Homicide and Work: The Impact of Mexico's Drug War on Labor Market Participation

Ariel BenYishay and Sarah Pearlman*

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Abstract:

We estimate the impact of the escalation of the drug war in Mexico on the mean hours worked among the general population. We focus on homicides, which have increased dramatically since 2006. To identify the relationship between changes in homicides and hours worked, we exploit the large variation in the trajectory of violence across states and over time. Using panel and instrumental variables regressions, we find that the increase in homicides has negatively impacted labor force activity. An increase in homicides of 10 per 100,000 in a given state is associated with a decline of 0.3 weekly hours worked among the state's population. For states most impacted by the drug war, in which homicides per 100,000 inhabitants have increased by 30-50 a year, this implies an average decline in hours worked of one to one and a half hours per week. These impacts are larger for the self-employed and are concentrated among the highest income quartiles. This highlights how the costs of crime tend to be unequally born by certain segments of the population.

JEL Codes:

Keywords: Crime, Labor force participation, Mexico

*Contact information: BenYishay, University of New South Wales, School of Economics a.benyishay@unsw.edu.au, Pearlman, Vassar College, sapearlman@vassar.edu

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1 Introduction

In the past five years, Mexico has witnessed a dramatic increase in violent crime. The well-publicized rise is the result of the drug war, which escalated in late 2006 after newly elected president Felipe Calderón launched a federal crackdown on drug cartels. The ensuing period has been marked by a significant rise in violent death, with annual drug related homicides increasing from approximately 2,120 in 2006 to 12,366 in 2011 (Trans-border Institute) and all homicides increasing from 25,780 to 37,375 (National Public Security System).[1] In total, more than 50,000 deaths are attributed to the conflict (Rios and Shirk 2012). The increases are concentrated geographically, with high intensity states experiencing increases beyond those seen in some countries officially at war. In a recent ranking of the most violent cities in the world, Mexican cities claimed five of the top ten spots, highlighting the relative intensity of the conflict (Citizen's Council for Public Safety and Criminal Justice, 2012).

The cost of war between the Mexican state and drug cartels has been high. In addition to billions of dollars in public funds spent to fight the cartels, casualties have spread beyond members of the cartels, police and army to the civilian population. The gruesome and public nature of many of the killings as well as the perception that cartel members can operate with impunity has generated a high level of fear within the population. Nationally representative victimization surveys show that the percentage of adults who feel the state in which they live is unsafe rose from 54% in 2004 to 65% in 2009, while the percentage of individuals who feel their work is unsafe rose from 13.7% to 19%[2].

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[1] On a per inhabitant basis, total homicides have risen from 24.8 per 100,000 inhabitants in 2005 to 34.2 in 2011.

[2] Author's calculations from the National Survey of Insecurity (ENSI). This is conducted by Mexico's statistical agency, INEGI, and the data and documentation are available on their website.

This increased fear of victimization can compound the costs of the conflict if it generates behavioral changes, such a reduction in hours spent working or studying, which are second best. Several papers have explored these indirect costs of violent crime. For example, in examining changes in work trends in the U.S., Hamermesh (1999) finds that higher rates of homicide explain lower levels of evening and early morning work in large cities and secular declines over time (the same is not true of non-violent crimes), and that these shifts resulted in losses on the order of 4 to 10 billion dollars. Monteiro and Rocha (2012) find that armed conflicts between drug gangs in Rio de Janeiro have led to a significant reduction in the educational attainment of children in these areas. Fernandez, Ibáñez and Peña (2011) find that rural households in Colombia who were victims of violent crime increase their supply of labor to off-farm activities. Rodriguez and Sanchez (2009) also look at the armed conflict in Colombia and find it significantly reduces the average years of schooling. Finally, Barrera and Ibáñez (2004) find that among municipalities in Colombia, in those where homicide rates are above the national median, school enrollment is significantly lower and declines as homicide rates increase.

A small number of papers also have investigated the impact of crime on individuals in Mexico. Braakman (2012) looks at the period from 2002 and 2005, which pre-dates the escalation of the drug war, and finds that crime victims sleep fewer hours at night and are more likely to take protective measures against crime, such as changing travel routes and transportation modes. Villoro and Teruel (2004) examine the impact of homicides in 1997 and estimate losses between 0.03 and 0.6 percent of GDP. Dell (2011) investigates the spillover effects of the federal war on the cartels. She finds that female labor force participation falls in municipalities where drug traffic and violence is diverted following government crackdowns on groups in surrounding areas. Finally, nationally representative victimization surveys in Mexico (ENSI 2009) find that close to half of respondents stop going out at night as a result of crime, while fifteen percent stop taking public transportation, eating out and going to events. The changes subsequently may reflect a decline in the willingness of people to work at night or a reduction in work availability due to declining demand for particular goods and services like restaurants.

We contribute to the literature on the costs of violent crime by investigating the impact of the drug war in Mexico on the labor force participation of adults. To explore this link we use data on annual changes in homicides for the years 2007 to 2010 and changes in weekly hours worked from one year panels on employment and occupation. We begin by estimating the effects on these annual changes while controlling for time-invariant characteristics and for time-varying individual and regional level heterogeneity. In particular, we control for economic shocks and changes in the composition of employment in states over time; factors that may jointly determine changes in criminal activity and labor market participation. Overall we find a significant negative effect of changes in homicides on hours spent working. An increase of 10 homicides per 100,000 over a one year period is associated with an average decline of 0.3 hours worked per week. This constitutes a decline of roughly one percent. We find larger effects for men than women and even larger differences by work type. Among salaried workers the response is three times lower than among the entire population. On the other hand, among self-employed workers the response to changing homicide rates is one and a half times higher than for the full population. This suggests that in states most affected by drug war violence, average hours worked by the self-employed have declined by up to two and a half hours a week. While we do not know if the larger response is due to greater exposure to violence or an enhanced ability to change work schedules, the results show one dimension along which the impacts of violent crime may vary.

We next take an instrumental variables approach to further control for regional level heterogeneity. We instrument for changes in homicides using kilometers of federal toll highways in a state. The logic behind the instrument is that the increase in violence clearly is linked to the federal crackdown on drug cartels. The crackdown weakened oligopolistic organizations and increased competition for valuable production and transport routes. This competition has been most severe over access to land transport routes to the U.S., the largest drug consumer market in the world and Mexico's largest trading partner. Federal toll highways are good measures of routes to the U.S. because the majority of transport of goods and services in Mexico occurs via highway and toll roads are the highest quality and most rapid highway routes. Furthermore, the majority was built between 1989 and 1994 or follow previously established routes, which means current economic or demographic factors do not determine their placement. Regressions of kilometers of toll highways on homicides show that states with more toll highways register significantly higher homicide increases than those with fewer routes. This relationship holds after controlling for state fixed effects and time varying factors such as GDP growth and unemployment. Furthermore, comparisons of other transportation routes, such as state highways, find no similar relationship, while comparisons of economic variables show no similar trend differences. This confirms that the steeper homicide trajectory experienced by high toll highway states is not simply a reflection of level differences across states, general transportation access or economic trends.

Results from two-stage least squares estimation provide further evidence that increasing homicides negatively impact labor force activity. The coefficients on yearly changes in homicides are negative in all but one case and, for working adults, are three or more times larger than the OLS coefficients. For salaried adults an increase of 10 homicides per 100,000 over a one year period is associated with an average decline of 1.2 hours worked per week, while for self-employed workers the associated decline is one hour per week. These constitute declines between three and five percent. Similar to the OLS results we find mild differences by gender when work type is not considered but large differences by work type. Dissimilar to the OLS results, however, we find higher effects for salaried workers than self-employed ones. Again, we do not know if this is due to different types of work and exposure to crime or a greater ability to adjust work hours.

This paper also differs from others in that we examine differential responses to the conflict by income. The ability to avoid crime, and therefore both exposure to and fear of crime, may vary by the resources available to individuals, and several papers provide evidence that crime is unequally born by households at different income levels. For example, Gaviria and Pagés (1999) examine victimization data from 17 Latin American countries and find that victims of property crime are more likely to be upper or middle income. On the other hand, DiTella et. al. (2010) examine a crime wave in Buenos Aires and find that victimization rates rose much more for poor households than wealthy ones. They find the increases are largely for crimes for which abatement measures are expensive, such as burglary, rather than for crimes for which abatement measures are cheap, such as mugging. Villoro and Teruela (2004) find similar results for Mexico City. Using data from 1999 they find that the impact of crime and crime prevention, particularly for property crime, is much higher for individuals in the lowest income quintiles. Finally, recent nationally representative victimization surveys from Mexico (ENSI) suggest that poor households have a reduced ability to deter crime. Households in the lowest income quintile are five times less likely than those in the highest income quintiles to invest in high value security items, like alarms and private security guards, and on average spend 4-5 times less on crime deterrence. We repeat the analysis by income quartile and find, interestingly, that the impacts are concentrated among the highest income quartile. While we do not know if this is driven by greater exposure to violence, greater fear of violence, or an enhanced ability to respond to both by changing work schedules, these results suggest that the costs of the violent conflict have been born unequally across income levels.

The paper proceeds as follows. In section 2 we describe the data for labor market activity and crime. In section 3 we outline our empirical strategy and estimate a fixed effect model. In section 4 we outline an instrumental variables strategy. In section 5 we investigate differential responses by income. In section 6 we conclude.

2 Data

2.1 Homicide Data

To measure the impact of the drug war we use changes in total homicides per 100,000 inhabitants by state and year. The homicide totals are compiled by the National Public Security System (SESNSP) using information sent by state police forces. We convert the totals into crimes per 100,000 inhabitants using population data from the National Council on Population (CONAPO). It is important to note that the totals are for all reported homicides, not just those linked with drug violence. As outlined in Figure 1.A. and Table 1, homicides rose significantly in Mexico from 2005 to 2010. Average homicides per 100,000 inhabitants rose from 23.6 in 2005 to 37.38 in 2010 while the maximum for any state rose from 47.79 homicides per 100,000 inhabitants to a staggering 127.64. Table 1 also shows that the drug war has played out unevenly over the country. The yearly standard deviations close to triple from 2005 to 2010 and the gap between the 25th percentile and the 75th and 90th percentiles widen significantly. Indeed, according to the Trans-border Institute, in 2010, the peak of the drug war, fifty six percent of all drug related killings occurred in just four states-- Chihuahua, Sinaloa, Tamaulipas and Guerrero (Rios and Shirk 2011). Furthermore, over seventy percent of the violence was concentrated in just 80 municipalities (out of close to 2500). Figure 2 demonstrates this uneven trajectory of violence across states. While a handful of states have experienced sharp increases in homicides, many others have experienced small increases and some have even experienced a decline. The map also shows that the homicide trajectories lack any distinct regional trend. High violence states are not concentrated in areas which, *ex-ante*, one would suspect to face higher levels of drug trafficking, such as the U.S. border, the Pacific or the Gulf coasts. This shows that geography alone cannot explain why some states have been more affected by the drug war than others.

Finally, Figure and Table 1 show that homicides did not begin to increase until 2007, after the federal government launched a crackdown on drug cartels. We detail the crackdown and its role in increasing violence in Section 4. In the meantime, since our goal is to estimate the impact of increased homicides stemming from the drug war, our main focus is on the years 2007 to 2010.

2.2 Data on Labor Market Activity

The data on labor market participation, including weekly hours spent on paid work, come from the Mexican National Survey of Occupation and Employment (ENOE), a rotating labor force survey conducted by the Mexican Census (INEGI). The ENOE, which began in 2005[3], follows urban and rural households for five quarters. From the entire sample in a given year, we restrict attention to individuals who enter the sample in the first quarter and can be followed for five quarters. This group constitutes approximately twenty percent of the full sample in any quarter, and given the rotating nature of the sample, should not differ substantively different from the complete one.

Using the ENOE surveys for the years 2007 to 2010 we create yearly panels based on adults who enter the survey during the first quarter of the year and are between the ages of 18 and 65. After further limiting attention to individuals who were born in the same state in which they reside, the result is a sample of 94,642 individuals. Given that individuals stay in the sample for a year at most, this creates a repeated cross-section of one-year panels. Non-participation in the labor force is coded as zero, such that adults out of the labor force are reported as having zero hours worked. Our primary emphasis therefore is on the intensive margin of labor force activity, rather than the

[3] It replaces the combination of the urban labor force survey (the ENEU) and the urban and rural survey, the ENE.

extensive margin[4]. Since we do not control for entry to and exit from the labor force in the full sample, in order to better capture the intensive margin effects, in some of the estimations we also consider the sub-sample of adults who are in the labor force at the beginning of the year and remain in the labor force one year later.

In terms of regional variation, the geographic unit of focus is the state. This is the finest level of geographic detail we can achieve, as ENOE is not representative at the municipal level and the regional, time-varying controls are not available at the municipal level. Finally, later in the paper we investigate differential responses by income. To do this we place individuals into income quartiles based on their total monthly household income relative to others in their minimum wage area (defined by INEGI).

Summary statistics on the sample are provided in Table 2. Sixty four percent of the sample is in the labor force starting at the beginning of the year. Of these, sixty seven percent are engaged in salaried work while close to thirty percent are self-employed. There are large differences in labor market outcomes across men and women. While eighty six percent of men enter the sample in the labor force, only forty five percent of women do. This partially explains the large gaps in hours worked by gender. On average men work close to forty hours per week, while women work only seventeen. These differences also are reflected in monthly income, which is significantly higher for men than women (although household income is not). Considering trajectories of work behavior over the year, the average change in weekly hours worked is close to zero. Again we see gender differences. For men the average change is a decline of 0.45 hours per week, while for women it is an increase of 0.26 hours per week. This gap exists despite the fact that women have higher exit rates from the labor force than men. On average close to seven percent of men exit the labor force

[4] The labor force survey is meant to capture all types of work, regardless of the formality of the employer or the worker. As a result both formal and informal labor market activity is counted.

over the year long period in which they are observed, as compared to ten percent of women. Given these differences, we explore the possibility that the increase in homicides have differential impacts by gender.

3 Estimation

3.1 Basic Model

We start with a model linking changes in hours spent working to changes in homicide.

$$\Delta hours_{ist} = \beta_0 + \beta_1 \Delta \text{hom}\, icides_{st} + \Delta X'_{it}\gamma + \Delta Z'_{st}\varphi + \lambda_t + \Delta e_{ist} \quad (1)$$

The outcome variable is the change in weekly hours worked over a one year period (from Q1 in year *t-1* to Q1 in year *t*) by individual *i* in state *s* in year *t*. This is a function of the one-year change in homicide rates in state s , changes in individual level characteristics (ΔX_{it}), changes in state level characteristics (ΔZ_{st}), year fixed effects, and unobserved changes at the individual and state level (Δe_{its}). The model also implicitly includes controls for time-invariant individual and state characteristics, as we look at changes by individuals who remain in the same state over a one year period. As a result fixed individual characteristics, such as skill or risk aversion, that may jointly determine where people live and their work habits, are netted out. Also netted out are level differences across states that may jointly determine time use and crime patterns. For example, certain states may have better institutions, larger state budgets, or a better educated workforce, leading to lower crime rates and more employment opportunities.

Given the potential for time varying individual and state level heterogeneity to bias the coefficient on changes in homicides, we discuss controls for each in detail. To control for time-varying, individual heterogeneity we include one year change in total household size, change in the number of children, change in labor force status, and for those in the labor force, change in industry of work (2 digit code). In addition, to reduce omitted variables bias stemming from individuals who move to reduce exposure to homicides, we limit the sample to individuals who were born in the state in which they currently reside. This is the closest we can come to eliminating movers given the lack of residence history in the survey.

To control for regional heterogeneity we include several time varying measures. We include one year changes in state-level GDP and unemployment rates to capture economic shocks that might change the returns to work and criminal behavior. We also consider controls for more specific changes to the composition of work opportunities within a state over time. To do this we include changes in the share of output for industries, defined by 2 digit codes, by state and year. These variables help control for the possibility that over time more labor intensive industries may differentially locate in states with higher or lower homicide rates. We also include controls for changes in state government spending to state GDP, as improving or deteriorating state budgets may alter public employment opportunities as well as police resources and crime. Finally, we include year fixed effects to capture nation-wide shifts in labor market opportunities and crime. This is particularly important as the intensification of the federal response to drug trafficking coincides with the beginning of the Great Recession in the U.S., which severely affected Mexico.

Identification in the model comes from variation within individuals across states and years. Specifically, we examine how changes in labor market behavior vary by average individuals by state and year as the homicide rates change across states and time. The large variation in the homicide trajectories across states over the six year period is key to establishing this relationship. The identifying assumptions is that after we control for individual and state fixed factors as well as observable time varying individual and state characteristics, the error term is not correlated with changes in homicides. In other words, we can identify a relationship between changes in behavior and crime if $E[e_{ist} \mid X_{it}] = 0$.

We estimate equation (1) using OLS and present the results in table 3. We estimate the model on the entire sample, separately for men and women, and separately for adults who start and stay in the labor force. In all cases we use population weights and robust standard errors. To show the importance of controlling for observable individual and regional heterogeneity, we also present results from a model that contains no controls. Panel A contains results for all adults, regardless of labor force participation or type of work. Panel B contains results only for adults who have salaried work at the beginning of the year. Panel C contains results only for adults who are self-employed at the beginning of the year.

Overall the results show a negative relationship between changes in homicides and changes in work. The coefficients on homicide changes are negative in all but one of the estimations and significant for all adults and men. In many cases the results from the model that contains the full set of individual, state and time controls are larger than those from the restricted model, suggesting that failing to account for individual and regional level heterogeneity leads to an underestimation of the impact of homicides on labor force behavior. Focusing on the results for the full sample with all controls (shown in Panel A column two), the results indicate that an increase of 10 homicides per 100,000 over a one year period is associated with an average decline of 0.3 hours worked per week for all adults. With the sample mean of hours worked of 27.5, this constitutes a decline of roughly one percent. This coefficient also suggests that in states where the drug war has been most acute--where homicides per 100,000 inhabitants have increased by 30-50 per year--average hours worked by adults have declined by 1.0-1.5 hours per week. The results for all adults indicate a slightly larger response among men than women. An increase of 10 homicides per 100,000 inhabitants is associated with a decline of 0.45 hours for men, as compared to 0.14 for women.

In examining differential response by labor type, we see that the impact of homicides is much larger for self-employed workers than salaried ones. The coefficient for salaried workers of both genders (shown in Panel B column two) is -0.011 and insignificant. This compares with a coefficient of -0.048 for self-employed workers that is significant at the 10% level (Panel C column two), despite a much smaller subsample of self-employed respondents. This suggests the response to changing homicide rates is close to five times as high for the self-employed as for salaried workers. This large difference may be due to two factors. First, self-employed workers likely have a greater ability to adjust their work schedules than salaried workers, making it easier to change their labor market activity in response to security concerns. Second, self-employed workers may face greater exposure to the crime itself; many of these self-employed individuals have less ability to invest in deterrence and prevention, and may operate their businesses in areas that are more frequented by criminals. For example, street vendors and drivers of informal buses and taxis are more likely to be impacted by violent crime while at work than office workers. While we do not know the specific channel through which the effects operate, the results show that the increase in homicides has led to significant declines in labor market activity, particularly among the self-employed.

4 Instrumental Variable Analysis

4.1 Empirical Strategy

We now turn to instrumental variables estimation, as we remain concerned that unobserved time-varying factors may lead to a spurious correlation between changes in homicides and labor market activity. For example, lower labor force participation may lead to greater involvement in drug cartels and therefore to higher changes in homicide rates, upwardly biasing our estimates. Similarly, changes in unobserved state-level characteristics may simultaneously determine changes in labor force participation and homicides. One such characteristic is changes in institutional quality, as an improvement in institutions may manifest itself in more work opportunities—thereby increasing labor force participation-- and more effective policing—thereby lowering homicides. In this case the estimates from the fixed effects regressions will be upwardly biased, overstating the impact of homicides on work behavior.

To eliminate potential bias from unobserved regional heterogeneity and reverse causality, we instrument for changes in homicide rates. To do so, we focus on changes in the intensity of drug-related homicides that took place differentially across Mexican states after the federal government launched a crackdown on drug cartels in December 2006. The crackdown began when newly elected president Felipe Calderón sent army troops into the state of Michoacán to battle narcotrafficers. This marked the first time the federal government directly engaged with the cartels, and the government has since increased its involvement dramatically, deploying thousands of army and federal police officers to various municipalities where cartels have operated. Through the capture and killing of cartel members and drug seizures, the crackdown achieved a weakening of oligopolistic organizations, altering the previous equilibrium in which production and transport routes were divided among rival groups (Rios 2012, Dell 2011). The increase in competition has come in the form of turf wars, as groups violently vie for the production and transport routes of their diminished rivals. This competition has been most severe over access to land transport routes to the U.S., the largest drug consumer market in the world and Mexico's largest trading partner for legal goods.

As a result of the crackdown and ensuing intensification in competition, states with more extensive land transport routes connected to the U.S. have seen sharp rises in cartel-related violence and homicide rates—whereas states with less extensive routes have not. We therefore consider both the timing of the crackdown and differences in the extent of federal toll highways across states—which measure access routes to the U.S. —to construct our instrument for homicide changes.

Specifically, we use the number of kilometers of federal toll highways in each state as our instrument to estimate the effects of homicide changes in the post-crackdown period[5].

Several factors make toll highways suitable instruments for access to transport routes to the U.S. and therefore increasing homicides. First, the majority of transport of goods and people to the U.S. from Mexico happens via highways. 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 (no breakdown is available, but person transport via rail in Mexico is very low). The reliance on highways for transport is higher than in the U.S. and Canada and largely is due to the poor state of Mexico's railroads, which only recently have improved under private concessions.

Toll highways themselves are part of a three tier system comprised of federal free highways, for which no toll is charged, federal toll highways, and state highways. Of the three types, federal toll highways are of significantly higher quality than the other two. These toll highways were built by the federal government or under private concession as an alternative to the overused and under-maintained free federal and state highways, and are the preferred routes for those that can afford the tolls[6]. Although toll roads make up only six percent of all highways, they comprise close to fifty percent of highways with four or more lanes (Secretaría de Comunicaciones y Transportes, 2009). These toll highways are less congested and usually are the fastest way to travel via road. For these reasons, toll highways are more likely to capture the transport of valuable goods to the U.S.—including drug shipments—than do other transport networks. In general, the toll roads follow or link the most transited and valuable routes, many of which run to the U.S. border. For example, toll

[5] The data on kilometers of highways are from the Annual Statisticals of Secretary of Communications and Transportation (SCT).

[6] For a review of the highway privatization process in other Latin American countries (Argentina, Colombia and Chile), see Engel et. al (2003)

highway segments link into seven crossing points into the U.S. This compares with only one crossing point into Mexico's southern neighbor, Guatemala. Figure 3 shows a map of the toll highway system as well as this map superimposed on the earlier one of homicide increases. The latter provides some visual confirmation of a relationship between toll highways and the increase in violence.

A second advantage of using toll roads as instruments is that a majority of the system was either built between 1989 and 1994 or follows previously established highway or rail lines. This means that more recent factors linked to homicide rates and labor market outcomes largely did not determine their placement. To further ensure this is the case, we fix our measure of toll highways at the year 2005, prior to the escalation of the drug war[7].

To test if toll highways indeed are related to the increase in homicides due to the escalation of the drug war, we plot annual homicide rates in states with more extensive federal toll highway networks (the 12 states above the mean of 231 kilometers) and those with less extensive networks (the 20 states below the mean). As shown in Figure 4, we observe a sharp increase in these rates in the former group in 2007, but only a very weak and more gradual increase in the latter group. Importantly, we observe no similar differences in trends between high and low highway states in other economic characteristics, such as GDP growth, unemployment, and the extensive margin of labor force participation. Regression results confirming the trends in the graph are shown in columns 3 through 10 in Panel A of Table 4. These results provide further evidence that states with more toll highways became more violent during the intensification of the drug war, and suggest the higher homicide trajectory for high toll highways states is not simply a reflection of varying economic trends.

[7] Toll highways do increase over the 2005-2010 time period. Total kilometers rise from 7,409 in 2005 to 8,397 in 2010, an increase of 13%. However, the rise is not uniform across states, and in approximately half total kilometers remain the same (Secretaría de Comunicaciones y Transporte, Annual Statisticals).

Figure 4 also shows that differences in federal highway networks do not appear to explain pre-crackdown annual changes in homicides. This further confirms that the increase in violence stems from the federal crackdown and is not due to other factors. For example, it is believed that Mexico took over Colombia's place as the major transport route of drugs into the U.S. starting from at least 1994 (Rios 2012). Second, an increase in political competition, which may have shifted the implicit agreements between the cartels and various levels of government, also predates the spike in violence by at least half a decade. In short, cartel-related violence responded most dramatically only after the federal crackdown began.

Finally, to ensure that toll roads are not picking up general access to transport rather than access to the U.S. specifically, we examine the relationship between the increase in homicides and other transit routes. We regress changes in homicides on kilometers of all federal highways (which include toll and free roads) and all highways (federal toll, federal free and state), and compare the results to those for toll highways alone. The results for toll highways, shown in columns 1 through 4 in Panel A of Table 4, show a clear relationship between toll highways and the post-crackdown increase in violence. Toll highways are positively and significantly correlated with the level of homicides and changes in the peak year of the conflict-- 2010—but are not correlated with either prior to the crackdown taking effect in2005. Meanwhile, as shown in Panel B of Table 4, no similar patterns are observed for all federal highways or all highways. There is no significant correlation between either measure and homicide levels or changes before or after the escalation of the drug war. We therefore argue that toll highways do a better job of capturing access routes to the U.S. than other forms of transit.

We thus focus our IV estimation on the 2007-2010 period and use federal toll highways as our instrument. To do so, we begin by considering the relationship between homicides and federal toll highway networks in levels:

$$homicides_{st} = \alpha_0 + \alpha_1 toll\ highway_s + \alpha_2 toll\ highway_s * t + \alpha_3 Z_{st} + \lambda_s + \lambda_t + \eta_{st}$$

where λ_s captures state-level fixed effects and λ_t captures year-level effects, and η_{st} is an error terms. As homicide rates in toll highway-intensive states appear to have risen consistently since 2007—with the increase approximately linear—we include a linear time trend that varies by the extent of toll highways in a given state.

Rewriting this equation in differences yields:

$$\Delta homicides_{st} = \gamma + \gamma_1 federal\ highway_s + \gamma_2 \Delta Z_{st} + \lambda t + \Delta\eta_{st}$$

We use this as our baseline first stage. In this specification, we do not rely on the correlation between federal highways and the *levels* of homicides in different states (which may be further correlated with other unobserved factors). Instead, we use only the increasing effect of highways on homicides over time as our exogenous variation by estimating the effect of federal highways on *changes* in homicides.

4.2 Estimation and Results

We rewrite the outcome and homicide equations for individual-level estimation as follows:

$$\Delta hours_{ist} = \beta_0 + \beta_1 \Delta homicides_{st} + \Delta X_{it}\gamma + \Delta Z_{st}\phi + \lambda \mathrm{t} + \Delta\epsilon_{\mathrm{ist}} \quad (4)$$

$$\Delta homicides_{ist} = \gamma + \gamma_1 federal\ highway_s + \gamma_2 \Delta Z_{st} + \lambda t + \Delta\eta_{ist} \quad (5)$$

The identification assumption is that our instrument is uncorrelated with the unobserved component of changes in hours worked, i.e. that $\mathrm{E}\ (\Delta\epsilon_{\mathrm{ist}} * federal\ highway_s \mid \Delta X_{it}, \Delta Z_{st}) = 0$. We estimate this system using two stage least squares. Results from the first stage are presented in Table 5 and the second stage in Table 6. Similar to the fixed effect model above, we repeat the exercise for the full sample, separately by gender, and separately by salaried and self-employed workers.

The first stage results in Table 5 show that the instrument—kilometers of toll highways—is positively and significantly correlated with annual changes in homicides in all of the estimations. After controlling for observable time varying factors, toll highways remain significant predictors of homicide increases. In general, a one standard deviation increase in toll highways (194.5 kilometers) is associated with 1.5 additional homicides per 100,000 inhabitants. Although these coefficients are lower than those for yearly increases (Table 4), values for the R-squared, the F-statistics for the test of weak identification and the Chi-squared statistics for the test of under-identification are very high. Thus, there is little evidence that the first stage suffers from weak identification.

The second stage results in Table 6 provide further evidence that homicides negatively impact labor force activity. The coefficients on the instrumented value for changes in homicides are negative in all but one of the estimations. As expected, however, the standard errors for the IV estimates are much larger and only one of the coefficients is significant. Nonetheless, it is useful to interpret the magnitudes of these estimates relative to those of our OLS specification. For example, the coefficient for all self-employed adults suggests that an increase in homicides per 100,000 inhabitants of 10 leads to an average decline in work hours of approximately 0.3 hours per week—a decline of approximately 1% that is consistent with our OLS results. Indeed, the IV estimates suggest when considering all adults, reverse causality and omitted variables are not likely to be major sources of bias in our OLS estimates.

At the same time, our IV results do indicate a difference in the heterogeneous responses to homicides. We find that salaried women reduce their working hours by roughly two hours in response to a rise in homicides of 10 per 100,000 residents—a reduction of more than 10% relative to their baseline hours worked. These results indicate that salaried women in states with the highest homicide spikes have reduced their working hours by as much as one-third to one-half—a dramatic response. We cannot identify the mechanism for this reduction, but note that it may be related to differences in real and psychic costs from violence borne by women in this group, as well as differences in their ability to afford to forego earnings to avert these costs.

Finally, we also find a large (two hours) but statistically insignificant response among self-employed men to a homicide rise of 10 per 100,000. The differential response among self-employed men relative to salaried ones is consistent with our OLS estimates. Indeed, our IV results generally offer evidence that increasing homicides lead to a non-trivial reduction in work hours that is consistent with our OLS findings.[8]

5 Heterogeneity by Income

Several papers have found that the burden of crime may fall unequally on households at different points of the income distribution (Gaviria and Pagés 1999, DiTella et. al. 2010, Villoro and Teruel 2004). To investigate the possibility of differential responses to changes in homicides by income, we return to our base model and estimate this specification on sub-samples of individuals based on their household income quartile.[9] The results are shown in Table 7. They show clear differences in the response to homicides by income. Interestingly, the results are concentrated in the highest income quartile. For all adults he estimated coefficient is three to twenty times larger than those for the other three quartiles. The coefficient for all adults, shown in column 10, implies that an increase of 10 homicides per 100,000 inhabitants is associated with a decline in hours worked per week of 0.5. This value suggests that for upper income adults in the states most affected by the drug war, hours

[8] For robustness we re-ran the IV regressions on the years 2005-2006. We find that in the first stage the coefficients on toll highways is approximately -0.001 and is significant. This suggests that prior to the drug war, an increase of toll highways of 100 kilometers is associated with a decline in homicides per 100,000 inhabitants of 0.1. This confirms that the instrument does a poor job of predicting changes in homicides prior to the federal crackdown. We also estimated the IV regressions over the 2007 to 2010 period using all federal highways and all highways, both federal and state, as instruments. The coefficients in the first stage on the instruments are close to zero in all cases, confirming that toll highways are better predictors of increases in homicides. These results are available upon request.

[9] Our data are constructed of rolling panels of individuals and thus may reflect compositional changes in labor force participation over time. However, the correlation between changes in homicide and changes in labor force participation is weak (-0.006) and thus unlikely to be driving our results.

worked have declined by one and a half to two and a half hours per week hours per week. Meanwhile, the response for adults in the lowest income quartile is close to zero while that of adults in the second lowest one is a decline of 0.2 hours. Similar to the results for self-employment, we do not know if these results are driven by greater exposure to violence, greater fear of violence, or an enhanced ability to respond to both by changing work schedules. Nonetheless, the results provide further evidence that the costs of violent crime are born unequally across income levels.

6 Conclusions

In this paper we estimate the impact of the escalation of the drug war in Mexico on the labor market outcomes of adults. We focus on the dramatic changes in homicides in a subset of states since 2007 and examine its impacts on changes in hours worked. To identify the relationship between changes in homicides and hours worked, we exploit the large variation in the trajectory of violence across states and over time. Using both OLS and instrumental variables regressions, we find that the increase in homicides has had a decidedly negative impact on labor force activity. An increase in homicides of 10 per 100,000 is associated with a decline in weekly hours worked of 0.3 hours. For states most impacted by the drug war, in which homicides per 100,000 inhabitants have increased by 30-50 a year, this implies an average decline in hours worked of one and one and a half hours per week. These impacts are larger for the self-employed and are concentrated among the highest income quartiles. This highlights how the costs of crime tend to be unequally borne across the population.

The findings are consistent with a broad literature on the role of institutions in leading to both short-run and longer-term economic development. This literature includes evidence on the effects of institutional deterioration during civil wars and other internal violent conflicts—most frequently related to control over the state (see Blattman and Miguel 2010 for a review). We contribute to this field by identifying the impacts of violence related to control over private resources—the effects of drug cartel violence on the economic behavior of private individuals. Indeed, we find that even when the risk of directly incurring such violence is less than 1%, private individuals may adjust their behavior by as much as 30-50%. These results suggest continued attention on the role of non-state actors in forging institutions that can sustain economic development.

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Figure 1: Change in Total Homicides

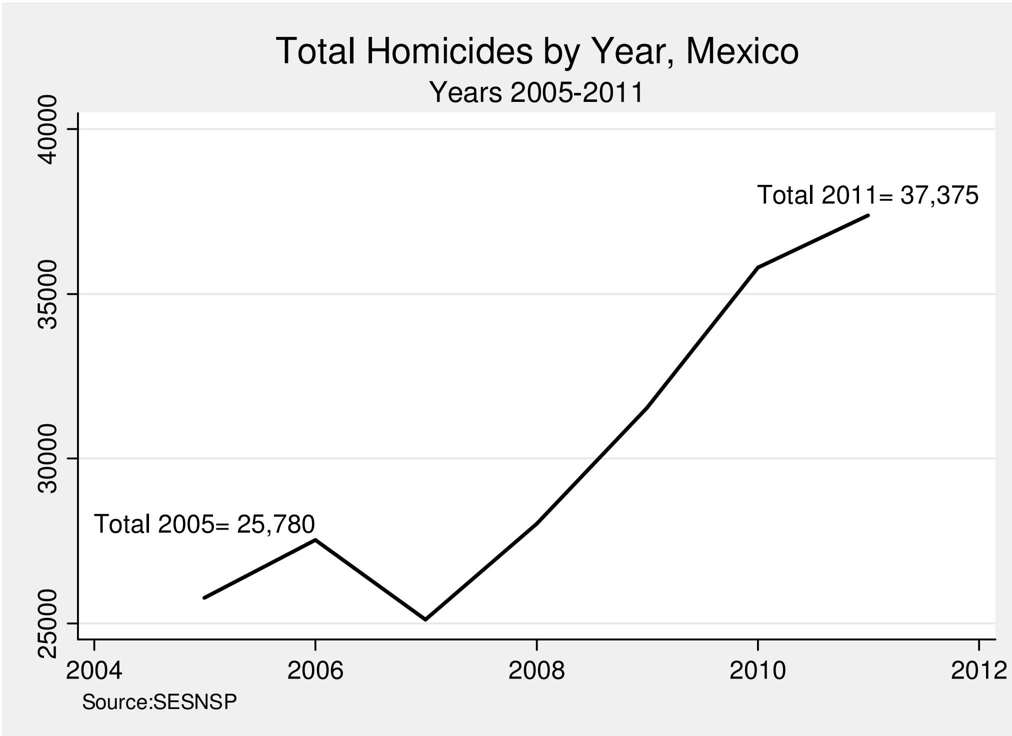


Figure 2: Geographic Distribution of 6 Year Change in Homicides

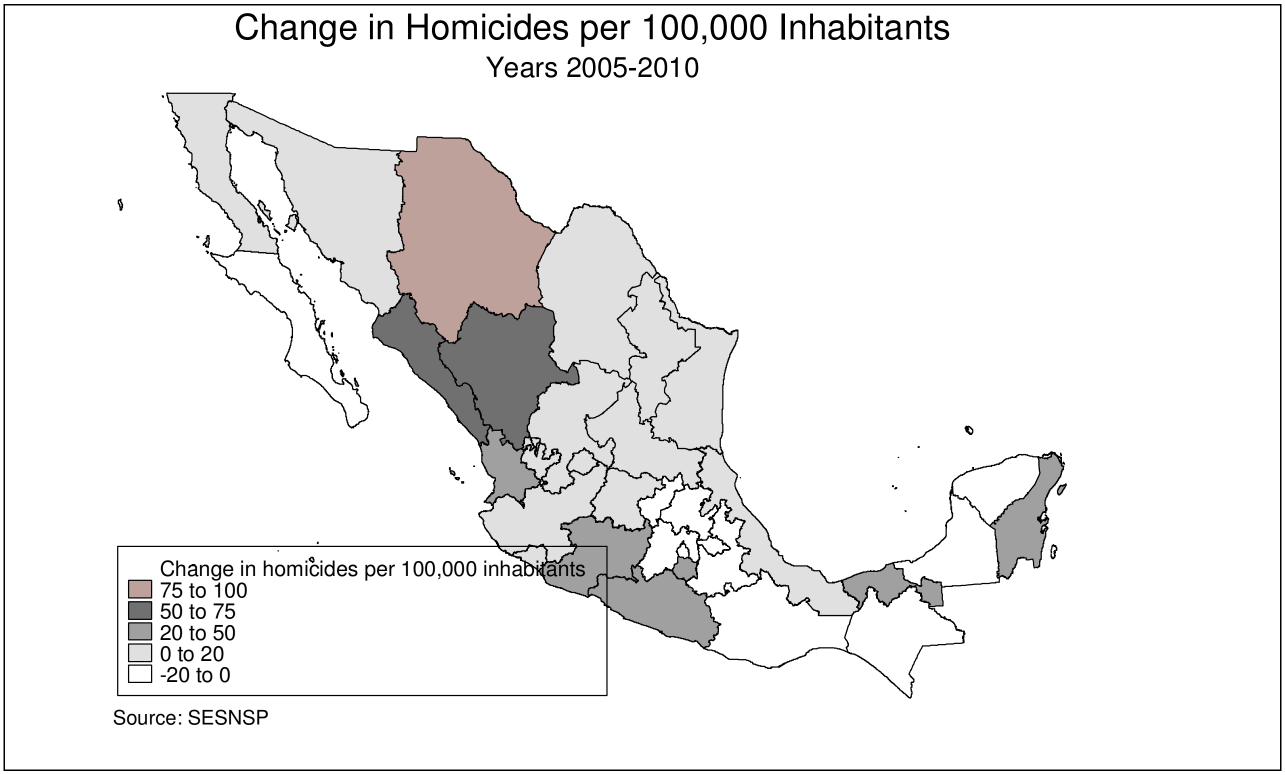
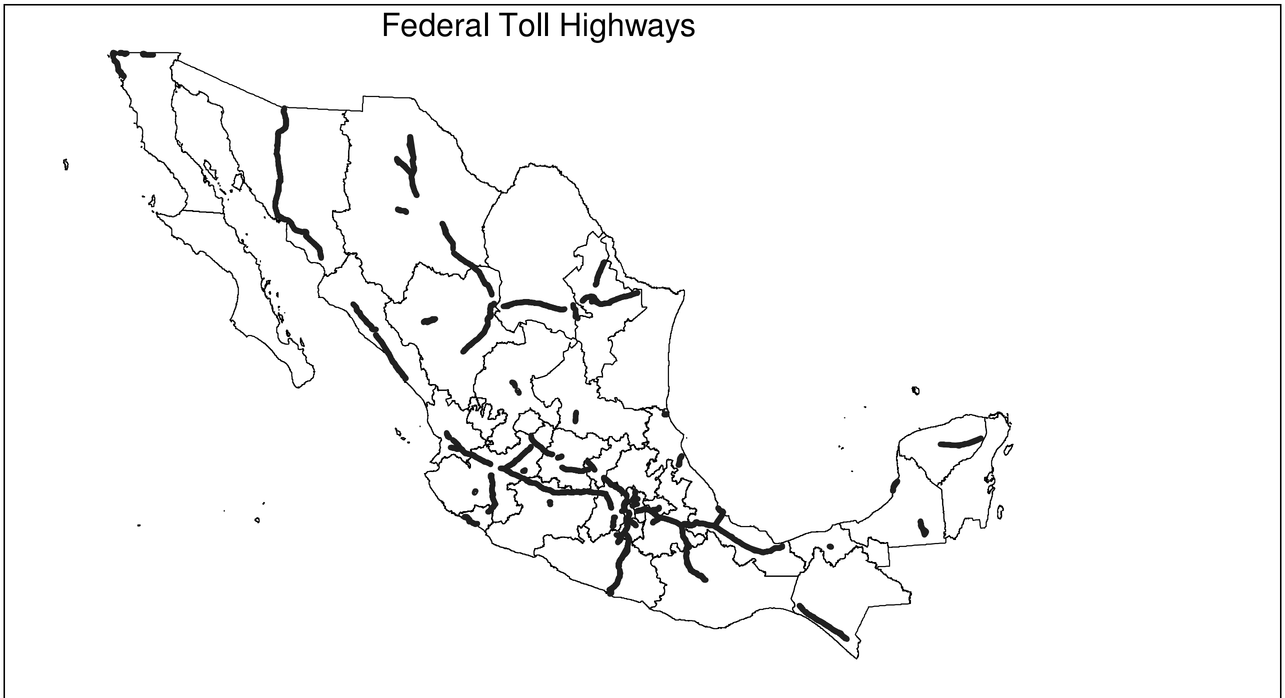


Figure 3: Federal Toll Highway System



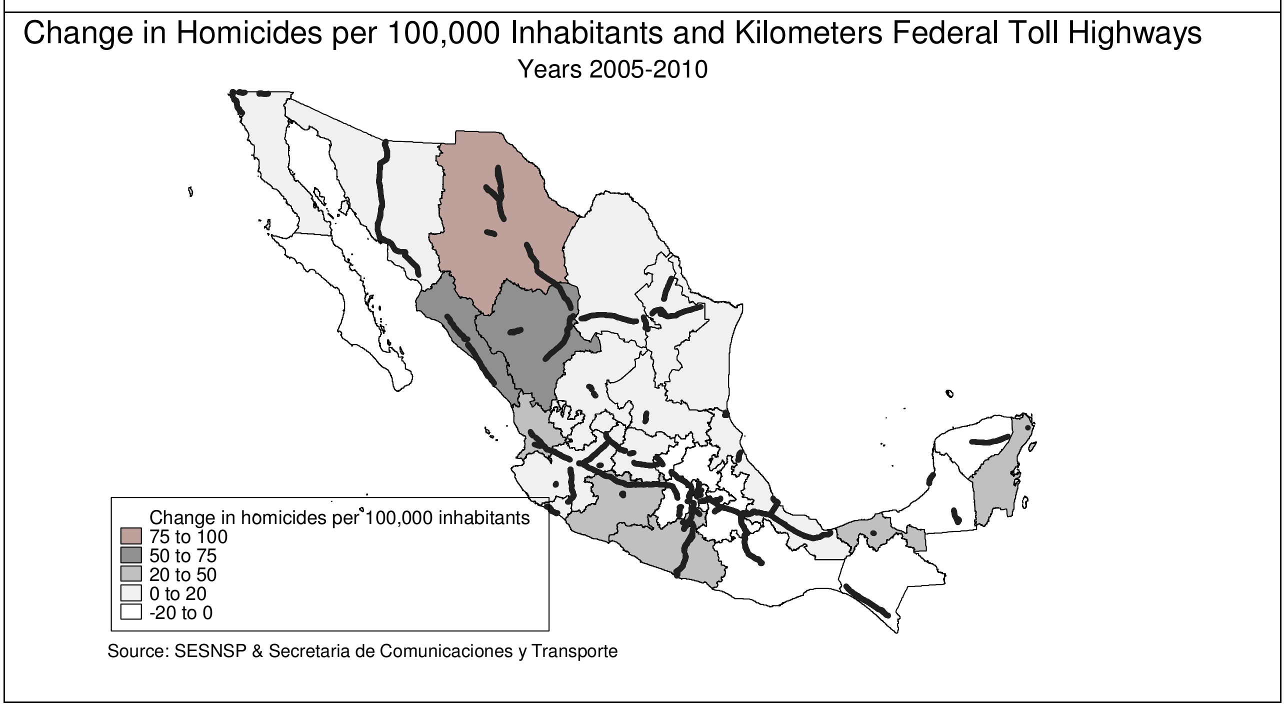


Figure 4: Falsification Tests

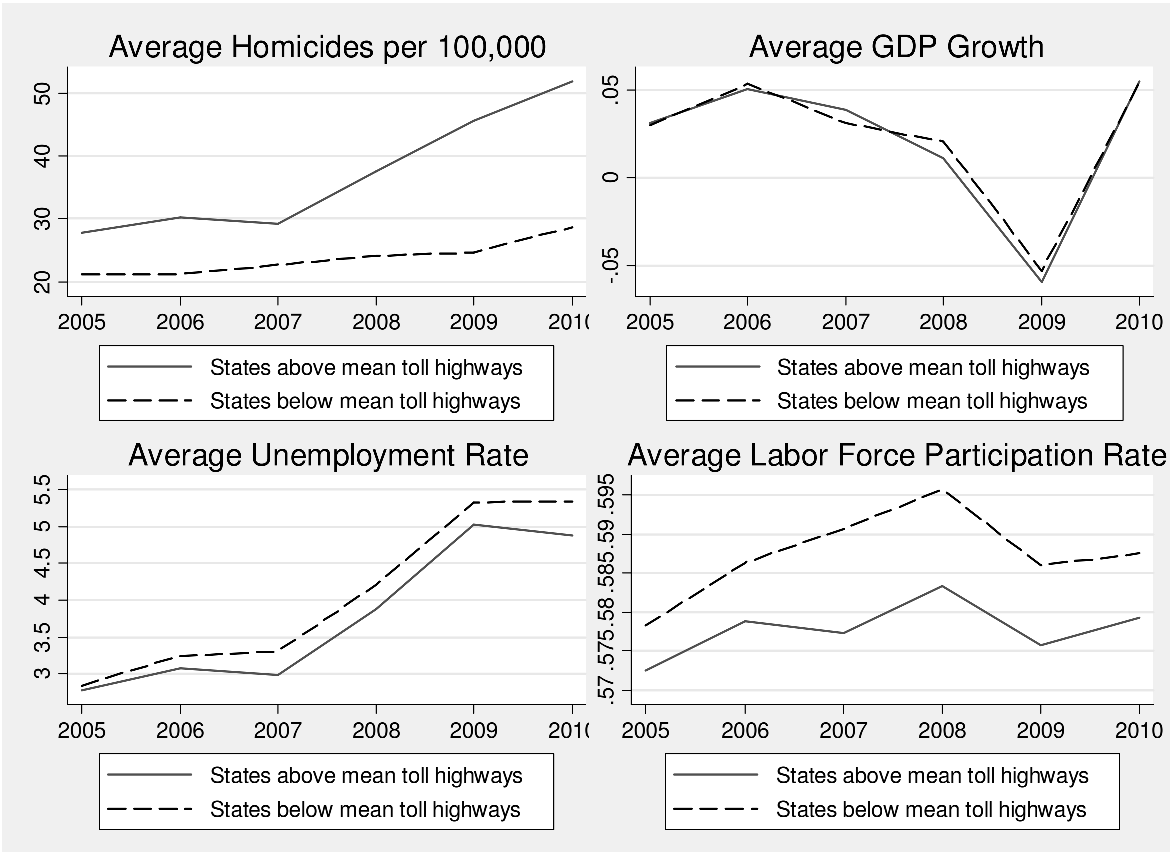


Table 1: Summary Statistics Homicides

Homicides per 100,000 inhabitants	All Years	Separately by Year					
		2005	2006	2007	2008	2009	2010
Mean	28.72	23.60	24.59	25.09	29.16	32.46	37.38
Standard deviation	18.46	9.79	10.98	10.14	16.55	23.74	28.16
Minimum	4.19	4.19	12.41	14.22	14.04	10.51	8.69
Maximim	127.64	47.79	53.33	55.04	77.11	107.06	127.64
25th percentile	17.09	17.27	16.19	17.63	16.80	16.59	19.79
50th percentile	22.09	19.96	20.58	20.69	22.00	23.36	26.67
75th percentile	35.10	32.65	32.96	34.62	37.47	38.57	47.30
90th percentile	48.83	37.12	40.73	37.18	47.91	63.05	65.66
Observations	192	32	32	32	32	32	32

Source: SESNSP (National Public Security System)

Table 2: Summary Statistics Labor Force Survey Data

Adults age 18-65	Full Sample			Adults who start
	All Adults	Men	Women	and stay in labor force
	(1)	(2)	(3)	(4)
Age	38.23	38.25	38.21	38.18
	(12.56)	(12.65)	(12.49)	(11.55)
Education:				
Primary	43.5%	41.3%	45.4%	38.3%
Secondary	30.5%	29.7%	31.2%	32.2%
Tertiary	25.9%	28.9%	23.3%	29.5%
Household size	4.70	4.68	4.72	4.65
(all indivinduals)	(2.02)	(1.99)	(2.05)	(1.98)
Children in household:	0.99	0.99	0.99	1.00
	(1.04)	(1.04)	(1.04)	(1.03)
Monthly income	2509.57	3862.64	1419.64	4359.38
(pesos)	(4281.67)	(5175.04)	(2977.42)	(4967.83)
Household monthly	6511.00	6766.26	6290.28	7588.08
income (pesos)	(8096.99)	(8075.69)	(8108.96)	(8398.21)
At beginning of year:				
In labor force	64.1%	85.9%	45.3%	100.0%
Unemployed	2.8%	3.6%	2.0%	0.0%
Of those in labor force:				
Self employed	29.2%	30.7%	27.0%	28.7%
Salaried work	65.4%	66.3%	63.9%	67.1%
Weekly hours worked	27.27	39.37	16.85	43.70
	(24.50)	(21.72)	(21.83)	(16.40)
Change in weekly	-0.07	-0.45	0.26	-0.08
hours worked	(20.81)	(22.43)	(19.29)	(16.92)
Over one year period:				
Exit labor force	8.7%	7.0%	10.2%	0.0%
Change industry	12.6%	18.7%	7.4%	22.8%
Observations	94642	43759	50883	53870

Averages weighted by population weights. Standard errors in parentheses. Source of data: ENOE

Table 3: Change in Hours Worked, OLS Results

Outcome= Change in weekly hours worked	All Adults						Adults who start and remain in labor force
PANEL A: All Adults	All Adults		Men		Women		All Adults
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Change Homicides	-0.022*	-0.029**	-0.018	-0.045**	-0.025	-0.013	-0.029**
	(0.012)	(0.012)	(0.018)	(0.019)	(0.015)	(0.015)	(0.012)
Year fixed effects	No	Yes	No	Yes	No	Yes	Yes
Individual time controls	No	Yes	No	Yes	No	Yes	Yes
State time controls	No	Yes	No	Yes	No	Yes	Yes
Observations	94,116	94,116	43,408	43,408	50,708	50,708	53,465
R-squared	0.000	0.001	0.000	0.002	0.000	0.002	0.002
PANEL B: Salaried Only	All Adults		Men		Women		All Adults
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Change Homicides	-0.004	-0.010	-0.020	-0.007	0.025	-0.011	-0.014
	(0.016)	(0.012)	(0.021)	(0.016)	(0.027)	(0.018)	(0.013)
Year fixed effects	No	Yes	No	Yes	No	Yes	Yes
Individual time controls	No	Yes	No	Yes	No	Yes	Yes
State time controls	No	Yes	No	Yes	No	Yes	Yes
Observations	41,772	41,772	25,226	25,226	16,546	16,546	37,210
R-squared	0.000	0.406	0.000	0.350	0.000	0.509	0.002
PANEL C: Self Employed Only	All Adults		Men		Women		All Adults
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Change Homicides	-0.044	-0.047*	-0.061	-0.055	-0.018	-0.023	-0.058*
	(0.032)	(0.028)	(0.037)	(0.034)	(0.062)	(0.046)	(0.030)
Year fixed effects	No	Yes	No	Yes	No	Yes	Yes
Individual time controls	No	Yes	No	Yes	No	Yes	Yes
State time controls	No	Yes	No	Yes	No	Yes	Yes
Observations	16,794	16,794	10,713	10,713	6,081	6,081	14,156
R-squared	0.000	0.239	0.001	0.230	0.000	0.277	0.006

Robust standard errors in parentheses. Estimated using survey weights *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Individual time controls include change in household size, number of children, labor force status and change in industry for those in labor force State time controls include changes in GDP, unemployment, public expenditure to GDP and the total share of production by industry

Table 4: Highways, Homicides, and Economic Variables

VARIABLES	Levels of Homicides 2005 (1)	Levels of Homicides 2010 (2)	Change in Homicides 2005-2006 (3)	Change in Homicides 2007-2010 (4)	Real GDP growth 2005-2006 (5)	Real GDP growth 2007-2010 (6)	Unemployment 2005-2006 (7)	Unemployment 2007-2010 (8)	Labor Force Participation 2005-2006 (9)	Labor Force Participation 2007-2010 (10)
Panel A: Federal Toll Highways										
Kilometers Toll	0.009	0.061**	0.002	0.012***	0.000	-0.000	-0.001	-0.001	-0.000	-0.000**
Highways	(0.009)	(0.024)	(0.003)	(0.004)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)
R-squared	0.032	0.179	0.009	0.064	0.012	0.002	0.009	0.004	0.019	0.035
Panel B: Other Highways										
Kilometers All Federal	0.002	0.009	0.000	0.002*						
Highways	(0.002)	(0.006)	(0.001)	(0.001)						
R-squared	0.028	0.064	0.002	0.023						
Kilometers All Federal	0.000*	0.001	0.000	0.000						
and State Highways	(0.000)	(0.001)	(0.000)	(0.000)						
R-squared	0.097	0.023	0.001	0.001						
Observations	32	32	64	128	64	128	64	128	64	128

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Highway values as of 2005. Source: Secretaria de Comunicaciones y Transporte

The coefficient for labor force participation for the year 2007-2010 is -0.0000315, with a standard error of 0.000015

Thus while it is statistically significant the coefficient is very close to zero

Table 5: Instrumental Variable First Stage Results

	Full Sample			Sub-sample
Outome variable=Change in Homicides	All Adults	Men	Women	Start & Stay in Labor Force
	(1)	(2)	(3)	(4)
Toll highway kilometers	0.008***	0.008***	0.008***	0.008***
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	94,116	43,408	50,708	53,465
R-squared	0.287	0.285	0.290	0.253
Kleibergen-Paap F statistic for weak identification	679.0	312.4	367.5	381.9
Kleibergen-Paap Chi squared statistic for underindentification	647.1	301.2	347.5	368.6
PANEL B: Salaried Workers Only	All Adults	Men	Women	Start & Stay in Labor Force
	(1)	(2)	(3)	(4)
Toll highway kilometers	0.008***	0.007***	0.009***	0.008***
	(0.000)	(0.001)	(0.001)	(0.001)
Observations	41,772	25,226	16,546	37,210
R-squared	0.290	0.288	0.299	0.261
Kleibergen-Paap F statistic for weak identification	255.3	137.9	121.9	246.0
Kleibergen-Paap Chi squared statistic for underindentification	242.7	132.4	114.2	235.6
PANEL C: Self -Employed Workers Only	All Adults	Men	Women	Start & Stay in Labor Force
	(1)	(2)	(3)	(4)
Toll highway kilometers	0.007***	0.008***	0.004***	0.008***
	(0.001)	(0.001)	(0.001)	(0.001)
Observations	16,794	10,713	6,081	14,156
R-squared	0.263	0.280	0.259	0.245
Kleibergen-Paap F statistic for weak identification	129.0	117.2	16.46	134.2
Kleibergen-Paap Chi squared statistic for underindentification	125.7	115.5	16.42	130.6

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Individual time controls inddue change in household size, change in children, in labor force status, and industry for those in labor force. State time controls indude changes in GDP, unemployment, public expenditure to GDP and the total share of production by industry.
Year fixed effects induded. Sample years 2007-2010

Table 6: Instrumental Variable, Second Stage Results

Outcome variable: Change in hours worked	Full Sample			Sub-sample
PANEL A: All Adults	All Adults	Men	Women	Start & Stay in Labor Force
	(1)	(2)	(3)	(4)
Change in homicides	-0.033	-0.033	-0.035	-0.065
	(0.078)	(0.122)	(0.100)	(0.088)
Observations	94,116	43,408	50,708	53,465
R-squared	0.001	0.002	0.002	0.002
PANEL B: Salaried Workers	All Adults	Men	Women	Start & Stay in Labor Force
	(1)	(2)	(3)	(4)
Change in homicides	-0.126	-0.079	-0.211*	-0.104
	(0.087)	(0.127)	(0.108)	(0.090)
Observations	41,772	25,226	16,546	37,210
R-squared	0.404	0.350	0.503	0.000
PANEL C: Self-Employed Workers	All Adults	Men	Women	Start & Stay in Labor Force
	(1)	(2)	(3)	(4)
Change in homicides	-0.099	-0.203	0.358	-0.098
	(0.195)	(0.179)	(0.726)	(0.199)
Observations	16,794	10,713	6,081	14,156
R-squared	0.239	0.228	0.267	0.006

Robsut standard errors in parenthese *** p<0.01, ** p<0.05, * p<0.1
Individual time controls indude change in household size, children, labor force status, and industry for those in labor force. State time controls indude changes in GDP, unemployment public expenditure to GDP and the total share of production by industry.
Year fixed effects induded. Sample years 2007-2010

Table 7: Heterogeneity by Income, OLS Results

Fixed Effect Results	Income Quartile 1			Income Quartile 2			Income Quartile 3			Income Quartile 4		
Change, hours worked	All Adults	Men	Women	All Adults	Men	Women	All Adults	Men	Women	All Adults	Men	Women
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Change Homicides	0.002	-0.041	0.029	-0.017	-0.003	-0.024	-0.001	-0.040	0.042	-0.052***	-0.036	-0.060**
	(0.023)	(0.041)	(0.027)	(0.025)	(0.040)	(0.032)	(0.023)	(0.034)	(0.030)	(0.020)	(0.030)	(0.026)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual time controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State time controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	20,616	8,869	11,747	23,816	10,819	12,997	24,900	11,755	13,145	24,784	11,965	12,819
R-squared	0.053	0.069	0.049	0.003	0.007	0.011	0.013	0.033	0.010	0.053	0.082	0.044

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Estimated using survey weights.

Individual time controls inddue change in household size, children, labor force status and industry, for those who remain in the labor force

State time controls indude changes in GDP, unemployment, public expenditures to GDP and the total share of production by industry