# Violence and Migration:

# Evidence from Mexico's Drug War[*]

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**Abstract**

The effect of violence on people's residential choice remains a debated topic in the literature on crime and conflict. We examine the case of the drug war in Mexico, which dramatically increased the number of homicides since late 2006. Using data from the Mexican Census and labor force surveys we estimate the impact of violence on migration at the municipal and state level. To account for the endogeneity of violence we use kilometers of federal highways interacted with cocaine supply shocks from Colombia as an instrument for the annual homicide rate. We argue that highways are good measures of pre-existing drug distribution networks, and the interaction with supply shocks arising in Colombia captures the time-variant nature of the value of these routes. After controlling for observed and unobserved area level heterogeneity, we find little evidence that increases in homicides have led to out migration, at the domestic level. We also find little evidence of international migration at the municipal level, but some evidence of it at the state level. Our results show a muted migration response that is incompatible with a story of wide-scale displacement from the violence.

*JEL classification:* O12, K42, O54, J11

*Keywords: Homicides, migration, drug-distribution networks.*

# 1   Introduction

The impact of violence on the affected communities is not well understood and has recently become a topic of significant research in development and labor economics. In this paper, we study the impact of the drug war and the related steep rise in homicides since 2006 on the residential choices of the Mexican population. The drug war began after newly elected president Felipe Calderón launched a federal assault on the drug cartels. Annual homicides increased from 10,452 in 2006 to 27,213 in 2011 (Trans-border Institute, 2012), and in total, more than 50,000 deaths are attributed to the conflict.[1] In addition, the increase in violence was geographically concentrated, with only 3% of municipalities accounting for seventy percent of the violence (Rios and Shirk, 2012). While the death toll is regionally concentrated, the fear of violence has been widespread among the general population. Nationally representative victimization surveys show that the proportion of adults who feel their state of residence is unsafe rose from rose from 49% in 2004 to 61% in 2009, and this increased feeling of insecurity occurred in states that did not become more violent as well as those that did.[2][3]

Hirschman (1970) states that there are two effective ways for citizens to express their discontent if the advantages of being in an organization (here their residential location), and hence their loyalties, decrease: "voice" or political participation as a way of exerting pressure on their public officials; and "exit", or migration to a more preferred location. On the issue of voice, Dell (2015) finds that violence escalates in municipalities where the party aligned with the crackdown on cartels closely wins an election. It is less clear, however, how election results reflect people's attitudes towards violence and their preferences for public officials to combat it. On the other hand, re-

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[1]Homicide data from municipal death records, accessed through Mexico's statistical agency, Instituto Nacional de Estadística y Geografía or INEGI (www.inegi.org.mx).

[2]Author's calculations from the National Survey of Insecurity (ENSI). Data and documentation are available on INEGI's website.

[3]In addition, the casualties have spread beyond the combatants (members of the cartels, police and army) to the civilian population. While comprehensive data on the victims of drug-related violence is not available, analysis of a sub-sample of drug-related crimes reported in newspapers between 2006 and 2012 provides an idea of the civilian cost (the Violence and Victims Monitor dataset, compiled by the Trans-border Institute). Of the 3,052 cases analyzed, the authors estimate that 1.5% of the victims are current or former mayors, while 2.4% are journalists or media support workers (Molzahn et. al 2013). Applied to all drug-related deaths, these numbers suggest the civilian cost is not small.

searchers are in agreement that, at least on an aggregate level, people will migrate away from their homes when they think there is a threat of violent behavior, from governments or dissidents, to their "personal integrity" (Moore and Shellman, 2008; Davenport, Moore and Poe, 2003). Contrasted with traditional migration, risk aversion and lack of information may affect violence-induced migration (Engel and Ibáñez, 2007). These migration choices also may be guided by distorted beliefs about the true level of violence. For example, Becker and Rubinstein (2011) highlight that since exposure to and costs from violence differ people may form different perceptions of insecurity.[4]

The expectation that rising violence may increase migration is supported by several papers which have looked at the U.S. and found that crime does lead individuals to move. For example, Cullen and Levitt (1999) analyze the phenomenon of population flight from city centers to surrounding suburbs, and find that an increase in various crimes leads to a significant decline in cities' population. At an individual level, Dugan (1999) finds that individuals who are victims of property crime are significantly more likely to move, while Xie and McDowall (2008) find that victims of violent crime are also likely to move, and do so more than victims of property crime. They also find that, in addition to their own victimization, people react to a heightened fear of crime and move in response to the victimization of immediate neighbors.

Evidence of re-location also is found for Colombia, a country that experienced a protracted conflict between the government, drug trafficking organizations and rebel groups. Papers find that households with greater exposure to violence in their own or surrounding areas were more likely to move to safer metropolitan areas (Engel and Ibáñez, 2007), while households in major cities with higher kidnapping risks from rebel groups were likely to send members abroad (Rodriguez and Villa, 2012).

In contrast to Colombia, however, the increase in drug violence in Mexico was sharp and sudden. Over the three year period of 2006 to 2009 total homicides rose by 90%. In terms of a migration response, there are several anecdotal reports of people leaving areas that have been

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[4]The authors examine the responses of Israelis to terror attacks during the "Al-Aqsa" Intifada. Occasional users of transportation services and coffee shops decrease their usage, but not frequent users. Media exposure and education affect the dissemination of information.

severely affected by the violence, with most accounts stating that migrants have moved across the border to the U.S. (Rice, 2011; Arceo-Gómez, 2013). In 2011 the Internal Displacement Monitoring Center compiled these and other accounts of Mexican people who moved due to drug violence, but concluded that existing estimates - which range from 220,000 to 1.6 million - are incomplete and that more reliable figures are needed. Indeed, on a broad scale almost no study has examined if the violence in Mexico led to wide-spread migration and subsequent population changes. One exception is Rios (2014), who finds that drug related homicides are highly correlated with unpredicted population declines at the municipal level. Rios's identification strategy, however, is limited as it does not control for unobserved area level factors that may jointly determine drug violence and migration decisions.[5] This omission is important as conflict can be linked with economic prosperity (Abadie and Gardeazabal, 2003), while socioeconomic factors at the area level can be significant determinants of displacement, even after conflict variables are controlled for (Czaika and Kis-Katos, 2008).[6]

In this paper we overcome the obstacle of controlling for unobserved area level heterogeneity by using an instrumental variables strategy. We instrument for annual violence using kilometers of federal highways interacted with cocaine seizures in Colombia. We argue that highways capture pre-existing drug distribution networks, and that the majority of violence has originated among cartels to gain control of these networks. Highways are a relevant predictor of the changes in local violence, but only after the start of the Drug War. In order to account for time variation in the value of drug distribution routes and address concerns about the exclusion restriction - specifically the direct link between highways and migration- we interact highways with drug interdiction efforts from Colombia. Seizures changed during the Drug War period and provided an external shock to the volume of drugs being transported across these routes (Castillo et. al. 2014).

Overall, we find no strong evidence that increasing homicides during the drug war period led to

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[5]Márquez-Padilla et. al. 2015, while studying the effect of drug violence on school enrollment in Mexico also find population declines, for various segments by age and gender, in response to violence.

[6]Another exception is Velásquez (2015) who finds that violence has increased migration for certain sub-populations. She corrects for time-invariant characteristics using a panel data set of individuals, but the strategy does not allow for the control of variables that change over time and affect migration and violence.

increased migration. We start with domestic migration, which arguably is less costly relocation and better captured by our data based on surveys of Mexican households. Instead of the positive relationship between violence and re-location reported in previous papers, we actually find a negative relationship once we use an instrumental variables model. A positive and significant relationship only emerges from an OLS model that fails to account for unobservable area level or time varying factors. Once we account for these factors we find that rising violence did not increase re-location, either across states or municipalities.

For international migration we find mixed results depending on the geographic level of aggregation. At the municipal level we find negative coefficients, showing that increased violence decreased the number of households that sent members abroad. At the state level, however, we find positive coefficients, suggesting the opposite. We argue these results may be a result of a heterogeneous response across municipalities in more violent states. In total, however, our results show a muted migration response to large increases in violence and one this is incompatible with a story of large-scale displacement. We propose that the results may be explained by multiple factors, including a low level of mobility among the Mexican population, perceptions of the differences in security in home and possible destination areas within Mexico, increases in the cost of re-location due to the violence itself, and adoption of alternate investment methods in response to violence.

# 2   Theoretical Framework

In basic migration models people or households choose to move by estimating the gain from migration, calculated as the difference in utilities at home ($h$) and destination ($d$) minus the cost of migration ($C$) (Borjas, 1987, 1999). People not only decide to migrate; they simultaneously decide where to migrate. The neo-classical theory of migration posits that one of the biggest factors influencing the benefits from economic migration is the difference between a person's present discounted value of lifetime incomes at home ($w_{ih}$) and destination ($w_{id}$), which are are determined

by own human capital, as well as discount rates (Todaro and Maruszko, 1987). Other economic factors, such as amenities at home and destination also impact the migration decision.[7][8]

Violence enters the migration decision through many factors. First, violence impacts the perception of insecurity in the home and destination location. Individuals value security, and thus the perception of insecurity enters directly into the utility function. The perception of insecurity at home ($S_{ifh}$) is influenced by victimization, but also by the reports of violence in the neighborhood or even in adjoining municipalities. For example, people may live in small and relatively non-violent municipalities, but their states may be violent. As a result, the perception that violence can spill over to their municipality in the future can cause people to move in the present.

The perception of insecurity in the destination area can differ depending on whether the migration decision is domestic or international. This is an important consideration in the case of Mexico, since the high rates of migration to the U.S. mean that potential movers likely simultaneously consider re-locating either to the U.S. or elsewhere in Mexico (Aguayo-Téllez and Martínez-Navarro, 2012). If a country in its entirety is believed to be unsafe, a household may be more compelled to move abroad. For example, Wood et. al. (2010) find that the increase in crime in the 1980s that plagued most of Latin America increased the probability that people in the region intended to move their entire household to USA. Individuals may believe longer distances increase their safety, and distance can be artificially inflated by the presence of national borders. Finally, violence can affect the permanence of a move. If people believe the violence in their place of origin is likely to subside over time, they may not migrate or the move may be temporary.

Second, violence can impact the economic well-being of an individual, and thus the migration decision, via its effects on household's human capital and financial investment decisions and local labor markets. In a fairly recent literature, authors find that drug violence negatively impacts

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[7]Xie (2014) assumes future incomes are also positively correlated with distance. People have the benefits of reaching broader labor markets if they travel longer distances.

[8]The availability of networks in destination $d$ also affects the cost-benefit analysis of the migration decision (McKenzie and Rappaport, 2010). The costs of migration not only include the monetary and psychic costs of moving but also the information costs about the destination, which might not be perfect and vary across individuals (Dustmann, 1992). All of these costs are a function of networks in the destination location, and smaller networks can increase costs and dampen incentives to migrate in the face of adversity. In addition, transportation costs, psychic costs and information costs also increase with distance, which means that longer distances may deter migration.

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school attendance and grades of children in Mexico (Michaelsen and Salardi, 2015; Orraca Romano, 2015).[9] For financial investment, there is limited evidence connecting savings increases and violent crimes, but some evidence in Brazil that property crime makes households thrifty (DeMello and Zilberman, 2008).[10] For labor markets, Robles et. al.(2013) and Velásquez (2015) find negative effects on local labor force participation and employment from marginal increases in violence in the Mexican context. On the other hand, drug gangs themselves may provide employment opportunities to local residents. These jobs may be more appealing if a gang controls an area, effectively becoming a local monopoly or if jobs in the legitimate sector are scarce or of lower pay. Finally, violence can lead to the threat of expropriation of property and increase tenure insecurity. The lack of well-defined property rights is seen to lock Mexican people to their land, and reduce international migration (Valsecchi, 2011). Criminal vandalism and violent crimes also have a negative impact on housing prices in an area, reducing incentives to move (Gibbons, 2004; Ihlanfeldt and Maycock, 2010). If these factors outweigh the insecurity from violence, we may find no out-migration in areas with greater cartel presence.

Third, violence may increase migration costs. Cartels aiming to dominate an area can try to prevent residents from moving. For example, the Congressional Research Service Report for Congress (2013) points out many instances where cartels either massacred migrants who were crossing the border, or tried to force migrants to move drugs across the border on their behalf.

Combining these factors in a cost benefit analysis, a person ($i$) decides to move if the differences in the expected utility from the destination and home location are larger than the cost of migrating. Expected utility from a respective location is a function of wages ($w$), local amenities ($Z$), other individual characteristics, such as wealth and fixed assets ($I$), and perceptions of insecurity ($S$):

$$U(w_{id}, I_{id}, Z_{id}, S_{id}) - U(w_{ih}, I_{ih}, Z_{ih}, S_{ih}) - C_i > 0$$

The equation above highlights that a person moves if the perceived differences in safety and

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[9]The role of selection into migration in determining education outcomes is explored, although it is likely that the lack of education opportunities in an area causes households to move out (Márquez-Padilla et. al. 2015).

[10]Ben-Yishay and Pearlman (2012) find that Mexican micro-enterprises have a lower probability of expanding or experiencing income growth in the face of property crime.

economic outcomes outweigh the cost. An individual therefore may remain in a location if the perceived gains in safety from the home to destination area or if the perceived differences in economic outcomes are sufficiently small. Several papers provide examples when both have been the case. Morrison (1993) finds that economic factors dominate violence as determinants of migration in Guatemala during the country's civil war, while both Morrison (1993) and Bohra-Mishra and Massey (2011) find that people are less likely to move at low and moderate levels of violence. Only at high levels of violence do individuals move. People may instead adjust to violence in alternative ways. For example, Braakmann (2012) shows that within-community differences in victimization risk in Mexico induce behavioral changes among individuals in terms of work-leisure time allocation and property protection.

Finally, it is important to note that in the empirical analysis that follows we focus on the push factor $S_{ih}$, or violence in the home area, rather than the pull factor, or the relative violence in the destination area. We do this since data for the perception of security at destination places, especially internationally is not available. The next section explains our data in detail.

# 3 Data

## 3.1 Homicide Data

To measure violence from the drug war we use data on intentional homicides from municipal death records, compiled and made publicly available by the National Statistical and Geographical

Institute (Instituto Nacional de Estadística y Geografía, or INEGI).[11] [12] [13] From this we construct an annual homicide rate for region $j$, measured as:

$$AnnualHomicide_{j,t} = \frac{Homicides_{j,t}}{Population_{j,t}}$$

For comparison we also construct an aggregated measure of violence over the Drug War period under study. We calculate total homicides from January 2007 to December 2010 and convert this to a homicide per 100,000 inhabitants as of 2005 using population data from the National Council on Population (CONAPO).[14]

Summary statistics for municipal and state level values are shown in Table 1. The sharp rise in homicides following the beginning of the federal crackdown on drug cartels in late 2006 is apparent. As shown in Panel A, at the municipal level homicides per 100,000 inhabitants rise from an average of 10.87 in 2005 to 21.24 in 2010- an increase of 98 percent; while the maximum jumps from 325 in 2005 to 847 in 2010- an increase of one hundred and sixty percent. As shown in Panel B, we see similar results at the state level. Average homicides rise from total homicides rise from 8.7 in 2005 to 25.9 in 2010- an increase of 198 percent- while the maximum increases over eight hundred percent.

The table also shows the growing disparity across areas in levels of violence following the start of the drug war. From 2005 to 2010 the standard deviation in homicides across municipalities

[11]In the municipal death records missing data and no homicides are coded in the same way, since municipalities without homicides in a given year do not appear. To distinguish between non-response and zero values we use information on all deaths, either from homicides or other causes. We assume if a municipality reports values for all deaths but not homicides, there were no homicides and the value is zero. If a municipality does not report values for all deaths or homicides, we assume the information is missing and code the value as a non-response.

[12]We use data from death certificates rather than police records as the publicly available data cover more years and all municipalities, making them more comprehensive. One difference between the two data sources is that the death certificate records only include intentional homicides, while the police record data also include manslaughter (unintentional homicide). This is helpful, as the drug related violence we are interested in does not include unintentional homicides.

[13]We also consider drug related homicides from Mexico's National Security Council (SESNSP) as our measure of homicides. These are available from December 2006 to September 2011, but given the lack of data on drug-related homicides prior to the drug war- a measure of pre-existing violence- we view these results as secondary. They are available upon request.

[14]We use the 2005 CONAPO projections because the 2010 projections, adjusted after the 2010 Census was complete, do not include revisions of earlier years. To avoid any changes in in homicides per 100,000 inhabitants that stem purely from estimation revisions we use the older projections which are consistent across all years.

increases more than one hundred percent, while at the state level it increases more than six hundred percent. The concentration of violence geographically also is evident from municipal and state maps, shown in Figure 1. To capture violence over the drug war period under study, these maps present homicides over the 2007-2010 period per 100,000 inhabitants. As shown in panel (a) of Figure 1, the majority of municipalities in Mexico have not exhibited high levels of homicides. Instead, a small number of municipalities exhibit high levels of both. The lower panel (b) shows a similar phenomenon at the state level.[15] Figure 1 also shows an absence of regional concentration in terms of where the most violent municipalities or states are located. The most violent areas are not exclusively along the U.S. border, and several are along the Pacific and Gulf Coasts. This highlights that the intensity of the drug war is not wholly determined by proximity to the U.S.

## 3.2 Migration Data

Our theoretical model considers individual migration decisions, but in the analysis that follows we create aggregate migration rates at the area level. We do this since we do not know individual's perceptions of security, and use actual violence at an area level as a proxy. We therefore examine the impact of violence in an area on the overall migration decisions of people in those areas. We are interested both in short-run flows, which tell us about the timing of the response, and accumulated flows over time, which tell us about large-scale shifts in the population. We use panel and cross-sectional data to capture each.

The first source of data is the 2010 Mexican Census, as accessed through IPUMS International, maintained by Population Center at the University of Minnesota. The Census is the only data set that is representative at the municipal level and provides information on movement across municipalities over time. The survey asks the current municipality of residence and the municipality of residence five years ago (in the year 2005). We record someone as a national migrant if they are

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[15]The homicide variable is calculated as a proportion of the area's population. Population is naturally higher when aggregated across municipalities at the state level. Not all municipalities within a state need to be similarly violent. Hence the range for homicides is lower in panel B.

older than five, lived in Mexico in 2005, and live in a different municipality in 2010 than in 2005.[16] Movements across or within states are counted equally, as the goal is to capture the sheer number of people relocating during the Drug War. The Census measure creates a five year domestic migration rate from 2005 to 2010. While it is possible the variable captures migration unrelated to the drug war (those who migrate prior to 2007) and misses temporarily displaced individuals (individuals who leave an area but return if the violence subsides); if, a significant portion of the population was displaced between 2007 and 2010, this should be captured by the Census measure.

The 2010 Census also has information on international migration. There is a module that asks households if a member has moved abroad in the past five years and, if so, the exact year of their departure. We use this information to count all individuals over the age of five, who lived in Mexico in 2005, and are reported to have moved between 2005 and 2010. We consider both a five year migration rate, which captures larger shifts in the population, and an annual migration rate, which captures short-term flows. It is important to note that both measures likely are lower bounds on the true incidence of international migration, as individuals who moved abroad with their entire household are not included.

The benefit of the Census is that it is representative at the municipal level, giving us a finer degree of geographic variation. The downside, however, is that individuals are not asked about the timing of their domestic re-location, hence annual measures of municipal-level domestic migration cannot be constructed. As we detail in the next section, time variation is important for the identification assumptions of our empirical model. We therefore turn to a second data source, the National Survey of Occupation and Employment (referred to by its Spanish acronym ENOE).[17] The ENOE is a rotating panel that surveys households for five consecutive quarters, is representative at the state level (not the municipal level), and keeps track of all members listed in the initial survey.[18] To create annual flows we restrict attention to households who enter the sample in the

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[16]Since our focus is migration decisions of individuals exposed to violence in Mexico, we remove individuals who lived outside the country five years ago. This means return migrants are not considered in the analysis.

[17]ENOE stands for the Encuesta Nacional de Ocupación y Empleo. The data and documentation for the ENOE are available on the INEGI website. www.inegi.org.mx

[18]We are unaware of any panel data set that is representative at the municipal or any one other than the ENOE that is representative at the state level. Panel data sets like the Mexican Family Life Survey, are only representative at the

first quarter of a given year, and record an individual as a national migrant if they are reported as; (a) moving to another state; or (b) moving within or to another state (anywhere else in Mexico) in any of the subsequent four quarters. The former is more likely to capture more costly internal migration, while the latter also includes less costly migration in the form of moving, for example, to another neighborhood in the same city. We count an individuals as an international migrant if they are reported as moving abroad in any of the subsequent four quarters. The ENOE therefore captures short-term migration, as it measures the number of individuals in a given state who move between the first quarter of a given year and the first quarter of the next year. Like the Mexican Census, the ENOE also may undercount the number of domestic and international migrants, since entire households that move cannot be identified.

To calculate migration rates we take the total number of individuals who moved either do-mestically or abroad and divide by the population in a given area at the beginning of the period. All of the migration totals are calculated using population weights. For example, the annual year domestic migration rate for state $j$ and year $t$ is calculated as:

$$\text{Domestic Migration Rate}_{j,t} = \frac{\text{Individuals Move to Another State}_{j,t}}{\text{Individuals in State}_{j,t}}$$

Summary statistics on 5-year aggregate and annual migration rates are provided in Table 2. Panel A and B contain measures of national and international migration, respectively. We re-iterate that the municipal level measures come from the Mexican Census, while the state level measures are from the ENOE.[19] Two conclusions emerge from Table 2. First, Panel A shows that domestic migration rates in Mexico are low. In 2010 the average five year national migration rate was 4.15%. Meanwhile, over the previous 10 year period (1995 to 2000) the national migration rate is 5.48%. These numbers are lower than comparable countries and highlight that the Mexican population is

regional level, as defined in accordance with the National Development Plan 2000-2006. This is a level of geographic aggregation that is much higher than the state, and therefore does not provide sufficient variation in violence to assess differences in possible migration responses.

[19]We calculate state level international migration rates from the Census to gauge differences between the Census and ENOE. For the five year migration rate, the correlation across the two data sources is 92.1%. For the annual migration rate, the correlation is 56.6%. This suggests the total number of international migrants over the five year period recorded by both data sets is similar, but that some discrepancy exists in recorded year of departure.

less mobile than populations used in other studies of re-location responses to violence. For example, in the U.S., in the 2005 to 2010 period, the inter-municipal migration rate was 12.3% (Ihrke and Haber, 2012). Over the 2000-2005 period, the five year migration rate for Argentina, Brazil, Ecuador, and Honduras were 7.2%, 10%, 8.3%, and 7.2% respectively (Bell and Muhidin, 2009). Finally, for Colombia, a country that also suffered from drug violence, the five year migration rate from 2005-2010 was 7.4% (Bell and Muhidin, 2009) - more than three percentage points higher than Mexico for the same period.

Second, the table shows the decline in international migration rates from 2005 to 2010. This is strongly seen in the state level rates, which fall from 0.22% in 2005 to 0.09% in 2010. This decline in international migration, specifically to the U.S., is thought to be the result of reduced job opportunities in the U.S., improved job opportunities in Mexico and increased border enforcement (Passel and Gonzalez-Barrera, 2012). This suggests there were multiple forces acting to reduce international migration during the Drug War period.

# 4 Estimation Strategy

## 4.1 Instrumental Variable: Rationale and Relevance

The migration rate of area $j$ in period $t$ can be outlined as a linear function of area homicides per 100,000 inhabitants during the same time period, observable area level characteristics ($M_j$), time fixed effects ($\delta_t$) and unobservable area level and time-period specific characteristics ($\epsilon_{j,t}$).

$$MigrationRate_{j,t} = \beta_1 + \beta_2 Homicides_{j,t} + \gamma M_j + \delta_t + \epsilon_{j,t} \tag{1}$$

The challenge to identifying $\beta_2$ stems from the existence of unobserved characteristics that may jointly determine migration decisions and homicides. Ex-ante, it is unclear what bias these characteristics may exert. On one side, factors such as institutions may put upward bias on the coefficient, if areas with weak institutions experience a larger increase in violence due to less effective

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police and judicial services and greater out migration if employers and job opportunities locate elsewhere. On the other side, factors such as the effectiveness of drug trafficking organizations may put downward bias on the coefficient if these organizations create more job opportunities– reducing the incentives to migrate– but also increase levels of violence.

To control for unobserved heterogeneity we instrument for area-homicides in period $t$ using kilometers of federal highways interacted with quantity of cocaine seized by Colombian authorities in the same period. In this section, we outline the rationale behind using this interacted variable, and separately discuss each part of the instrument.

We begin with a discussion regarding the use of highways. First, the beginning of the Drug War coincides with the federal government crackdown on drug trafficking organizations, which began in December of 2006. This is apparent by looking at the summary statistics in Table 1, but also has been documented by Dell (2015), who examined the impact of government crackdowns on drug trafficking. She finds that violence increased most sharply in areas where the government directly confronted drug trafficking organizations. Other potential explanations for the violence, including increased political competition that changed implicit agreements between the government and cartels, Mexico taking Colombia's place as the major distributor of drugs to the U.S., and changes in relative prices which increased the production of marijuana and opium within Mexico (Dube et. al., 2014), either pre-date the conflict by many years or cannot be timed exactly to late 2006.[20] These factors may work in conjunction with the government crackdown to explain the perpetuation of violence after 2007; however in isolation they cannot explain the timing of the increase.

The government crackdown on the cartels entailed the capture and killing of members of drug trafficking organizations and the seizure of drugs and weapons (Guerrero-Gutiérrez, 2011). In doing so the government weakened previously oligopolistic organizations, leading to turf wars as organizations fought for control of the drug production and distribution networks of their weakened rivals. One argument is that increased competition was most severe over access to distribution

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[20]For example, it is believed that Mexico took over Colombia's place as the major distributor of drugs to the U.S. in 1994. This was a result of the U.S.'s efforts to close off the Caribbean routes into the U.S. (through Miami) and increased trade flows between Mexico and the U.S. due the signing of NAFTA.

networks-and specifically land transport routes- to the U.S., the largest drug consumer market in the world and Mexico's largest trading partner for legal goods (Rios 2011, Dell 2015). Arguably, areas with more access to distribution routes should experience the largest increases in violence.

This leads to the second part of the logic that includes federal highways in the instrument - namely, highways capture distribution networks to the U.S. First, the majority of transport of goods and people from Mexico to the U.S. occurs via highway. The North American Transportation Statistics Database indicates that in 2011, approximately 65% of Mexican exports to the U.S. were transported via highway, while 82% of Mexican travel to the U.S. occurred via highways and rail.[21] Second, federal highways are the highest quality road routes, with more stretches of paved roads and roads with four, as opposed to two, lanes. Federal highways, particularly the toll ones, frequently are the fastest and easiest way to travel between areas in Mexico. Third, the federal highway system includes the most transited and valuable routes, many of which run to and cross the U.S. border.[22] For example, the federal highway system has seven crossing points into the U.S, as compared to only one crossing point into Mexico's southern neighbor, Guatemala. Finally, the U.S. Department of Justice (2010) estimates that most drugs are smuggled into the U.S. via land routes using commercial or private vehicles, and these are then transported across the U.S. using highways.[23] It therefore is very likely that many drug shipments are transported through Mexico using the same routes as legal goods and the routes used within the U.S. Finally, by using highway values from 2005 - which pre-dates the Drug War- we ensure that more recent factors linked to homicide rates and migration do not determine their placement.

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[21]No breakdown is available, but person transport via rail in Mexico is low. The reliance on highways for transport largely is due to the poor state of Mexico's railroads, which only recently have improved under private concessions.

[22]Federal highways consist of free highways, for which no toll is charged, and toll highways. The data come from the 2005 Annual Reports for each state. For two states (Puebla and Oaxaca) it was necessary to impute values, as breakdowns were not given for each municipality. The imputation was done using data on registered passenger trucks from the Annual Reports for each state.

[23]In the National Drug Threat Assessment, the U.S. Department of Justice (2010) states that most drugs are smuggled into the U.S. over land, and not via the sea or air. The study also states that: "To transport drugs, traffickers primarily use commercial trucks and privately owned and rental vehicles equipped with compartments and natural voids in the vehicles. Additionally, bulk quantities of illicit drugs are sometimes commingled with legitimate goods in commercial trucks." The report also talks about major corridors for trafficking within the U.S., all of which are along highway routes. For example, within the primary corridor "Interstate 10 as well as Interstates 8 and 20 are among the most used by drug couriers, as evidenced by drug seizure data..."

Highways alone instrument for cross-sectional municipal level regressions, where the explanatory variable is the aggregate homicide deaths from 2005 to 2010. To test the hypothesis that highways are a relevant predictor of homicides during the Drug War period, we regress homicides per 100,000 inhabitants on federal highway kilometers in 2005 for each year in the 2000 to 2010 period. Results for municipalities are shown in Panel A of Table 3, while results for states are shown in Panel B. The results show a clear relationship between highways and homicides, but only after the Drug War. At the municipal level the coefficients on federal highways in years prior to 2008 are insignificant, while at the state level they are insignificant prior to 2006. After the Drug War begins federal highways became a positive and significant predictor of homicides. Furthermore, the strength of this relationship increases over time, with the largest coefficients found in 2010. Hence, areas with more federal highways indeed became more violent over time.

The problem with using highways alone is that the exclusion restriction, which assumes that federal highways do not directly affect migration rates, likely does not hold. First, highways influence the transportation costs associated with migration to or from certain areas, which will directly affect migration rates. Second, highways might capture changes in economic activity due to linkages to the U.S, and important consideration as the commencement and escalation of the drug war coincides with the Great Recession in the U.S., which had a large impact on Mexico. Areas that suffered more during the recession may exhibit higher migration rates, but also greater increases in violence, if drug trafficking organizations are better able to recruit members, expand their operations, and challenge rivals in these same areas. Again, in this case federal highways may be directly correlated with our outcome variable, violating the exclusion restriction.

We therefore employ an instrumental variable that exploits time variation to capture the portion of transportation networks not directly related to migration. Specifically, following Castillo, Mejia and Restrepo (2014) we use changes to the quantity of cocaine being shipped from Colombia to Mexico to capture variation in the value of drug distribution networks to the U.S. over time. Unlike other drugs that reach the U.S. from Mexico, such as marijuana or heroin, cocaine is not produced in Mexico. All of the cultivation of coca leaves, the main input into cocaine, and the refinement of

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these leaves into cocaine occurs in three countries: Peru, Bolivia and Colombia (UNODC World Drug Report 2013), with Colombia being the dominant producer. According to the 2013 United Nations World Drug Report, Colombia was responsible for 54% of all coca cultivation and 61% of all cocaine production in 2007. These numbers remain high despite a large-scale anti-drug policy enacted by Colombian authorities in the late 1990s.[24]

The amount of cocaine reaching Mexican borders, in turn, depends on the efforts of Colombian authorities to combat drug trafficking, and specifically their efforts to seize cocaine supplies. In recent years Colombia has increased its interdiction efforts, leading to greater external shocks to the supply of cocaine reaching Mexico (see Castillo, Mejia and Restrepo, 2014 for details). These shocks likely alter the use of highways to transport drugs to the U.S., and have been documented to change the level of violence in these areas (Castillo, Mejia and Restrepo, 2014). To measure these external shocks we use data from the Colombian Defense Ministry on tons of cocaine seized by Colombian authorities in each year.[25] These totals are presented in Panel A of Figure 2, and show no clear upward or downward trajectory over the Drug War period. Thus the cocaine seizures do not appear to be capturing a parallel time trend to that of homicides over the time period considered.

Seizures should capture changes in supply of drugs being transported through Mexico but be uncorrelated with events in the U.S. or Mexico. To provide evidence of this we estimate the relationship between monthly cocaine seizures in Colombia and monthly trade flows of "legal goods" using measures of exports from the IMF Direction of Trade Statistics over the period of January 2004 (first available in DOTS) to April 2012. As shown in Appendix Table A.1, there is no significant relationship between cocaine seizures in Colombia and: (1) bilateral trade flows between Colombia and Mexico; (2) bilateral trade flows between the U.S. and Colombia; (3) trade flows between Colombia and the rest of the world; (4) bilateral trade flows between the U.S. and

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[24]In an earlier year (2000) Colombia was estimated to produce 79% of the world's cocaine supply.

[25]We are grateful to Juan Camilo Castillo for providing us with these data. We use total tons of cocaine seized by Colombia authorities rather than an estimate of total cocaine production as the latter depends upon estimates of potential cocaine production, which come from the United Nations Office on Drugs and Crime. In the 2013 World Drug Report, UNODC notes that due to a new adjustment factor for small fields the estimated figures for 2010 and 2011 are not comparable to those from earlier years. The 2010 estimate shows a significant decline from earlier years. As a result, we use seizure data, which is more consistent over the 2005-2010 time period we consider.

Mexico; and (5) trade flows between Mexico and the world.

We also find no positive correlation between Colombian cocaine seizures and migration to the U.S., as measured by the number of new Mexican immigrants captured in the American Community Survey (ACS). As seen in Panel B of Figure 2, the relationship between seizures and immigration is negative, even after the Drug War begins. This suggests cocaine seizures are not directly associated with a rise in Mexican migration to the U.S.

## 4.2 The Model

Our instrument is the interaction of kilometers of federal highways in the year 2005 with thousands of tons of cocaine seized by Colombian authorities each year. The identification assumption is that shocks to cocaine supplies impact the value of highways for drug transport and violence related to control of these routes, but have no direct effect on migration costs.

The first stage of our instrumental variables model is the following:

$$Homicides_{j,t} = \alpha_1 + \alpha_2(FederalHighwayKilometers_j^{2005} * CocaineSeizures_t) + M_j'\theta + \delta_t + e_{jt}$$

(2)

The second stage is:

$$MigrationRate_{j,t} = \beta_1 + \beta_2\widehat{Homicides}_{j,t} + M_j'\gamma + \delta_t + \epsilon_{j,t} \qquad (3)$$

where $\widehat{Homicides}_{j,t}$ are fitted values from the first stage regression.

To estimate the model we use panel data on international migration at the municipal level from the Census and panel data on domestic and international migration at the state level from labor force surveys. For comparison to previous studies we also include results from cross-sectional data on domestic and international migration from the Census. For the Census we have annual data on the 2005 to 2010 period, while for the ENOE we have data from the 2005 to 2011 period. The outcome variable is homicides per 100,000 inhabitants in area $j$ in time period $t$. This is a function of the instrument, time-invariant area characteristics ($M_j$), time period fixed effects ($\delta_t$),

and unobserved area-year factors ($\epsilon_{j,t}$).

The area level controls we use are as follows. At both the state and municipal level we include controls for economic activity and wealth. At the state level we use annual real GDP and unemployment rates. At the municipal level, since we do not have annual data or GDP values, we use unemployment rates in 2010 and 2000, average years of education for adults, the percentage of households with running water, and household income per capita in the year 2000. We also account for pre-existing levels of violence by including average homicides per 100,000 inhabitants for the years 2003 and 2004. To account for time invariant migration costs we include all non-federal (state) highways as of 2005. A larger highway network should reduce the cost of moving elsewhere in Mexico and abroad, but these costs likely are general to the entire highway network, rather than specific to federal highways. Indeed, federal highways make up only 20% of all highway kilometers as of 2005, which means that state highways should capture a large degree of the time invariant migration costs associated with a road network. Thus our instrument captures changes in the value of the drug distribution routes conditional on the pre-existing local transportation network. Finally, we include population density to account for the possibility that both homicide and migration rates are higher in urban areas.[26]

# 5  Results

The first stage results from the instrumental variables model are shown in table 4. The second stage IV results for domestic migration are shown in Table 5, while the second stage IV results for international migration are shown in Table 6. To show the extent to which unobserved area level heterogeneity may bias the results we also estimate all models via OLS. For ease of interpretation we re-scale the migration rates by multiplying by 100 (thus a migration rate of 1.5% becomes 1.5). These results are presented alongside the second stage IV results in Table 5. All coefficients are

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[26]Unemployment rates, years of education, income in 2000, the number of households with running water and previous migration rates are constructed by the authors from the 2000 and 2010 Census. The state highway variable comes from the state statistical abstracts provided by INEGI. Population density is calculated using information on square kilometers as of the year 2005 from INEGI and population as of the same year from CONAPO. We also remove 2 municipalities with national out migration rates in excess of 50% in 2010.

population weighted. Standard errors are shown in parentheses.[27]

## 5.1 First Stage Results

The results of the first stage IV regressions in Table 4 show that the strong relationship between federal highways and homicides remains after we control for area level characteristics. In all cases the coefficients on the instrument are large and significant. For example, the coefficient in column one implies that a one standard deviation increase in federal highways (48 kilometers) is associated with a rise in homicides per 100,000 inhabitants of 10.2– approximately eleven percent of a standard deviation. The Anderson-Rubin LM $\chi^2$ value and Angrist-Pischke $F$ values are sufficiently high to reject the respective nulls of an under-identified model and an identified model that suffers from a weak correlation between the instrument and the endogenous variable. Overall the results confirm that federal highways and federal highways interacted with cocaine seizures in Colombian are relevant predictors of which municipalities and states became more violent during the Drug War.

## 5.2 Second Stage Results: National Migration

The results for national migration, which arguably is the less costly form of migration, are shown in Table 5. In general we find a muted migration response in our preferred model, which uses time variation. As shown in column two, which measures migration to another state, we find negative and significant coefficients. This suggests that higher homicides led to a decrease rather than an increase in inter-state migration. When we consider migration to any other location in Mexico, including the same state, we continue to find a negative coefficient (column four). Although this value is insignificant, the upper bound of the 95% confidence interval suggests that a two standard deviation increase in annual homicides per 100,000 inhabitants leads to an increase in relocation, either within or across states, of 0.14%. This is low given the scale of increase in violence.

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[27]For annual international migration we cluster standard errors at the municipal level. We do not cluster standard errors for the state-level models as there are only 32 states, below the number needed for the clustered standard errors to be unbiased (Angrist and Pischke 2009, Kezdi 2004).

We also find a muted response in the municipal cross-section, which is not our preferred model but which we include to provide comparison with previous literature. As shown in column 5, the OLS coefficient is positive and significant; a result in line with those from other studies that report a migration response to violence. This conclusion disappears, however, once we control for unobserved regional heterogeneity using the IV model. The IV coefficient becomes statistically insignificant, and, at 0.0063% suggests that a two standard deviation increase in homicides per 100,000 inhabitants is associated with an increase in outmigration of 4% over a five year period. This value is small given the scale of the increase in violence and time period considered (5 years), and incompatible with a story of large-scale displacement. Overall the results provide little evidence that increasing homicides led to higher domestic migration.

## 5.3    Second Stage Results: International Migration

As shown in Table 6, when we look at international migration rates, the conclusions are slightly different. At the municipal level the results are similar to those for domestic migration, as we find negative coefficients in all cases. This shows that an increase in homicides led to a decrease in the percentage of individuals who move abroad. For example, the coefficient in column 4, which uses the municipal panel, suggests that a one standard deviation increase in violence led international migration to fall by 0.41%. This constitutes a large decline given that average international migration rates are around 0.29%.

What is interesting, however, is that at the state level the IV coefficient is positive and significant (column 2), suggesting that increased violence in the state led more, rather than fewer, individuals to move abroad. [28] To reconcile the differences in the municipal and state level results we turn to the "perception of insecurity" variable in our theoretical model. As highlighted in the data section, municipalities did not uniformly become more violent, and generally a small number of municipalities drive increased violence at the state level. The result is that in states that became

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[28]We also get positive coefficients if we limit the years to 2007 to 2010 or if we use annual international migration flows from the Census rather than the ENOE. Thus the discrepancy in the state and municipal results is not due to the time frame or deviations in the recorded year of migration in the ENOE.

more violent, the variation in violence across municipalities is high (the correlation between average violence and the standard deviation is 91%), which could lead to different perceptions of insecurity and heterogeneous migration responses. Specifically, the perception of violence could be greater in less violent municipalities in more violent states than in more violent municipalities in these same states. The migration response therefore is greater in less violent municipalities than in more violent ones. This asymmetry in perceptions of violence is similar to Becker and Rubinstein's (2011) analysis of responses to terrorist attacks in Israel. They find that individuals with less exposure to possible attacks react more strongly than those with greater exposure, suggesting they form more exaggerated perceptions of violence. These same differences may explain the gap between the municipal and state level results.

Furthermore, there can be data discrepancies between the ENOE and Mexican Census that impact the differences between state and municipality-level responses to violence. As mentioned earlier, the correlation in state-level five-year aggregate international migration is high across the two data sources, but the correlation is lower for annual state-level migration rates (footnote 19). If the nature of undercounting varies between the datasets, we could be dealing with responses from two different populations.[29] It is difficult to ascertain the extent to which attrition of households from either sample is correlated with violence.

# 6  Robustness Checks

## 6.1  Local Average Treatment Effect

The IV estimates reflect the average impact of homicides for municipalities that become more violent in 2007-2010 as a result of highways within their boundaries. One concern with these local

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[29]The extent of undercounting is likely to be higher in the Census compared to the ENOE. For example, in ENOE 2010, an average of 3.5% households were seen to leave the sample between rounds. It was unclear whether this was due to international or internal migration. To partially gauge the extent of missing households in the Census, we consider the number of new Mexican immigrants in the U.S. with multiple family members over the Drug War period. One-fourth had three or more family members, of which at least one was a child. This constitutes an increase from the previous ten year period average of 20%.

average treatment estimates surrounds the heterogeneity with which highways predict homicides. Some areas may become more violent without having federal highways, or some areas may experience a fall in conflict despite a substantial endowment of highways. If the-number of "defier" municipalities is sufficiently large they may cancel the impact of the "complier" municipalities (where presence of highways weakly increased violence or where the lack of highways weakly reduced violence). In order for our results to be representative of all locations that become more violent due to disputes over the distribution networks, the assumptions of monotonicity and independence of the instrumental variable must hold (Imbens and Angrist, 1994). Section 4 presented arguments for independence, and showed that it was less of a concern for the instrument that included time variation. In this section we focus on the requirement of monotonicity.

Monotonicity implies that, after controlling for observable characteristics, the coefficient on the highways variable should be weakly positive for all municipalities in the first stage regressions:

$$Homicides_j = \alpha_1 + \alpha_{2,j} InstrumentalVariable_j + M_j' \theta + e_{jt} \tag{4}$$

Monotonicity holds even if the impact of highways varies across areas (the $\alpha_{2,j}$ coefficients) as long as they have the same sign. Of course, $\alpha_{2,j}$ cannot be calculated for each geographic unit $j$, and thus some level of aggregation is needed. To do this we place municipalities into quartiles based on the level of predicted homicides.

We predict annual homicide rates during the 2007-2010 Drug War period using all observable controls except federal highway kilometers separately for the subsample of municipalities with highways and no highways. Coefficients for predicted values are calculated from the group of municipalities without highways. It is important to note that 42% of municipalities have no federal highways.[30] Predicted homicides are divided into quartiles, and municipalities are assigned accordingly. We then calculate the mean levels of actual homicides by quartile for both categories of municipalities and compare the true and predicted values. The results of this exercise are presented in Figure 3. Average homicide rates for the municipalities with highways are higher than those for

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[30]There are no states in Mexico without federal highways, hence this exercise is done only at the municipal level.

municipalities with no highways in all cases. The difference between the two groups rises with the quartile of violence, and the largest difference is seen in quartile 4, providing evidence that the strongest effect is for municipalities with the most highways.

Next, we present results from equation (5), but aggregated by quartile of predicted violence in Table 7. The coefficient on highways is weakly positive for all quartiles, and increasing with the level of violence. This is true for both the municipal cross-section results in panel A and the municipal panel results in Panel B. The effect of the treatment is heterogeneous across quartiles but always weakly positive, as seen from the positive coefficients on the instrument in all the first stage regressions. This lends credence to the belief that defiers are not counteracting the responses of compliers.

## 6.2   Higher Frequency Time Variation

Our current state level results consider only annual variation, and use a panel (the ENOE) where attrition rates are not low. We therefore also consider quarterly variation in migration from the ENOE, as this allows us to see if the results are robust to higher frequency time variation. To construct quarterly migration variables we calculate the number of individuals recorded as moving either domestically or abroad and divide by the total population as measured by the ENOE (this leads to slightly higher migration rates as the population values in the ENOE are lower than in the Census). The results are shown in Table 8, and are very similar to those from the model that uses annual variation. Although the estimated IV coeffients are larger– likely a product of higher migration rates from a smaller population base– the general conclusions remain. Thus our state level findings are robust to the consideration of higher frequency time data and are not being driven by selective attrition from the panel.[31]

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[31]Given the small number of time periods we have, cross-sectional variation drives our results more than time series variation. For this reasons we include municipal or state controls in lieu of area fixed effects in our main regressions. There are concerns, however, that our results are not robust to fixed factors at the state or regional level that may explain the link between homicides and migration. We examine if our results are robust to the addition of state fixed effect or regional fixed effects, defined by five regions; North, Central, East, West and South. The second stage IV coefficients, available upon request, are similar in size and sign to those from our original model.

## 6.3 Migration Dynamics

In this section we explore the dynamics of migration in more detail. In particular, we explore the possibility that people's perceptions about violence and the benefits of moving may be driven by previous rather than contemporaneous homicides. This is likely if people are more likely to respond to increases in violence they view as permanent rather than temporary, and lagged values can better capture the former rather than the latter. We therefore consider a one and two period lag in the re-location response, by estimating the interacted IV model, instrumenting for lagged homicides using kilometers of federal highways in 2005 multiplied by cocaine seizures in the previous year or two periods. All other controls remain the same.

The results for domestic migration are shown in Panel A of Table 9, while the results for international migration are shown in Panel B. In general they are similar to the initial results. We find a negative and significant effect of lagged homicides on domestic migration at the state level, a negative but insignificant effect of homicides on international migration at the municipal level, but a positive and significant effect of homicides on international migration at the state level. Thus considering lagged violence our conclusions about the migratory response do not change.

# 7    Conclusion

In this paper we investigate if the large increase in homicides that took place in Mexico after the start of the Drug War led to increased migration, both to other parts of Mexico and abroad. To identify the relationship between violent death and migration rates at the municipal and state level we instrument for the violence using kilometers of federal highways interacted with shocks to the cocaine supply from Colombia. We argue that federal highways capture pre-existing drug-distribution networks, a key asset driving the dissent among cartels, and between cartels and the federal government, and the interacted instrument captures the variation to the value of these networks over time. After controlling for observable and unobservable area level characteristics we

find little evidence that homicides related to the Drug War led to increased domestic migration. We also find little evidence of increased international migration at the municipal level, but some evidence of increased migration at the state level. While we cannot account for entire families that moved abroad, our results generally are inconsistent with anecdotal accounts of wide-scale displacement as a result of the Drug War, as well as cross-sectional or panel-data estimates of the effect of violence on migration in Mexico that fail to account for time-variant heterogeneity across regions.

Several factors may explain the lack of relocation response in the face of large-scale violence. First, the Mexican population is not particularly mobile. Domestic migration rates were low prior to the commencement of the Drug War and have fallen further since. Second, migration is a costly response to violence, and people may change their labor market and household savings and investment decisions to adapt to insecurity. Violence may additionally dampen the incentives to move by increasing tenure insecurity regarding fixed assets like land and reducing property values. Third, the Drug War coincided with macroeconomic events that reduced the incentives to move abroad, particularly to the U.S. The Great Recession combined with increased border security made migration to the U.S. more costly, and it is possible that in the absence of the conflict net flows would have fallen even further. Finally, inaccuracies in the perceptions of violence across different locations in Mexico may deter domestic migration. National surveys reveal weak correlations between actual and perceived increases in violence at the state level, which may lead people to think that moving domestically will not lead to an appreciable increase in safety. For all of these reasons, even though life has become difficult in some areas as a result of the Drug War, the average individual may find moving to be too costly.

Finally, our analysis is positive rather than normative in nature. We find that people largely do not re-locate in response to large increases in violence, but it could be the case that if the costs were lower or if people had accurate perceptions of violence in the home and destination locations, migration would be the optimal adjustment mechanism. Without more information on alternative responses or the extent to which information and monetary barriers limit migration, it

is impossible to know if the decision to stay in increasingly violent areas is first or second best. We also do not attempt to measure the total welfare cost of the violence, or the extent to which welfare could be improved by re-location, but view such analysis as fruitful, particularly for policy makers attempting to improve individuals' ability to manage higher levels of violence. Further work on how people form perceptions of violence and the ways in which they adapt are necessary to perform a welfare exercise and further our understanding of the total societal costs of violence.

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# TABLE 1: Summary Statistics: Homicides

| PANEL A: Municipal Level | Sum 2007-2010 | Totals by Year 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | All Years |
|---|---|---|---|---|---|---|---|---|
| Mean | 58.91 | 10.87 | 11.4 | 10.03 | 12.95 | 16.35 | 21.24 | 13.8 |
| Standard deviation | 93.9 | 22.61 | 24.51 | 19.82 | 30.49 | 35.17 | 49.42 | 32.15 |
| Minimum | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Maximum | 2068.89 | 325.73 | 567.64 | 304.88 | 609.76 | 938.8 | 847.46 | 938.8 |
| | | | | | | | | |
| 25th percentile | 12.37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 50th percentile | 31.93 | 3.42 | 3.69 | 2.86 | 4.44 | 6.86 | 6.49 | 4.55 |
| 75th percentile | 65.43 | 12.85 | 13.7 | 11.17 | 14.33 | 18.09 | 19.71 | 14.83 |
| 90th percentile | 145.62 | 27.48 | 29.76 | 28.36 | 32.22 | 41.94 | 57.17 | 34.92 |

| Panel B: State Level | Sum 2007-2010 | Totals by Year 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | All Years |
|---|---|---|---|---|---|---|---|---|
| Mean | 68.8 | 8.69 | 9.01 | 8.14 | 13.31 | 19.13 | 25.9 | 15.81 |
| Standard deviation | 75.56 | 4.97 | 6.09 | 4.85 | 14.01 | 22.48 | 35.33 | 21.05 |
| Minimum | 9.09 | 2.02 | 2.22 | 2.56 | 2.42 | 1.82 | 1.8 | 1.79 |
| Maximum | 396.38 | 18.7 | 24.77 | 23.87 | 75.21 | 105.97 | 183.31 | 183.31 |
| | | | | | | | | |
| 25th percentile | 27.32 | 4.81 | 4.36 | 4.74 | 5.66 | 7.42 | 7.03 | 5.96 |
| 50th percentile | 40.71 | 6.47 | 6.64 | 6.37 | 7.95 | 10.22 | 14.27 | 9.45 |
| 75th percentile | 71.77 | 13.04 | 12.16 | 10.98 | 16.16 | 18.64 | 27.92 | 16.67 |
| 90th percentile | 158.67 | 16.98 | 18.54 | 15.21 | 31.47 | 55.12 | 52.78 | 27.97 |

Note: The all years summary statistics at the state level are for years 2005-2011.

Source: INEGI.

## TABLE 2: Summary Statistics: Migration

PANEL A: National Migration

| | Municipal Level | State Level, by year | | | | | |
| | 2005-2010 Period | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| Mean across areas | 4.15% | 0.31% | 0.29% | 0.32% | 0.32% | 0.29% | 0.27% |
| Standard Deviation | (0.067) | (0.002) | (0.002) | (0.002) | (0.002) | (0.001) | (0.001) |

PANEL B: International Migration

| | Municipal Level | Municipal Level, by year | | | | | |
| | 2005-2010 Period | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| Mean across areas | 1.50% | 0.18% | 0.33% | 0.34% | 0.32% | 0.29% | 0.25% |
| Standard Deviation | (0.015) | (0.002) | (0.003) | (0.003) | (0.004) | (0.004) | (0.004) |

| | State Level | State Level, by year | | | | | |
| | 2005-2010 Period | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|
| Mean across areas | 2.71% | 0.22% | 0.22% | 0.16% | 0.14% | 0.11% | 0.09% |
| Standard Deviation | (0.023) | (0.002) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |

Municipal level observations=2455. State level observations=32

Municipal level data are from the 2010 Mexican Census. State level data are from annual ENOE surveys.

We also compare state level international migration rates from the Census and ENOE. For the 2005-2010 period, the total international migration at the state level from the Census is 3.11%, slightly higher than the ENOE total. Across all states the correlation between the Census and ENOE five year international migration rates is 92.1%. For the annual international migration rates, the correlation between the census and the ENOE is 56.6%.

Source: Mexican Census, as accessed through IPUMS, and the ENOE.

TABLE 3: Kilometers Federal Highways and Homicides

| Outcome Variable: Homicides per 100,000 inhabitants | Year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| **Panel A: Municipal Level** | | | | | | | | | | | |
| Federal Highways, 2005 | -0.00608 | -0.00566 | 0.000312 | -0.00230 | -0.00636 | -0.000871 | 0.00112 | 0.00448 | 0.0371*** | 0.0737*** | 0.125*** |
| | (0.0119) | (0.0108) | (0.0122) | (0.00918) | (0.0108) | (0.00950) | (0.0103) | (0.00833) | (0.0128) | (0.0146) | (0.0207) |
| | | | | | | | | | | | |
| Observations | 2,425 | 2,428 | 2,428 | 2,429 | 2,429 | 2,434 | 2,434 | 2,434 | 2,434 | 2,434 | 2,433 |
| R-squared | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.003 | 0.010 | 0.015 |
| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| | | | | | | Year | | | | | |
| **Panel B: State Level** | | | | | | | | | | | |
| Federal Highways, 2005 | 0.107 | 0.0874 | 0.0945 | 0.0922 | 0.0761 | 0.0953 | 0.137* | 0.0952 | 0.235** | 0.380** | 0.506** |
| | (0.0861) | (0.0826) | (0.0824) | (0.0814) | (0.0750) | (0.0839) | (0.0772) | (0.0598) | (0.108) | (0.150) | (0.239) |
| | | | | | | | | | | | |
| Observations | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 |
| R-squared | 0.049 | 0.036 | 0.042 | 0.041 | 0.033 | 0.041 | 0.096 | 0.078 | 0.137 | 0.176 | 0.130 |

Standard errors in parentheses ***p<0.01, **p<0.05, *p<0.1          Source: INEGI

# TABLE 4: First Stage Results

| Geographic Variation: | Municipal Level | | State Level |
|---|---|---|---|
| Data | Panel | Cross-Section | Panel |
| Outcome: Homicides per 100,000 inhabitants | (1) | (2) | (3) |
| Federal Highway Kilometers 2005 * | 0.24172*** | | 0.03938*** |
| Cocaine Seizures in Colombia | (0.07172) | | (0.01237) |
| Federal Highway Kilometers 2005 | | 0.21519*** | |
| | | (0.04791) | |
| | | | |
| Observations | 14,268 | 2,425 | 224 |
| Angrist-Pischke F value | 11.36 | 20.17 | 10.13 |
| Anderson Rubin LM ChiSquared value | 14.23 | 20.10 | 10.26 |

Robust standard errors in parentheses.          *** p<0.01, ** p<0.05, * p<0.01.

Municipal controls include average homicides from 2003-2004, population density, average years of schooling, % of HHs with running water, unemployment in 2010 and 2000, income per capita in 2000, whether or not the municipality is on the U.S. border, kilometers of state highways in 2005, and year fixed effects for the panel.

State controls include average homicides from 2003-2004, population density, annual real GDP per capita and unemployment, non-federal highways in 2005 and year fixed effects.

Source: Mexican Census, as accessed through IPUMS, ENOE, INEGI, Colombian Ministry of Defense.

## TABLE 5: OLS and Second Stage IV Results: Domestic Migration.

| Geographic Variation: | State Level | | State Level | | Municipal Level | |
|---|---|---|---|---|---|---|
| Data: | Panel (Another State) | | Panel (Anywhere in Mexico) | | Cross-Section | |
| Model: | OLS | IV | OLS | IV | OLS | IV |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Annual Homicides, | -0.00085** | -0.00954** | -0.00206 | -0.01405 | | |
| per 100,000 inhabitants | (0.00038) | (0.00391) | (0.00200) | (0.00889) | | |
| Homicides 2007-2010, | | | | | 0.00221** | 0.00630 |
| per 100,000 inhabitants | | | | | (0.00091) | (0.00880) |
| Observations | 224 | 224 | 224 | 224 | 2,425 | 2,425 |

Robust standard errors in parentheses.     *** $p<0.01$, ** $p<0.05$, * $p<0.01$.

## TABLE 6: OLS and Second Stage IV Results: International Migration.

| Geographic Variation: | State Level | | Municipal Level | | | |
|---|---|---|---|---|---|---|
| Data: | Panel | | Panel | | Cross-Section | |
| Model: | OLS | IV | OLS | IV | OLS | IV |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Annual Homicides, | 0.00016 | 0.00482** | -0.00002 | -0.00633*** | | |
| per 100,000 inhabitants | (0.00028) | (0.00245) | (0.00012) | (0.00233) | | |
| Homicides 2007-2010, | | | | | -0.00094** | -0.00604 |
| per 100,000 inhabitants | | | | | (0.00039) | (0.00389) |
| Observations | 224 | 224 | 14,268 | 14,268 | 2,425 | 2,425 |

Robust standard errors in parentheses.     *** $p<0.01$, ** $p<0.05$, * $p<0.01$.

Notes for tables 5 and 6: Municipal controls include average homicides from 2003-2004, population density, average years of schooling, % of HHs with running water, unemployment in 2010 and 2000, income per capita in 2000, whether or not the municipality is on the U.S. border, kilometers of state highways in 2005, and year fixed effects for the panel.

State controls include average homicides from 2003-2004, population density, annual real GDP per capita and unemployment, non-federal highways in 2005 and year fixed effects.

Source: Mexican Census, as accessed through IPUMS, ENOE, INEGI, Colombian Ministry of Defense.

TABLE 7: Heterogeneous Responses by Quartile of Violence

| | Quantiles predicted homicides without highways | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| PANEL A: Domestic Migration | quartile=1 | | quartile=2 | | quartile=3 | | quartile=4 | |
| Municipal Cross-Section | First Stage | Second Stage | First Stage | Second Stage | First Stage | Second Stage | First Stage | Second Stage |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Federal Highway kilometers 2005 | 0.13327 | | 0.13843*** | | 0.35193*** | | 0.45865** | |
| | (0.084) | | (0.046) | | (0.063) | | (0.198) | |
| Homicides 2007-2010 per 100,000 inhabitants | | 0.02844 | | 0.01838 | | -0.01000 | | 0.01165 |
| | | (0.038) | | (0.024) | | (0.011) | | (0.011) |
| Observations | 606 | 606 | 607 | 607 | 607 | 607 | 605 | 605 |
| Angrist-Pischke F test | 2.527 | 2.527 | 9.067 | 9.067 | 31.36 | 31.36 | 5.373 | 5.373 |
| Kleinbergen-Paap rK LM ChiSq. | 2.559 | 2.559 | 9.081 | 9.081 | 30.29 | 30.29 | 5.424 | 5.424 |

| | quartile=1 | | quartile=2 | | quartile=3 | | quartile=4 | |
|---|---|---|---|---|---|---|---|---|
| PANEL B: International Migration | First Stage | Second Stage | First Stage | Second Stage | First Stage | Second Stage | First Stage | Second Stage |
| Municipal Panel | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Federal Highway Kilometers 2005* | 0.07583 | | 0.07649 | | 0.43207*** | | 0.91468*** | |
| Cocaine Seizures in Colombia | (0.070) | | (0.068) | | (0.083) | | (0.209) | |
| Homicides per 100,000 inhabitants | | -0.01993 | | -0.03219 | | -0.00985*** | | -0.00964*** |
| | | (0.024) | | (0.031) | | (0.003) | | (0.003) |
| Observations | 2,349 | 2,349 | 2,376 | 2,376 | 2,380 | 2,380 | 2,395 | 2,395 |
| Angrist-Pischke F test | 1.184 | 1.184 | 1.257 | 1.257 | 27.05 | 27.05 | 19.19 | 19.19 |
| Kleinbergen-Paap rK LM ChiSq. | 1.190 | 1.190 | 1.264 | 1.264 | 26.90 | 26.90 | 19.15 | 19.15 |

Robust standard errors in parentheses. In panel B standard errors are clustered at the municipal level.          ***p<0.01, **p<0.05, *p<0.01.

Municipal controls include: average homicides per 100,000 inhabitants for 2005 and 2006, population density, unemployment in 2010 & 2000, average years schooling adults, % households with running water, income per capita in 2000, and non-federal highways in 2005 and year fixed effects.

Source: Mexican Census, as accessed through IPUMS, INEGI, Colombian Ministry of Defense.

## TABLE 8: Robustness Checks: Higher Frequency Time Variation

| Outcome Variable: | Domestic Migration (Another State) | | Domestic Migration (Anywhere) | | International Migration | |
|---|---|---|---|---|---|---|
| Model: | OLS | IV | OLS | IV | OLS | IV |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Quarterly Homicides, | -0.00262** | -0.02916** | -0.00433 | -0.05393 | 0.00090 | 0.04132*** |
| per 100,000 inhabitants | (0.00124) | (0.01332) | (0.00406) | (0.03909) | (0.00097) | (0.01415) |
| | | | | | | |
| Observations | 896 | 896 | 896 | 896 | 896 | 896 |
| Angrist-Pischke F test | | 15.52 | | 15.52 | | 15.52 |
| Anderson Rubin LM ChiSquared | | 15.53 | | 15.53 | | 15.53 |

Robust standard errors in brackets. Standard errors are clustered at the municipal level.
*** p<0.01, ** p<0.05, * p<0.01.

Controls include average homicides from 2003-2004, population density, annual real GDP per capita and unemployment, non-federal highways in 2005, quarter and year fixed effects.

Source: ENOE, INEGI, Colombian Ministry of Defense.

## TABLE 9: Robustness Checks: Lagged Crime and Migration Patterns

**PANEL A: Domestic Migration**
2nd Stage IV Results

| | State Level Panel (Annual) | | | | State Level Panel (Quarterly) | | | |
|---|---|---|---|---|---|---|---|---|
| Migration Type | Another State | | Anywhere in Mexico | | Another State | | Anywhere in Mexico | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Homicides, one year lag | -0.00758* | | -0.01709 | | -0.04528*** | | -0.14069*** | |
| | (0.00401) | | (0.01070) | | (0.01456) | | (0.04636) | |
| Homicides, two year lag | | -0.01132** | | -0.02268 | | -0.03813*** | | -0.11811*** |
| | | (0.00524) | | (0.01423) | | (0.01379) | | (0.04391) |
| Observations | 192 | 160 | 192 | 160 | 896 | 896 | 896 | 896 |
| Angrist-Pischke F test | 7.975 | 10.21 | 7.975 | 10.21 | 18.87 | 18.55 | 18.87 | 18.55 |
| Anderson Rubin LM ChiSquared | 8.145 | 10.26 | 8.145 | 10.26 | 18.81 | 18.50 | 18.81 | 18.50 |

**PANEL B: International Migration**
Geographic and Time Variation

| | Municipal Panel (Annual) | | State Panel (Annual) | | State Panel (Quarterly) | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Homicides, one year lag | -0.00721** | | 0.00495* | | 0.01112 | |
| | (0.00322) | | (0.00267) | | (0.00928) | |
| Homicides, two year lag | | -0.01115** | | 0.00573* | | 0.01677* |
| | | (0.00502) | | (0.00310) | | (0.00997) |
| Observations | 11,890 | 9,512 | 192 | 160 | 896 | 896 |
| Angrist-Pischke F test | 11.93 | 10.21 | 7.975 | 10.21 | 18.87 | 18.55 |
| Anderson Rubin LM ChiSquared | 14.10 | 11.34 | 8.145 | 10.26 | 18.81 | 18.50 |

Robust standard errors in brackets.     *** p<0.01, ** p<0.05, * p<0.01.

Lagged homicides instrumented with kilometers of federal highways multiplied by a one period lag in cocaine seizures.
All regressions include state or municipal controls and year fixed effects.
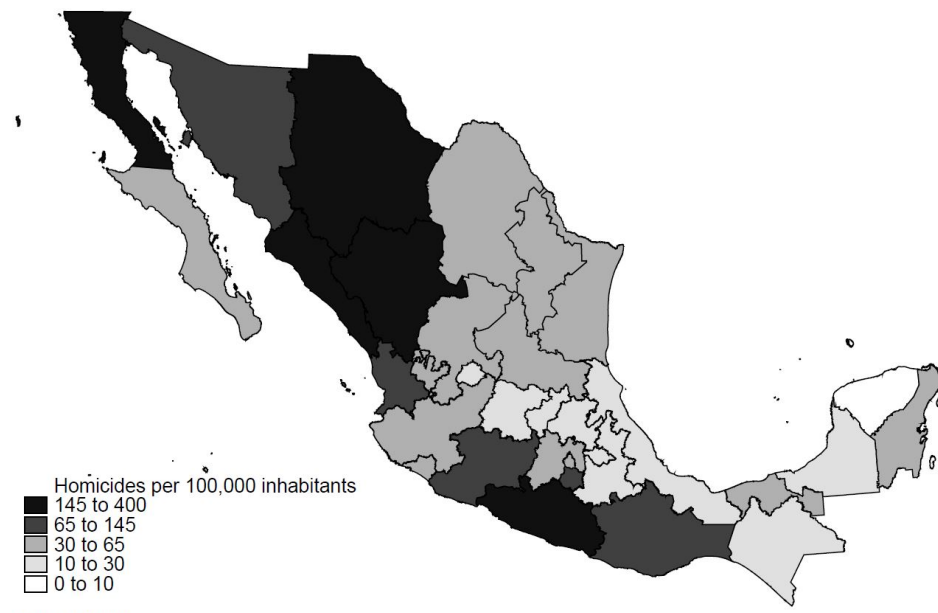Source: Mexican Census, as accessed through IPUMS, ENOE, INEGI, Colombian Ministry of Defense.

# FIGURE 1: Total Homicides for 2007-2010 per 100,000 Inhabitants

## (a) Municipality Level Variation



Homicides per 100,000 inhabitants
- 400 to 2100
- 145 to 400
- 65 to 145
- 30 to 65
- 0 to 30
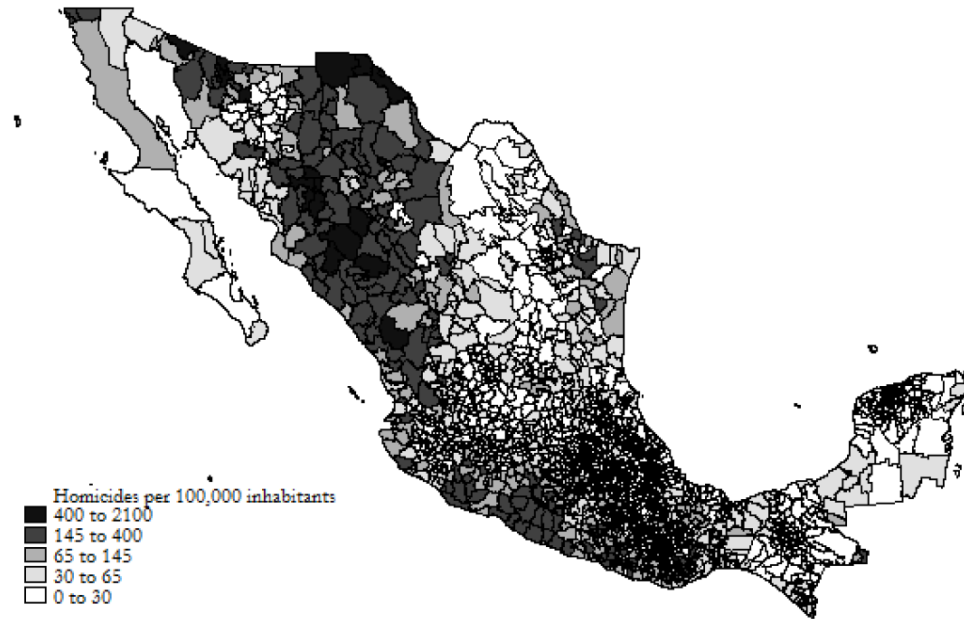
Source:INEGI

## (b) State-Level Variation



Homicides per 100,000 inhabitants
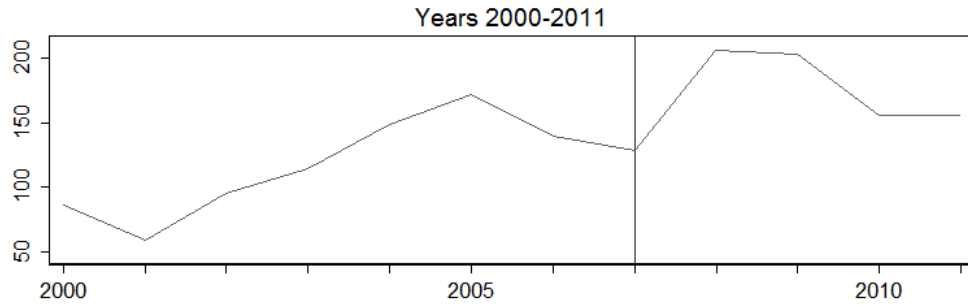- 145 to 400
- 65 to 145
- 30 to 65
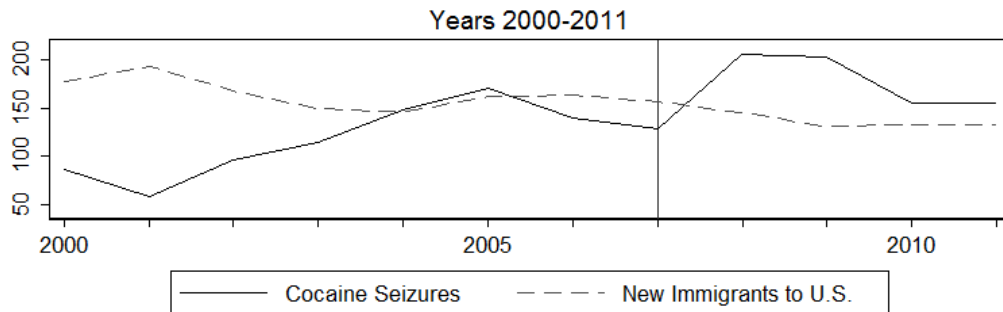- 10 to 30
- 0 to 10

Source: INEGI

# FIGURE 2: Cocaine Seizures in Colombia: 2000-2011

## (a) Annual Changes in Thousands of Tons



## (b) Cocaine Seizures in Colombia (thousands of tons) & New Mexican Immigrants to the U.S (tens of thousands).
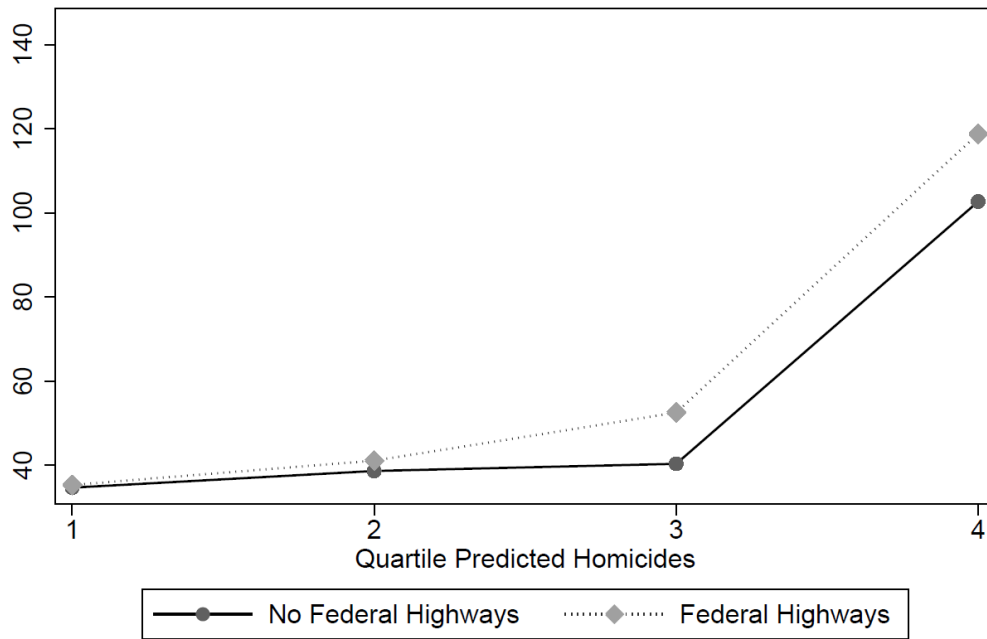


Note: The correlation between annual cocaine seizures in Colombia and new Mexican immigrants to the U.S. is -0.79.

Source: Colombia Defense Ministry and American Community Surveys.

# FIGURE 3: Test of Monotonicity

Average actual homicides by predicted homicide quartile



Quartiles from predicted homicide values without highways.

## TABLE A.1: Cocaine Seizures in Colombia and Official Exports

| Outcome: Cocaine Seized by Colombian Authorities Monthly data, January 2004 - April 2012 | Colombia, Exports | | | Mexico, Exports | |
|---|---|---|---|---|---|
| | Mexico (1) | United States (2) | World (3) | United States (4) | World (5) |
| Colombian exports to Mexico | 82.65166 (66.98469) | | | | |
| Colombian exports to the U.S. | | 0.44371 (1.65411) | | | |
| Colombian exports to the world | | | 0.39775 (0.65803) | | |
| Mexican exports to the U.S. | | | | -0.03587 (0.22173) | |
| Mexican exports to the world | | | | | 0.00789 (0.15651) |
| Observations | 100 | 100 | 100 | 100 | 100 |
| R-squared | 0.01530 | 0.00073 | 0.00371 | 0.00027 | 0.00003 |

Standard errors in brackets.     *** p<0.01, ** p<0.05, * p<0.01.

Exports in millions of U.S. dollars. Cocaine seizures in tons
Montly data on exports from January 2004 to April 2012 from the IMF, Direction of Trade Statistics.
Monthly data on cocaine seizures from the Colombian Ministry of Defense.