin deterred migration as well. Moreover, decomposing the differences of mean predictions of migration between periods 2000–2005 and 2005–2010, periods 1 and 3 provided further insights regarding the role of violence. For instance, the results show that average migration should be lower in the period 2005–2010 than in the period 2000–2005 under each period determinants' conditions; however, unexplained factors (linked to migration determinant elasticities, and hence to perceptions) caused that actual average migration in the period 2005–2010 was greater. Moreover, average migration in the period 2010–2015 was smaller than that of the period 2005–2010, despite homicide rates were on average higher their level condition (actual violence) contributed proportionally less to the rise of average migration than their unexplained part (perceived violence).

The relatively greater influence of perceived violence, rather than actual violence, on migration despite of increasing homicide rates reflects a smaller level of reaction (or sensibility) to violence with the passing of time. This finding may be justifiable under adaptation theory and evolutionary psychology concepts such as adaptive fear which explain that individuals modify their behavior before risky situations as mechanisms of defense, i.e., people evolve to survive, adapting to changing dangerous conditions.

List of abbreviations

2FE	Two-way fixed effects
3FE	Three-way fixed effects
FDI	Foreign direct investment
GDP	Gross domestic product
GME	Generalized maximum entropy
INEGI	National Institute of Statistics and Geography
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary least squares
PPML	Poisson pseudo maximum likelihood

Declarations

Availability of data and materials

The datasets generated and/or analyzed during the current study are available in INEGI's repository, www.inegi.org.mx.

Competing interests

The author declares that he has no competing interest.

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Author's contribution

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References

Aguallo-Tellez, Ernesto; José Martinez-Navarro (2013): Internal and International Migration in Mexico: 1995-2000. Applied Economics, 45(1), 1647-1661.

Alvarado, Steven E.; Douglas S. Massey (2010): In Search of Peace: Structural Adjustment, Violence, and International Migration. The Annals of the American Academy of Political and Social Science 630(1), 137-161.

Anam, Mahmudul; Shin-Hwan Chiang (2007): Rural-Urban Migration of Family Labor: A Portfolio Model. Journal of International Trade and Economic Development 16(3), 325-335.

Arceo-Gomez, Eva (2012): Drug-Related Violence and Forced Migration from Mexico to the United States. Centro de Investigacion y Docencia Economicas. Working Paper 526.

Barrera-Osorio, Felipe; Vincente Garcia-Moreno; Harry A. Patrinos; Emilio Porta (2011): Using the Oaxaca-Blinder Decomposition Technique to Analyze Learning Outcomes Changes Over Time: An Application to Indonesia's Results in PISA Mathematics. World Bank Policy Research Working Paper 5584.

Bartel, Ann P. (1979): The Migration Decision: What Role Does Job Mobility Play? The American Economic Review 69(5), 775-786.

Basu, Sukanya; Sarah Pearlman (2017). Violence and Migration: Evidence from Mexico's Drug War. IZA Journal of Development and Migration 7(18), 1-29.

Bean, Frank D.; Susan K. Brown (2015): Demographic Analyses of Immigration, in: Brettell, Caroline B.; James F. Hollifield (eds.), Migration Theory. New York, 67-89.

Becker, Gary S.; Yona Rubinstein (2011): Fear and the Response to Terrorism: An Economic Analysis. CEP Discussion Paper 1079.

Bohra-Mishra, Pratikshya; Douglass S. Massey (2011). Individual Decisions to Migrate During Civil Conflict. Demography 48(2), 401-424.

Borjas, George J. (1987). Self-Selection and the Earnings of Immigrants. The American Economic Review 77(4), 531-553.

Buss, David M. (2012): The Evolutionary Psychology of Crime. Journal of Theoretical and Philosophical Criminology 1(1), 90-98.

Cameron, Adrian C.; Pravin K. Trivedi (2005): Microeconometrics. Methods and Applications. Cambridge, U.K.: Cambridge University Press.

Ceron Monroy, Hazael; Jose Eliud Silva Urrutia (2017): La Relación Entre un Proxi de la Dinámica de la Inseguridad Pública y el Turismo Internacional a México: un Análisis Econométrico. El Periplo Sustentable 33(1), 105-131.

Chapman, Rose; Irene Styles; Laura Perry; Shane Combs (2010): Nurse's Experience of Adjusting to Workplace Violence: A Theory of Adaptation. International Journal of Mental Health Nursing 19(1), 186-194.

Chiquiar, Daniel; Gordon H. Hanson (2005): International Migration, Self-Selection, and the Distribution of Wages: Evidence from Mexico and the United States. Journal of Political Economy 113(2), 239-281.

Corral, Paul; Mungo Terbish (2015): Generalized Maximum Entropy Estimation of Discrete Choice Models. The Stata Journal 15(2): 512-522.

Duntley, Joshua D. (2015): Adaptations to Dangers from Humans, in : Buss, David M. (ed.), The Handbook of Evolutionary Psychology. Hoboken, NJ: John Wiley & Sons, Inc., 224-249.

Elder, Todd E.; John H. Goddeeris; Steven J. Haider (2009): Unexplained Gaps and Oaxaca-Blinder Decompositions. IZA Discussion Papers 4159.

Engel, Stephanie; Ana M. Ibañez (2007): Displacement Due to Violence in Colombia: A Household-Level Analysis. Economic Development and Cultural Change 55(2), 335-365.

Feldmeyer, Ben; Darrell Steffensmeier; Casey T. Harris; Shahin Tasharrofi (2018): Immigration and Violent Crime in California, 1980-2012: Contextualization by Temporal Period and Race/Ethnicity. Migration Letters 15(2), 197-214.

Fitzgerald, David S. (2015): The Sociology of International Migration, in: Brettell Caroline B.; James F. Hollifield (eds.), Migration Theory. New York, 115-147.

Flores, Miguel; Mary Zey; Nazrul Hoque (2013): Economic Liberalization and Contemporary Determinants of Mexico's Internal Migration: An Application of Spatial Gravity Models. Spatial Economic Analysis 8(2), 195-214.

Harris, John R.; Michael P. Todaro (1970): Migration, Unemployment and Development: A Two-Sector Analysis. The American Economic Review 60(1), 126-142.

Ibañez, Ana M.; Carlos E. Velez (2005). Civil Conflict and Forced Migration: The Micro Determinants and the Welfare Losses of Displacement in Colombia. CEDE Working paper 2005-35.

Jann, Ben (2008): The Blinder-Oaxaca Decomposition for Linear Regression Models. The STATA Journal 8(4), 453-479.

Massey, Douglas S. (2015): A Missing Element in Migration Theories. Migration Letters 12(3), 279-299.

Meseguer, Covadonga; Sandra Ley; J. Eduardo Ibarra-Olivo (2017): Sending Money Home in Times of Crime: The Case of Mexico. Journal of Ethnic and Migration Studies 43(13), 2169-2192.

Morrison, Andrew R. (1993). Violence or Economics: What Drives Internal Migration in Guatemala? Economic Development and Cultural Change 41(4), 817-831.

Neumark, David (1988). Employer's Discriminatory Behavior and the Estimation of Wage Discrimination. The Journal of Human Resources 23(3), 279-295.

Organisation for Economic Cooperation and Development. (OECD, 2011): How's Life? Measuring Well-Being. OECD Publishing. https://www.oecd-ilibrary.org/economics/how-s-life_9789264121164-en.

Peeters, Ludo (2012): Gravity and Spatial Structure: The Case of Interstate Migration in Mexico. Journal of Regional Science, 52(5), 819-856.

Piore, Michael J. (1979): Birds of Passage: Migrant Labor and Industrial Societies. New York, NY: Cambridge University Press.

Quintana, Luis; Uberto Salgado (2016): Migración Interna Mexicana de 1990-2010: un Enfoque Desde la Nueva Geografía Económica. Revista Problemas del Desarrollo 184(47), 137-162.

Quiroz Felix, Jorge; Ramon Amadeo Castillo Ponce; Juan Manuel Ocegueda Hernandez; Rogelio Varela Llamas (2015): Delincuencia y Actividad Económica en México. Norteamerica 10(2), 187-209.

Ramirez de Garay, Luis David (2014): Crimen y Economía: Análisis de la Tasa de Homicidio en México a Partir de Variables Económicas (2000, 2005, 2010). Estudios Sociológicos 32(96), 505-540.

Rios Contreras, Viridiana (2014). The Role of Drug-Related Violence and Extortion in Promoting Mexican Migration. Unexpected Consequences of A Drug War. Latin American Research Review 49(3), 199-217.

Robles, Gustavo; Gabriela Calderon; Beatriz Magaloni (2013): Las Consecuencias Económicas de la Violencia del Narcotráfico en México. IDB Working Paper No. IDB-WP-426.

Soloaga, Isidro; Gabriel Lara Ibarra; Florian Wendelspiess (2010): Determinantes de la Migración Interestatal: 1995-2000 y 2000-2005, in: Yúnez, Antonio (ed.), Los Grandes Problemas de México. México, 171-196.

Stanley, T. D.; Stephen B. Jarrell (1998). Gender Wage Discrimination Bias? A Meta-Regression Analysis. The Journal of Human Resources 33(4), 947-973.

Stark, Oded; David E. Bloom (1985): The New Economics of Labor Migration. Frontiers in Demographic Economics 75(2), 173-178.

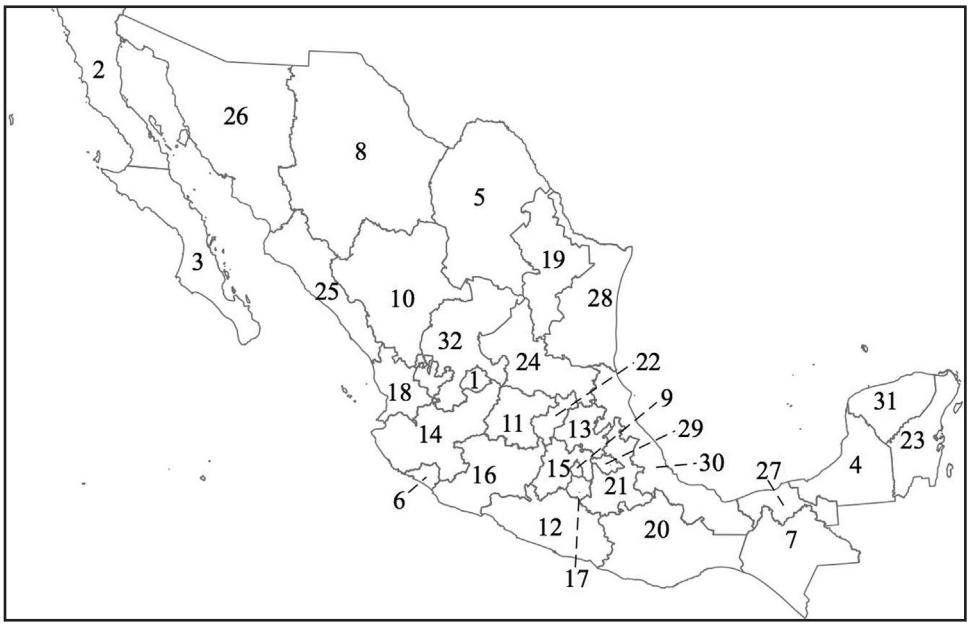
Todaro, Michael (1980): Internal Migration in Developing Countries: A Survey, in: Easterlin, Richard A. (ed.), Population and Economic Change in Developing Countries. Chicago, 361-402.

Varela Llamas, Rogelio; Juan Manuel Ocegueda Hernandez; Ramon A. Castillo Ponce (2017): Migración Interna en México y Causas de su Movilidad. Perfiles Latinoamericanos 25(49), 141-167.

Villarreal, Andres; Erin R. Hamilton (2012): Rush to the Border? Market Liberalization and Urban- and Rural-Origin Internal Migration in Mexico. Social Science Research 41(2012), 1275-1291.

Ybañez Zepeda, Elmyra; Rafael Alarcon (2014). Turbulencia Económica, Violencia y Cambios Migratorios en la Frontera Norte de México, 1990-2010. Migración y Desarrollo 22(1), 61-90.

Appendix A. States of Mexico



Code	Name	Code	Name
1	Aguascalientes	17	Morelos
2	Baja California	18	Nayarit
3	Baja California Sur	19	Nuevo Leno
4	Campeche	20	Oaxaca
5	Coahuila de Zaragoza	21	Puebla
6	Colima	22	Queretaro
7	Chiapas	23	Quintana Roo
8	Chihuahua	24	San Luis Potosi
9	Mexico city	25	Sinaloa
10	Durnago	26	Sonora
11	Guanajuato	27	Tabasco
12	Guerrero	28	Tamaulipas
13	Hidalgo	29	Tlaxcala
14	Jalisco	30	Veracruz
15	Mexico state	31	Yucatan
16	Michoacan	32	Zacatecas

Appendix B. Migration data

	Immigration			Emigration			Net migration variation		
State	**P1**	**P2**	**P3**	**P1**	**P2**	**P3**	**P1–P2**	**P2–P3**	**P1–P3**
Aguascalientes	28,488	32,887	34,130	11,915	19,157	17,512	−0.17	0.21	0.00
Baja California	137,390	123,726	114,880	44,117	96,512	74,160	−0.71	0.50	−0.56
Baja California Sur	33,635	60,218	46,584	8,562	14,236	18,734	0.83	−0.39	0.11
Campeche	21,343	27,472	36,884	16,869	23,286	20,311	−0.06	2.96	2.70
Coahuila de Zaragoza	36,116	48,418	50,051	35,355	48,613	49,202	−1.26	−5.35	0.12
Colima	21,303	32,466	32,180	11,061	14,800	16,064	0.72	−0.09	0.57
Chiapas	19,144	40,437	42,889	75,176	89,504	95,990	−0.12	0.08	−0.05
Chihuahua	54,685	46,367	40,800	33,975	64,454	51,545	−1.87	−0.41	−1.52
Mexico city	159,869	204,888	283,102	382,622	588,895	444,875	0.72	−0.58	−0.27
Durango	19,683	29,971	25,835	28,047	37,737	38,791	−0.07	0.67	0.55
Guanajuato	49,230	73,008	74,286	42,512	60,290	57,109	0.89	0.35	1.56
Guerrero	24,621	41,024	34,440	60,176	85,865	109,502	0.26	0.67	1.11
Hidalgo	56,421	93,919	94,424	38,274	56,145	60,646	1.08	−0.11	0.86
Jalisco	90,912	131,557	130,012	82,389	120,016	120,914	0.35	−0.21	0.07
Mexico state	323,378	464,284	403,100	234,864	261,553	326,643	1.29	−0.62	−0.14
Michoacan	45,387	62,782	52,091	55,144	81,145	92,652	0.88	1.21	3.16
Morelos	44,674	63,117	60,909	24,552	36,646	42,354	0.32	−0.30	−0.08
Nayarit	28,112	48,836	39,405	20,900	25,071	26,116	2.30	−0.44	0.84
Nuevo Leon	82,853	114,089	141,654	40,069	61,718	61,280	0.22	0.53	0.88
Oaxaca	40,926	66,126	57,408	66,274	85,671	91,018	−0.23	0.72	0.33
Puebla	77,367	104,349	113,371	74,636	110,804	113,342	−3.36	−1.00	−0.99
Queretaro	55,739	77,462	105,431	20,441	32,685	31,379	0.27	0.65	1.10
Quintana Roo	84,725	122,690	116,616	22,124	41,811	46,968	0.29	−0.14	0.11
San Luis Potosi	31,484	45,561	39,593	38,094	51,038	58,692	−0.17	2.49	1.89
Sinaloa	39,730	55,784	65,660	74,725	81,582	80,191	−0.26	−0.44	−0.58
Sonora	40,244	62,686	56,812	35,376	45,963	41,928	2.44	−0.11	2.06
Tabasco	18,351	31,396	35,583	47,526	56,090	53,044	−0.15	−0.29	−0.40
Tamaulipas	94,726	87,741	58,520	42,710	74,215	88,865	−0.74	−3.24	−1.58
Tlaxcala	21,496	29,924	29,019	14,120	20,982	21,861	0.21	−0.20	−0.03
Veracruz	93,576	159,584	134,177	191,791	198,937	199,758	−0.60	0.67	−0.33
Yucatan	27,584	40,470	51,044	24,169	32,392	34,294	1.37	1.07	3.90
Zacatecas	16,628	23,417	20,077	21,255	28,843	35,227	0.17	1.79	2.27

Notes: P1 denotes period 1: 2000–2005. P2 denotes period 2: 2005–2010. P3 denotes period 3: 2010–2015.

Appendix C. Homicide data

	Average homicides			AHR			AHR variation		
State	**P1**	**P2**	**P3**	**P1**	**P2**	**P3**	**P1–P2**	**P2–P3**	**P1–P3**
Aguascalientes	23	54	59	0.039	0.078	0.073	1.034	−0.069	0.894
Baja California	441	984	749	0.289	0.540	0.338	0.867	−0.374	0.169
Baja California Sur	29	38	82	0.100	0.110	0.183	0.101	0.658	0.825
Campeche	50	49	70	0.113	0.095	0.120	−0.158	0.260	0.061
Coahuila de Zaragoza	135	221	690	0.088	0.131	0.361	0.485	1.758	3.094
Colima	50	67	206	0.146	0.173	0.442	0.183	1.555	2.024
Chiapas	341	323	417	0.149	0.123	0.135	−0.179	0.097	−0.099
Chihuahua	572	2,774	2,540	0.290	1.311	1.094	3.519	−0.165	2.772
Mexico city	941	931	1,092	0.151	0.145	0.163	−0.039	0.121	0.077
Durango	175	586	591	0.192	0.591	0.533	2.082	−0.098	1.779
Guanajuato	213	332	756	0.073	0.104	0.202	0.420	0.936	1.748
Guerrero	640	1,194	2,293	0.348	0.613	1.022	0.763	0.666	1.937
Hidalgo	82	91	197	0.057	0.058	0.106	0.012	0.828	0.850
Jalisco	464	648	1,368	0.113	0.144	0.267	0.282	0.846	1.367
Mexico state	1,926	1,710	2,889	0.232	0.185	0.272	−0.204	0.468	0.169
Michoacan	592	769	881	0.238	0.295	0.294	0.241	−0.003	0.236
Morelos	181	247	529	0.182	0.230	0.419	0.263	0.821	1.300
Nayarit	124	220	283	0.206	0.343	0.372	0.664	0.082	0.800
Nuevo Leon	120	392	1,193	0.045	0.133	0.358	1.954	1.682	6.920
Oaxaca	625	606	740	0.295	0.267	0.285	−0.094	0.067	−0.034
Puebla	370	343	532	0.119	0.099	0.136	−0.171	0.376	0.141
Queretaro	87	70	118	0.098	0.067	0.093	−0.311	0.375	−0.052
Quintana Roo	99	124	150	0.177	0.182	0.163	0.028	−0.109	−0.084
San Luis Potosi	180	215	331	0.125	0.136	0.186	0.089	0.373	0.496
Sinaloa	442	1,097	1,359	0.266	0.628	0.690	1.365	0.099	1.599
Sonora	237	464	595	0.160	0.287	0.318	0.795	0.107	0.988
Tabasco	103	162	254	0.085	0.122	0.165	0.434	0.351	0.937
Tamaulipas	238	419	1,026	0.128	0.203	0.453	0.589	1.227	2.539
Tlaxcala	50	54	85	0.081	0.077	0.105	−0.048	0.372	0.305
Veracruz	373	447	933	0.083	0.092	0.172	0.111	0.875	1.083
Yucatan	41	42	50	0.037	0.034	0.036	−0.082	0.053	−0.033
Zacatecas	88	103	344	0.104	0.114	0.337	0.100	1.955	2.252

Notes: P1 denotes period 1: 2000–2005. P2 denotes period 2: 2005–2010. P3 denotes period 3: 2010–2015.
AHR, Average homicide rate.

Appendix D. Descriptive statistics and correlation matrix of main variables

Descriptive statistics

	2000–2005			2005–2010			2010–2015		
	Mean	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
Homicide rate average (per 1,000 people)	0.15	0.036	0.348	0.24	0.033	1.311	0.3	0.035	1.1
Net migration	1,935	10	214,547	2,668	19	301,099	2,642	3	242,120
Real GDP (2013 million pesos)	405,807	67,928	2,205,990	441,185	77,491	2,408,621	491,133	90,143	2,681,442
Unemployment rate	3.26	1.18	5.80	3.88	1.40	6.05	4.86	2.19	6.62
Education (years of schooling)	7.4	5.4	9.6	8.1	6.1	10.2	8.6	6.7	10.5
FDI (millions US dollars)	737.1	76.6	6,199.8	803.2	82.7	5,921.7	978.7	121.8	4,871.9
Birthrate (average child born to women/total women)	2.7	2.0	3.1	2.5	2.0	3.0	2.4	1.9	2.8
Population (in thousands, 15 years and older)	1,963.8	284.9	8,286.9	2,150	341.5	9,241.7	2,450.7	449.2	10,635.4
Wage (daily, pesos)	146.9	115.3	230.0	202.6	164.9	299.6	250.6	202.5	359.1
Immigrant proportion	2,813	10	339,056	1,935	10	214,547	2,668	19	301,099

GDP, gross domestic product; FDI, foreign direct investment.

Correlation matrix

	ldist	**lgdp**	**lunem**	**leduc**	**lfdi**	**lthomav**	**difbth**	**lpop**	**difw**	**lpor-mig**
ldist	1									
lgdp	−0.0789*	1								
lunem	−0.1196*	0.2666*	1							
leduc	0.0766*	0.2721*	0.7225*	1						
lfdi	−0.0392*	0.7098*	0.4876*	0.5316*	1					
lthomav	0.1048*	0.0532*	0.0185*	0.1695*	0.1999*	1				
difbth	0	−0.3016*	−0.2492*	−0.4554*	−0.3348*	0.1264*	1			
lpop	−0.2009*	0.7707*	0.1443*	−0.0225*	0.6419*	0.1533*	−0.0513*	1		
difw	0	0.4569*	0.1591*	0.3218*	0.4190*	−0.1086*	−0.6200*	0.2054*	1	
lpormig	−0.3414*	−0.0544*	0.0421*	0.1659*	0.0784*	0.0080*	−0.0724*	−0.1523*	−0.0920*	1
fronteraUS	0.2081*	0.2882*	0.2407*	0.3720*	0.4505*	0.2654*	−0.2443*	0.1360*	0.1185*	0.0822*

Notes: * denotes significance level ($p < 0.05$). Variables are log of distance (ldist), log of real GDP (lgdp), log of unemployment rate (lunem), log of education (leduc), log of FDI (lfdi), log of homicide rate average (lthomav), birthrate difference between origin and destination (difbth), log of population (lpop), wage difference between origin and destination (difw), and log of immigrant proportion (lpormig).

Appendix E. Decomposition of mean prediction differences between periods 1 and 2 and periods 1 and 3

	Decomposition P1–P2		Decomposition P1–P3	
	Explained	**Unexplained**	**Explained**	**Unexplained**
Total	−0.275	0.671	0.107	0.259
	(0.069)**	(0.02)**	(0.073)	(0.036)**
Log distance	0	0.263	0	−1.07
	(0.000)	(0.046)**	(0.000)	(0.053)**
Log GDP (destination)	0.018	−6.69	0.040	−17.99
	(0.007)**	(0.366)**	(0.007)**	(0.554)**
Log GDP (origin)	−0.002	4.4	−0.006	3.06
	(0.002)	(0.382)**	(0.004)	(0.44)**
Log unemployment (destination)	0.008	−0.314	0.019	−2.11
	(0.009)	(0.075)**	(0.022)	(0.106)**
Log unemployment (origin)	0.027	−0.024	0.064	−2.36
	(0.005)**	(0.041)	(0.011)**	(0.075)**
Log FDI (destination)	0.004	0.321	0.014	2.01
	(0.005)	(0.198)	(0.015)	(0.233)**
Log FDI (origin)	0.001	0.455	0.005	7.21
	(0.004)	(0.135)**	(0.011)	(0.286)**
Log homicide rate (destination)	−0.048	−0.432	−0.101	0.685
	(0.008)**	(0.211)*	(0.014)**	(0.310)*
Log homicide rate (origin)	0.029	0.471	0.062	4.51
	(0.006)**	(0.221)*	(0.012)**	(0.248)**
Log population (destination)	0.051	6.02	0.125	13.54
	(0.018)**	(0.499)**	(0.019)**	(0.612)**
Log population (origin)	0.001	−1.96	0.002	−9.13
	(0.002)	(0.437)**	(0.004)	(0.601)**
Log immigrant proportion	−0.317	−0.272	−0.089	0.125
	(0.059)**	(0.028)**	(0.058)	(0.033)**
Border with USA	0	−0.078	0	0.201
	(0.003)	(0.011)**	(0.003)	(0.018)**

Notes: **$p < 0.01$, *$p < 0.05$. Origin, destination, and path-specific fixed effect coefficients are omitted to save space. Birthrate difference and wage difference are omitted since all their coefficients were insignificant.

P1 denotes period 1: 2000–2005. P2 denotes period 2: 2005–2010. P3 denotes period 3: 2010–2015. Linear decompositions take P1's coefficients as reference. Homicide rates for males (15 years and older).

GDP, gross domestic product; FDI, foreign direct investment.

Appendix F. Decomposition of mean predictions differences between periods 1 and 2 and periods 1 and 3

	Decomposition P1–P2		Decomposition P1–P3	
	Explained	**Unexplained**	**Explained**	**Unexplained**
Total	−0.223	0.619	0.186	0.180
	(0.069)**	(0.02)**	(0.072)*	(0.033)**
Log distance	0	0.296	0	−1.05
	(0.000)	(0.045)**	(0.000)	(0.053)**
Log GDP (destination)	0.017	−5.55	0.038	−18.2
	(0.006)**	(0.362)**	(0.007)**	(0.574)**
Log GDP (origin)	−0.006	3.46	−0.013	3.82
	(0.003)*	(0.446)**	(0.004)**	(0.447)**
Log unemployment (destination)	0.018	−0.348	0.042	−2.24
	(0.009)*	(0.070)**	(0.021)*	(0.104)**
Log unemployment (origin)	0.037	−0.28	0.086	−2.46
	(0.005)**	(0.066)**	(0.011)**	(0.073)**
Log FDI (destination)	0.003	0.733	0.010	2.2
	(0.005)	(0.199)**	(0.015)	(0.245)**
Log FDI (origin)	0.001	0.483	0.004	7.53
	(0.004)	(0.146)**	(0.011)	(0.30)**
Log homicide rate (destination)	−0.040	−0.057	−0.079	0.889
	(0.007)**	(0.191)	(0.012)**	(0.295)**
Log homicide rate (origin)	0.036	1.18	0.072	4.58
	(0.006)**	(0.26)**	(0.011)**	(0.234)**
Log population (destination)	0.052	4.97	0.128	13.24
	(0.018)**	(0.485)**	(0.019)**	(0.593)**
Log population (origin)	0.003	−1.74	0.009	−10.09
	(0.002)	(0.356)**	(0.004)*	(0.623)**
Log immigrant proportion	−0.316	−0.337	−0.088	0.088
	(0.058)**	(0.027)**	(0.057)	(0.033)**
Border with USA	0	−0.094	0	0.221
	(0.002)	(0.012)**	(0.002)	(0.019)**

Notes: $^{**}p < 0.01$, $^{*}p < 0.05$. Origin, destination, and path-specific fixed effects coefficients are omitted to save space. Birthrate difference and wage difference are omitted since all their coefficients were insignificant.

P1 denotes period 1: 2000–2005. P2 denotes period 2: 2005–2010. P3 denotes period 3: 2010–2015. Linear decompositions take P1's coefficients as reference. Homicide rates for young males (15–39 years old).

GDP, gross domestic product; FDI, foreign direct investment.