Green Gold: Avocado Production and Conflict in Mexico*

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Abstract

The surge in global demand for Mexican avocados, particularly from the United States, has led to increased production and revenue in avocado-producing municipalities of Mexico. I show that these external changes in avocado global consumption patterns have influenced conflict levels in Mexico. Combining geographical variations in avocado cultivation suitability and fluctuations in avocado demand over time, I find a notable rise in homicides among agricultural workers in municipalities that are well-suited for avocado production. I demonstrate that this rise in homicides is not explained by the increased presence of drug cartels but rather heightened competition between cartels for resources in municipalities where avocados are produced. These findings suggest that cartels vie for territorial control, diversifying their income sources, including the avocado industry, in response to their relatively limited influence over drug markets and routes.

Keywords: Avocado production, Conflict, Mexico

JEL: D7, O13, Q3

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1 Introduction

The expansion of high-value export crops in response to external demand shocks presents an important opportunity for poverty reduction and economic development (Boone et al., 2022; Uribe-Castro, 2021). However, for countries with low-quality institutions, this blessing may instead prove a curse, as an increase in the value of lootable resources may foster the emergence of criminal activities looking to profit from the booming sector (Cisneros et al., 2022; Crost and Felter, 2019; Dube and Vargas, 2013; Mehlum et al., 2006). These activities range from extortion to property and violent crimes to conflict incidents in civil wars (Charlton et al., 2021; Guardado and Pennings, 2020; Harari and Ferrara, 2018; Hastings and Ubilava, 2023; Ubilava et al., 2023) and lead to the emergence of rent-seeking criminal organizations, or the expansion of existing ones (Estancona and Tiscornia, 2022). For instance, the boom in the production of high-value exports at the end of the 19th century in Italy –sulfur, oranges and lemons– created a demand for private protection and led to the emergence of the Sicilian mafia (Buonanno et al., 2015; Dimico et al., 2017).

Given the increasing demand for high-value commodities and the persistent changes in economic conditions, how producers and various criminal organizations interact with each other remains an empirical puzzle. The increasing demand for high-value commodities could attract crime in simple forms, e.g., property or crop theft by individuals (Boone et al., 2022). However, it could also attract organized crime groups or criminal organizations, e.g., gangs, mafias, or drug trafficking organizations, that appropriate rents through extortion or violence (Dimico et al., 2017; Rios, 2013; Shirk and Wallman, 2015). Farmers may cooperate or coexist with criminal groups. In this case, criminal groups and farmers set an agreed upon 'tax' rate that farmers are willing to pay as quid pro quo for security and protection (Blattman, 2022; Buonanno et al., 2015). In this context, the presence of multiple competing criminal organizations could lead to confrontation over territorial control, with the winning group establishing a monopoly on looting (Atuesta and Pérez-Dávila, 2017; Blattman, 2022; Olson, 1993).

In this paper, I estimate the effects of increasing external demand for agricultural products on the intensity of conflict and whether the presence of criminal organizations further intensifies the conflict. The focus of my analysis is avocado production at the municipal level in Mexico during the period 2005-2019. As the largest producer and exporter of avocados in the world (Huang et al., 2023), as well as a home to an extensive network of criminal organizations (Atuesta and Pérez-Dávila, 2017), Mexico provides a compelling context in which to study the effects of demand shocks in agricultural production areas on conflict intensity. Avocados are Mexico's third most exported commodity and the United States its largest importer. The value of avocado exports increased over the time period covered by this study by over 455%. The increase in demand for avocados created a persistent and positive income shock that could affect conflict intensity and attract criminal organizations. To the best of my knowledge, this paper is the first to estimate the impact of a persistent income shock upon criminal behavior in an area with multiple criminal organizations.

The ideal experiment would compare otherwise identical municipalities that experience an increase in the production of avocados with those where production remains constant. In the absence of randomization, my analysis faces different challenges. First, the decision to plant and grow avocados is endogenous to farmers. Second, diverse agroclimatic conditions across different regions of the country introduce complexity, making it difficult to directly compare any two areas in terms of avocado production. Third, the decision to engage in avocado cultivation may exhibit correlations with socioeconomic and political conditions, increasing the likelihood of a municipality experiencing crime.

I tackle these challenges by considering a Bartik-type variable that combines geographical variation in avocado cultivation suitability with fluctuations in the United States' demand for avocados over time to create a measure of *potential avocado production* in a given year. This measure dynamically captures the areas more suited to meet the increased demand for avocados. Critically, I rely upon the identifying assumption that the United States' demand for avocados is not correlated with changes over time in violence across municipalities in Mexico (Goldsmith-Pinkham et al., 2020).

My empirical findings suggest that the rising demand for avocados increases the homicide rate at the municipal level. Using detailed information on the characteristics of the victims coming from death certificates, I show that this increase in the overall homicide rate is driven by an increase in the homicide rate of agricultural workers. Specifically, my estimates suggest that a one-standard-deviation increase in my measure of suitability to absorb the demand for avocado increases the homicide rate of agricultural workers by one additional death. This is a statistically and economically significant size effect of 20% when compared to the 5.78 mean homicide rate of agricultural workers. Furthermore, this increase explains 6% of the rise in violence, when compared to the 16.96 mean overall homicide rate in the sample.

My results are robust to using alternative measures of my main treatment variable, my outcome variables, and is also robust to estimation over different subsamples of my population. To validate my identification strategy, I also show that there is no relation between the homicide rate of agricultural workers and the suitability to grow crops other than avocados. Finally, to tackle some of the limitations of the fixed effects estimator with large longitudinal data (Millimet and Bellemare, 2023), I re-estimate my main specification using the Rolling First Difference (RFD) and the Rolling Twice-First Difference estimators, which accounts for the presence of unobserved time-varying heterogeneity. In particular, I show that my main estimates represent a lower bound for the actual treatment effect.

I use information on homicides, threats, incidents of extortion, and incidents of kidnapping from police reports to analyze effect upon other types of criminal activities. In terms of homicides, I show that my estimates are robust to the source of information about homicides. I find that there are no changes in the number of threats or of kidnapping cases but that there is a decrease in the number of extortion cases in response to the demand shock. Although surprising, this last result can be explained by underreporting of criminal behavior to the police in the presence of increased cartel activity (Atuesta et al., 2018).

To examine the role of cartels, I use information from the Mapping Criminal Organizations project (Sobrino, 2020). First, I show that a one-standard-deviation increase in my measure of suitability to absorb the demand for avocados increases both the probability of cartel presence and the number of cartels in a given municipality. This increase is driven by both the expansion of traditional cartels—the 9 main Mexican drug cartels that have been present since the 1990s—and of the non-traditional cartels—the newly formed cartels or splinters of traditional cartels that have more local presence. Second, I show that the pre-existing presence of cartels, traditional or non-traditional, does not drive the increase in the homicide rate.

I also study cooperation between cartels and local communities, and competition between cartels. In terms of cooperation, I find a decrease in the homicide rate of agricultural workers in areas where cartels have operated since the 1990s, fully offsetting the increase given by the demand shock. This result lends credence to the idea that cartels may exert some form of governance over local communities (Blattman, 2022; Lessing, 2015, 2020; Sobrino, 2020). To proxy for territorial control, I study heterogeneous effects by presence of two or more cartels and find that the presence of multiple cartels –traditional or non-traditional– has no effect on homicides of agricultural workers. However, the presence of multiple newer, non-traditional cartels increases the homicide rate of cartel-related individuals. This result is consistent with the idea that criminal organizations battle to take control of a "profitable" territory in response to their relatively limited influence over drug markets and routes (Atuesta and Pérez-Dávila, 2017; Rios, 2013; Shirk and Wallman, 2015).

This paper makes three contributions to the resource curse and rent-seeking literature. First, to the best of my knowledge, this is the first paper to analyze a persistent income shock on conflict. Previous studies have focused on temporal income shocks that can be attributed to sudden and sharp short-lived changes in the price of the commodities (Boone et al., 2022; Cisneros et al., 2022; Crost and Felter, 2019; Dube et al., 2016; Dube and Vargas, 2013) or to changes in employment during harvesting season in labor intensive crops (Guardado and Pennings, 2020; Harari and Ferrara, 2018; Hastings and Ubilava, 2023; Ubilava et al., 2023). In these cases, demand for crops is more stable and the demand shock is less likely to transform conflict dynamics over an extended period.

Second, I show that increased demand for avocados increased the homicide rates of agricultural workers in municipalities more suitable for growing avocados. Using detailed information on the victims' characteristics, I can classify the homicide victims by occupation and show the presence of selective killings. Previous studies have not done this as they have used aggregated information on the overall homicide rate, violent incidents in civil conflict, such as attacks or clashes between groups (Crost and Felter, 2019; Dube et al., 2016; Dube and Vargas, 2013; Guardado and Pennings, 2020; Harari and Ferrara, 2018; Ubilava et al., 2023), or data on social unrest, such as political violence, riots, and protests (Cisneros et al., 2022; Crost and Felter, 2019; Hastings and Ubilava, 2023). The only exception I am aware of is the study of (De Haro, 2022), who uses a similar classification by occupation of homicides.

Third, I show how cooperation and competition between criminal organizations and farmers yield different results in terms of conflict intensity and victimization. In particular, I provide evidence that the presence of multiple criminal organizations leads to an increase in the homicide of cartel-related individuals, rather than the rest of the population. Other studies on competition have analyzed changes in the overall homicide rate when cartels enter or exit a municipality in Mexico (Sobrino, 2020), when the relative profitability of a crop increases, leading to competition between producers (De Haro, 2022; Dube et al., 2016), or when new criminal opportunities emerge (Battiston et al., 2022; Estancona and Tiscornia, 2022; Piccato, 2022; Wainwright, 2016). These studies, however, have used aggregated measures of conflict that do not allow them to differentiate types of victims and may overestimate the effect of competition on homicides. The papers that are closer to mine are those of Estancona and Tiscornia (2022) and De Haro (2022). Estancona and Tiscornia (2022) develop a model suggesting that access to a good's export values creates opportunities for immediate profit, similar to the effect of the demand shock for avocados that I explore here, further affecting the intensity of the conflict. On the other hand, De Haro (2022) suggests that the increase in homicides in Mexico is driven by a substitution effect between avocado and poppy production. Her results are similar to mine as she finds that areas more suited for growing avocados experience an increase in the homicide rate; however, she did not find that the demand shock attracts more presence of cartels in these areas. Her results complement mine as she focuses on the substitution effect whereas I focus on the persistent income effect of avocado production.

The rest of the paper is organized as follows. Section 2 provides some institutional background. In section 3, I describe the empirical strategy to estimate the relation between the areas most suited for growing avocados and conflict, and section 4 explains the main sources of data. I present the main results of avocado production on homicides in section 5; while in section 6, I present robustness checks. In section 7, I explore the potential mechanisms that may explain the changes in homicides. Finally, the last section concludes.

2 Context

In this section, I present the context of the avocados and the agricultural sector in Mexico; the Mexican war on drugs and the increasing trend in violence since its start; and the potential interactions between these two activities.

2.1 Avocados and agricultural sector

Avocados are originally from the Americas, but are currently produced in every continent. In 2019, the Americas produced 73.5% of the global production, and Mexico alone produced 2.3 million metric tons (MMT) making it the largest producer in the world.[1] Mexico is also the largest avocado exporter in the world, with nearly 0.95 MMT valued at over USD 2.4 billion exported to the United States (SAGARPA, 2017; USDA, 2020). Figure 1 shows the evolution of the volume of avocados produced in Mexico and the volume exported. In addition, it summarizes the number of municipalities producing the fruit. The agricultural sector – and avocado production– benefited from different trade agreements signed by Mexico starting in the 1990s. Beers, avocados, and berries are the three main products, valued from 2012 to 2018 at 3,768 USD million, 3,201 USD million, and 2,106 USD million respectively (SIAP, 2018). The latter two products are mainly exported to

[1] Data recovered from FAO stats. According to Miller (2020), Mexico, Peru, Chile, the Dominican Republic, and Colombia, account for 71% of the avocados grown in the world .

United States and they are two of the products with a higher increase in the value exported. For instance, during the 1990s, the production of avocado was stable at around 0.8 million of tons per year. After North American Free Trade Agreement (NAFTA) was in place, avocado production began to increase steadily reaching 2.3 million of tons in 2019. Avocado trade values increased by over 455% (USDA, 2020).

The United States banned Mexican the import of Mexican avocados in 1914 to protect the local production of Avocados claiming that the presence of pests in Mexico could damage local orchards (Miller, 2020). Starting in 1997, as part of NAFTA negotiations, avocados coming from the state of Michoacan were allowed to be imported to 19 states of the United States during the winter season. Mexican avocados were perfect to supplement avocado production in United States. Avocados produced in California have a peak season for harvesting in between April and July, whereas in Mexico they are produced all year long. In 2001, the United States government expanded the shipping zone and season for avocado imports, and since 2007, there are virtually no restrictions for avocados coming exclusively from the state of Michoacan. In 2016, the Animal and Plant Health Inspection Service (APHIS) lifted the restrictions placed upon avocados, allowing imports coming from any Mexican states[2] as long as they meet the requirements and were accompanied by a phytosanitary certificate (APHIS, 2016).

Although the majority of the Mexican avocado production is concentrated in the state of Michoacan, 29 out of 32 states in Mexico had at least one municipality growing avocado between 2003 and 2019. This production is used to meet the internal demand for avocados, and to export to other destinations, besides the United States, such as Canada and Japan. Each of these last two countries represents around 7% of the total exports of Mexican avocado and more than 90% of their respective imports of avocado. In the case of the United States, Mexican avocados represent a similar share of the total imports, although they are the largest buyers of Mexican avocados with around three quarters of the total export (Huang et al., 2023; SAGARPA, 2017; USDA, 2020). In addition, exports to the United States come almost exclusively from Michoacan, a state also known for the presence of criminal groups that have been recently linked with shortages of limes (Estancona and

[2] Approvals for the import of avocados are made on a state-by-state basis. At the time of the extension rule, Jalisco was the first new Mexican state that met the requirements, apart from Michoacan, and it was authorized to export avocados to the United States in 2021. Subsequent Mexican states will be approved as each of them demonstrates its ability to meet the requirements (APHIS, 2016).

Tiscornia, 2022),[3] another crop that has increased its production to satisfy US demand.[4]

The lifting of the ban in the 1990s caused 'the green rush' in the state of Michoacan. Farmers and drug organizations replaced their production of marijuana for that of avocados, as the latter became a billion-dollar export business overnight (Miller, 2020). Criminal organizations 'taxed' farmers per hectare of orchards and, in some cases, they also 'taxed' government officials. Those farmers who opposed had their orchards burned and their families terrorized. Those who abandoned their orchards were forced to sign the land over to the criminal organizations. For instance, by the mid-2010s, *Los Caballeros Templarios* (The Knights Templars, a DTO based in Michoacan) was estimated to have direct ownership of about 10 per cent of the orchards in the state and indirect control of a much larger percentage (Miller, 2020).

2.2 The Mexican War on Drugs

For most of the 20th century, Mexico had a passive attitude toward the drug trade, with Mexican politics dominated by the Institutionalized Revolutionary Party (PRI) during this period. It was only the last PRI president, Ernesto Zedillo (1994-2000), and his successor, Vicente Fox (2000-2006), the opposition president from the right-wing National Action Party (PAN), that implemented security reforms and crackdowns (Chabat, 2010). The strategy mainly focused on destroying marijuana and opium crops in mountainous regions (Utar, 2018). Starting in December 2006, after the election of the PAN candidate Felipe Calderón, the Mexican government made fighting organized crime a major priority. During his second week in office, Calderón deployed 6,500 federal troops to combat trafficking, and by the end of his presidency, approximately 45,000 troops were involved (Dell, 2015).

After the initial deployment of troops in what was called *Operativo Conjunto Michoacán*, the escalating violence was unexpected and it led to a bloody war between cartels to control drug routes and production of illegal substances (Salcedo, 2021). The crackdown of the drug cartels led to an

[3]For instance, see The New York Times or npr for media coverage.

[4]Although avocados, limes, and berries have increased their demand in recent years, I focus on avocados because their production has increased consistently for more than 20 years, while the production of blueberries and raspberries increased after 2012. For instance, one of the factors driving the growth in recent years of the Mexican blueberries were subsidies (Wu et al., 2018). Additionally, among these agricultural products, avocados are the most important, while berries—like strawberries, blueberries, raspberries, and loganberries—are second. Lime is among the 20 more exported products in Mexico, valued at 513 USD million, one sixth of the value of avocados and about one forth of that of berries. Additionally, the dollar value of avocado imports is higher than that of pineapples, bananas, and strawberries combined, despite of the United States importing more kilograms of all three of them.

impressive escalation of violence (Figure 2) due to confrontations between the state and the cartels, as well as between and within cartels (Battiston et al., 2022; Lessing, 2015; Rios, 2013; Shirk and Wallman, 2015). The war on drugs differently affected areas that had more presence of state armed forces (Atuesta and Ponce, 2017; Rios, 2013; Salcedo, 2021; Shirk and Wallman, 2015) and areas that supported the national government, i.e., were mayors where members of the same party as the president (Dell, 2015; Shirk and Wallman, 2015). Cartels began to expand to municipalities in an attempt to diversify their sources of income and to control any market that seems favorable, including markets for legal commodities (Estancona and Tiscornia, 2022; Piccato, 2022; Wainwright, 2016), in a multi-commodity criminal approach. For instance, the war on drugs pushed cartels into oil thefts, a new business that started to emerge shortly after (Battiston et al., 2022).

The intensification of the conflict led some criminal organizations to split themselves due to their leaders being captured or killed. For instance, after the death of the leader of the *La Familia Michoacana* cartel (The Michoacan Family), a split between successors led to the creation of the *Los Caballeros Templarios* cartel (The Knight Templars). Similarly, the foundation of the *Jalisco Nueva Generacion* cartel (Jalisco New Generation) was due to a power vacuum and the split into smaller factions of the *Milenio* cartel. These splits led to an increase in the number of municipalities with cartel presence and multiple cartels being active (Calderón et al., 2015; Rios, 2013; Sobrino, 2020). Figure 3 presents evidence of this expansion.

3 Empirical Strategy

3.1 Main specification

I am interested in whether the increasing production of avocados has led to changes in the intensity of conflict. The ideal experiment would compare the number of homicides in areas that have different avocado production levels for reasons otherwise unrelated to violence. However, I can not consider such a comparison as it is reasonable to assume that the presence of avocado orchards could be affected by the conflict intensity. On the one hand, cartels may exert violence against avocado farmers who may decide to leave and stop producing, and on the other, farmers may decide to change their production of avocados to avoid being 'taxed' by cartels (see section 2).

To approximate such an experimental idea, I consider a Bartik-type or shift-share variable that combines geographical variation in avocado cultivation suitability and the growth in the demand for avocados in the United States, defined as follows:

$$Z_{mt} = \hat{S}_m \times \log(D_t)$$

where $\hat{S}_m$ is a predicted avocado suitability index, whose construction I explain in section 4.1.1, and it takes values between zero and one, where higher values means that municipality m is more suited to growing avocado. D_t is an external demand shock that proxies the growth of the avocado export sector.[5] This variable measures which areas are more suited to absorb the change in demand for avocados. Intuitively, this is a measure of *potential production* of avocados. To ease interpretation, I standardized this measure to have zero mean and unit variance. I discuss both variables in more detail below in section 4.

Using this measure of *potential production*, I estimate the following specification:

$$Y_{mt} = \beta Z_{mt} + \pi_m + \delta_t + \sum_{c \in W_m} [c \times \delta_t] + \varepsilon_{mt} \ , \tag{1}$$

where Y_{mt} is the homicide rate in municipality m and year t, which proxies for intensity of conflict. π_m and δ_t are municipality and year fixed effects respectively. W_m is a vector control variables interacted with year fixed effects. It includes the linear distance between the municipality and the state capital, and municipal characteristics observed in 2000, comprising the (log) population, the Gini coefficient, and a social gap index. The error term ε_{mt} is clustered at the municipality level to account for potential correlation across time within municipalities. To account for the sampling variance of the generated regressor $\hat{S}_m$, I block-bootstrap my standard errors preserving the municipality clusters. In addition to the bootstrap standard errors, to account for potential spatial correlation, I use a 500 kilometers radius to calculate the Conley (1999) standard errors. The parameter of interest β measures how changes in the areas more suited to absorb the demand for avocado (potential production) affect the homicide rate.

3.2 Identification

My identification comes from the differential suitability to cultivate avocados to evaluate how an external demand shock affects production in different municipalities. Specifically, the United States' demand for avocados is not correlated with changes over time in violence across municipalities in Mexico. Furthermore, municipalities that produce avocados either for internal consumption or to

[5] I am using the variable in logs rather than in levels to approximate the growth rate of the demand shock (Dube and Vargas, 2013; Mejía and Restrepo, 2015). Estimates in Table D.2 show that my results are not sensitive to the specification using the log of D_t. See section D.1.2.

export to other countries should not be affected by this demand shock. Notice, I cannot leverage identification coming from the demand as I do not have multiple demand shocks (Goldsmith-Pinkham et al., 2020). In particular, I do not have data on other countries' consumption, such as Canada or Japan, the second and third most important buyers of Mexican avocados.

To achieve valid identification, the demand for avocados in the United States or the suitability to grow avocados should be exogenous to the intensity of conflict in Mexico. Notice, recent literature on shift-share specifications suggests that both variables do not need to be exogenous to have valid identification.[6] In my case, I argue that the demand for avocados in the United States is exogenous to cross-sectional conflict intensity in Mexico, as the latter has not interrupted the supply of avocados coming from Mexico. The growth in availability of avocados in the United States has come mostly from the importation of Mexican avocados, although its share of total imports has been stable in the last decade. The cover the United States' excess demand for avocados, the volume of avocados imported from other countries –such as Peru or Colombia– has also been increasing.

On the other hand, I could also argue that suitability to grow avocados is exogenous to conflict as it is based on agroclimatic characteristics that should not affect conflict intensity. However, I construct the suitability index using observational data –i.e., whether or not a municipality has grown avocados– that could have been affected by the conflict, e.g. criminal organization forcing farmers to produce avocados (Miller, 2020). For this reason, I cannot claim that the avocado suitability index is completely exogenous.

A possible threat to my identification may be caused by municipal characteristics that may be correlated with the potential production, i.e., the suitability index (Ferri, 2022; Goldsmith-Pinkham et al., 2020; Jaeger et al., 2018). For instance, areas more suited to growing avocado have higher levels of inequality or poverty, are less populated or far from an important market. To account for this potential threat, as a robustness to my main specification, I flexibly control for the interaction between these variables and year fixed effects in some of my specifications.

4 Data

My main data set consists of a panel of municipalities in Mexico for the period 2005-2019. Below, I describe the sources and information available for the main explanatory variable and the outcome

[6] For instance, Borusyak et al. (2021) show that their identification comes through exogenous shocks while allowing for endogenous shares while Goldsmith-Pinkham et al. (2020) and Borusyak and Hull (2023) suggests that identification comes through the shares.

variables. Tables 1 and 2 present the descriptive statistics for all the variables used in my analysis.

4.1 Measure of 'potential production'

4.1.1 Avocado suitability index

I exploit cross-sectional variation across municipalities using an avocado suitability index. Following Mejía and Restrepo (2015), I construct the index based on agroclimatic characteristics at the municipal-level. To uncover the determinants of avocado production, I estimate the following model:

$$\begin{aligned} S_m = \quad & \alpha_0 + \alpha_1 altitude_m + \alpha_2 altitude_m^2 + \alpha_3 water_m + \alpha_4 water_m^2 \\ & + \alpha_5 soil_m + \alpha_6 soil_m^2 + \sum_{p=1}^{15} \alpha_p A_{mp} + \epsilon_m \end{aligned} \tag{2}$$

where $altitude_m$ is the average altitude of the municipality m, $water$ is a measure of water availability using the average annual precipitations (in mm) from 1990 to 2000, $soil$ is an index of soil suitability for common agricultural crops. To control for geological characteristics, A_{mp} is an indicator taking the value of one if a municipality m belong to Mexican physiographic region p. These regions do not necessarily overlap with administrative or political borders, therefore a municipality can have part of its area in more than one of these regions, i.e., the dummies are not mutually exclusive (see Appendix B and Figure B.1). I consider a municipality to be part of physiographic region p if any part of the area of the municipality lie in the area of the region.

The outcome variable S_m takes the value of one if municipality m has reported a positive area cultivated with avocados in any year of the sample, using information from the Agricultural and Fisheries Information Service (SIAP) from the Mexican Secretariat of Agricultural and Rural Development (SAGARPA). This data contains municipal-level information about the number of hectares cultivated, the yield, and the annual volume and value of production for each municipality from 2003 to 2009 for a variety of crops, including avocados. Figure 1 summarizes this information by showing the total revenues from avocado production in current Mexican pesos over time. Alternatively, I use the information on the average productivity (yield) instead of the dummy indicator of avocado presence.

Table 3 presents estimates of variations of this model. In Column (1), I estimate equation 2 using a logit model and, in Column (2), a Linear Probability Model; in Column (3) and Column (4), I use the yield in levels and transformed using the inverse hyperbolic sine (I.H.S.), respectively, instead of the dummy indicator of avocado presence. My results suggest that the three variables present a positive but decreasing relationship with the presence (productivity) of avocados. This result is in line with other estimates that suggest that there are a wide range of values of water and altitude under which avocados can be cultivated, but they have optimal values within that range (De Haro, 2022; Miller, 2020). In terms of soil quality, the quadratic relation is less obviously interpretable as higher values means the municipality has a more favorable soil for different crops. A possible explanation is that more favorable areas are used to grow other cash crops. Overall, these agroclimatic variables explain 16.3 percent of the variation.

Using my estimates from Column (1), I create a measure of avocado suitability index S_m for all municipalities with agroclimatic data:

$$\hat{S}_m = f(altitude_m, water_m, soil_m; \hat{\boldsymbol{\alpha}}) \tag{3}$$

where $f(\cdot)$ is a flexible function of the estimates $\hat{\boldsymbol{\alpha}}$. In particular, I use a logit function to predict the index $\hat{S}_m$ so that it takes values between zero and one, where higher values represent areas more suitable for growing avocados. Alternative, I use a linear function of the estimates when they come from a linear regression. Similarly, when I use yield as the outcome, the values of the index will fall outside the zero-one range.

My index $\hat{S}_m$ varies across municipalities but not over time and its spatial distribution is shown in Figure 4. Panel a shows the areas that has avocado presence by summarizing the average annual production (yield), while panel b summarizes the avocado suitability index ($\hat{S}_m$) by quintiles. The areas more suited to grow avocado are clustered along the pacific coast (south west of Mexico) and the Yucatan peninsula (east of Mexico) due to the water availability.

4.1.2 External demand

I exploit time variation in the demand for avocados using the availability of pounds per person for consumption in the United States. There is no data that allows me to recover the actual demand for avocados, therefore I proxy it with availability of the fruit. Figure 5 shows that availability in pounds per person increased fourfold in the last three decades, going from 2 pounds per person in 1990 to 8 pounds per person in 2020. This increase in availability comes mainly from imports as local production in the country has remained constant, or even decreased, in this period. In particular, the share of avocados that come from Mexico represents about 90% of the United States' total imports and 75% of the avocados consumed in the country. To keep with the demand, United States avocado imports have increased from other countries such as Peru and, more recently, Colombia (Figure 6).

4.2 Homicide and conflict data

Data on homicides come from the National Department of Health Information (SINAIS). It consists of individual level information for which a death certificate was generated and includes detailed information on the cause of death (including homicides), the location of occurrence, and individual characteristics such as age, gender, and occupation. Using the location of residence and cause of death, I calculate the homicide rate per 100,000 people in each municipality-year.[7] Based on the victim's occupation, sex, and age reported, I classify the victim into one of three groups and calculate their respective homicide rate. Figure 7 summarizes how I classify homicides. The first group consists of the victims whose occupation was agricultural workers. The second group consists of male victims between the ages of 15 and 40 whose occupation was not agricultural workers as this population group is more likely to take part in cartel activities.[8] The third group consists of any victims that do not belong to either of the first two groups.

I focus on homicides and use the SINAIS data for three reasons. First, homicides are the most reliably registered crime, although the kidnapping, extortion, and disappearances and mass graves are also associated with Mexican crime groups (Prieto-Curiel et al., 2023; Shirk and Wallman, 2015).[9] Second, the SINAIS data includes detailed information on the occupation, sex, and age of the victims, which allows me to improve with respect to previous studies. Third, SINAIS data is more accurate than other sources, such as police reports, as it contains information about all individuals for whom a death certificate was generated. Police report data suffers from underreporting as file cases are not open and investigated (Atuesta et al., 2018).

[7]The correlation between the victims' location of residence and location of occurrence is 0.9902. See Appendix C for details on the classification of homicides.

[8]There is no other information that allow me to classify the victims as cartel related. Other occupations include professionals, merchants, personal and security services, artisan workers, heavy machinery and drivers. To create mutually exclusive groups, I am excluding agricultural workers from the group of (possibly) cartel related. I explore the sensitivity of this classification in section 6 and Appendix D.

[9]I use information from the National System of Public Security (SPP) on the number of homicides, extortion, kidnapping, and threat cases reported to the police in section 7 below. I do not have information on disappearances that allow me to identify possible under-report of homicides, as there is not death certificate generated in those cases.

4.2.1 Presence of cartels

Data on the presence of cartels comes from the Mapping Criminal Organizations project.[10] This is the most complete attempt to map criminal organization in Mexico at the cartel-municipal-level from 1990 to 2020. It approximates the presence of 75 different cartels in a municipality by analyzing whether the cartel is mentioned in local news (Sobrino, 2020).[11] Using this data, I identify whether a cartel is present (extensive margin) in each municipality-year, and how many cartel there are (intensive margin). Furthermore, to identify the cartels with likely greater national presence, I split cartels into traditional –the 9 main cartels that have been present since the 1990s– and non-traditional cartels –the newly formed cartels or splinters of traditional cartels.[12]

5 Results

My main results for the homicide rates, using the classification of the victims, are presented in Table 4. Column headers report the outcome variable and rates are expressed in 100,000 people using the municipality population of 2010. Estimates in all columns include municipality and year fixed effects, and even columns include the interaction between municipal-level controls and year fixed effects. To ease interpretations, the mean of the dependent variable in the sample is reported in the bottom of the table.

5.1 Main results: homicide rate

I find a positive effect of increasing demand for avocado on the homicide rate. I also find that the increase in the homicide rate is driven by an increase in the homicide rate of agricultural workers.

Focusing on the homicide rate of agricultural workers in Panel A and the most demanding specification (Column (4)), a one-standard-deviation increase in the area more suited to absorb

[10] I thank Fernanda Sobrino who shared this data with me.

[11] This data can suffer from measurement error as actual presence could be related to no news reporting (Atuesta et al., 2018); however, this is the more complete data set at this level. Coscia and Rios (2012) report the present during the 1900s and the 2000s. Other sources report the presence of more criminal organizations at the national level but they do not cover a long period. For instance, Prieto-Curiel et al. (2023) identifies 150 different organizations in 2020 using based on *Drug Policy Program* (PPD) data from the *Centro de Investigación y Docencia* (CIDE).

[12] The Mexican prosecutor's office and the DEA recognized the Gulf Cartel, the Juarez Cartel, *La Familia Michoacana*, the Tijuana Cartel, the Sinaloa Cartel, Beltran-Leyva Organization, Jalisco New Generation Cartel, Los Zetas, and The Knights Templar as the 9 main Drug Trafficking Organizations (De Haro, 2022; Sobrino, 2020). For a brief historical description of cartels formation in Mexico, see Atuesta and Pérez-Dávila (2017).

the demand for avocados increases the homicide rate of agricultural workers by 1.06 additional homicides per 100,000 people. This effect is statistically and economically significant, and represents a substantial size effect of 18.3% with respect to the 5.76 mean homicide rate of agricultural workers. In general terms, this additional death represents a 6% increase with respect to the 16.96 mean homicide rate in the municipality. I do not find an effect statistically different from zero for the homicide rate of (potentially) cartel related individuals nor for the rest of the population.

To account for potential spatial correlation between municipalities, I report the Conley (1999) standard errors using a 500 kilometers radius, following Sobrino (2020), in addition to the block-bootstrapped standard errors in Table 4. The former are more conservative than the block-bootstrapped standard errors by around 10% while keeping their significance at the conventional levels. Given the similarity of the standard errors, in the following tables, I only report the block-bootstrap at the municipal level.

A possible threat to my identification may be caused by difference in municipal characteristics that may be correlated with my explanatory variable, as discussed above (Goldsmith-Pinkham et al., 2020). To account for this possibility, even column estimates in Table 4 include the interaction between municipal-level control and year fixed effects. Reassuringly, the magnitude of the estimated coefficients is robust to the inclusion of controls.

5.2 Avocado production

Using information on actual avocado production, I could estimate its relationship with the intensity of conflict using a two stage least squares. Specifically, I estimate:

$$y_{mt} = \theta avocado_{mt} + \tau_m + \psi_t + \sum_{c \in W_m} [c \times \psi_t] + \eta_{mt} \ ,$$

where $avocado_{mt}$ is a measure of avocado production. τ_m and ψ_t are municipality and year fixed effects, respectively. Municipal characteristics W_m are as defined above and are interacted with year fixed effects. The parameter of interest is θ. The first-stage is as follows:

$$avocado_{mt} = \gamma Z_{mt} + \lambda_m + \phi_t + \sum_{c \in W_m} [c \times \phi_t] + \upsilon_{mt} \ ,$$

where λ_m and ϕ_t represent municipality and year fixed effects.

I show that my measure of potential production explains the production of avocado. Table 5 reports the first-stage estimates using different measures of avocado production in levels and in logs.[13] Specifically, I use four separate treatment variables: the total area cultivated (in hectares) with avocado, the volume and the value of the avocado production, and the value of the production per capita. I find a positive relationship between my measure of areas more suited to absorb the demand for avocados and the actual production of avocados, both in levels and in logs. Focusing on the main specification, which is in Column (8), a one-standard-deviation increase in area more suited to absorb the demand for avocado increases the value of avocado production per capita by 1,319 Mexican pesos.

I find a positive effect of avocado production on the conflict intensity using potential production as the excluded instrument. For intuition purposes, I use the value of avocado production per capita in the municipality as my measure of avocado production. Focusing on Column (4) in Panel B of Table 4, I find that an increase in 1,000 Mexican pesos per capita, increases the homicide rate of agricultural workers by 0.76 additional deaths per 100,000 people. Remarkably, this estimate is similar in size to the reduce form estimate reported in Panel A.

I take with caution the results coming from this specification as the monotonicity assumption may not be satisfied. Assuming that the measure of potential production is exogenous to the conflict intensity, as discussed previously (see section 3.2), my instrument of potential production is relevant and meets the exclusion restriction. However, I cannot guarantee that the monotonicity assumption holds. In particular, even if I can assume that municipalities with low potential to produce avocados are producing them (compliers) due to the increasing demand, I can not completely rule out that municipalities with high potential to produce avocados are not producing them (defiers).

5.3 Time-varying unobserved heterogeneity

One possible threat to my identification strategy is the presence of time-varying unobserved heterogeneity that is not captured by the fixed effects. The presence of this type of heterogeneity is more likely to happen with large longitudinal data and it will bias my estimates (Millimet and Bellemare, 2023). To account for this possibility, I re-estimate my main specification using the First Difference (FD), Twice-First Difference (TFD), the Rolling First Difference (RFD), and the Rolling Twice-First Difference (RTFD) estimators.[14] I report in Table 6 these alternative estimates, in

[13] I use the inverse hyperbolic sine instead of the natural logarithm as there is presence of zeros in my data. I show that the results are not driven by this transformation in Appendix E.

[14] The Rolling First-Difference model and the Rolling Twice First-Difference model can be estimated with or without a constant term. The First-Difference model with a constant assumes that $E[\alpha_i^{t',T} - \alpha_i^{t',s}] = c$, where $\alpha_i^{s,s'}$ is the time-varying part of the unobserved heterogeneity over period defined by s and s' and t' is the period where there is a

addition to the fixed effects (FE) estimates to ease comparison.

My results suggest that there is presence of unobserved characteristics that are not accounted for the fixed effects estimator. For instance, the various policies adopted around the Mexican "war on drugs" could have generated structural breaks in the homicide rate that are not accounted for the fixed effects. Indeed, the FD estimates on the overall homicide rate is larger that those of the FE. This increase is largely explain by an increase in the homicide rate of the rest of the population, which speaks about the changes in the conflict intensity in Mexico. Similarly, the FD and TFD estimates on the homicide rate of agricultural workers are larger than those of the FE, while they still explain the change in the overall homicide rate. Therefore, I can assume that the FE estimates represent a lower bound off the true effect.

6 Robustness

It might be the case that most of the variation is due to the way the explanatory and outcome variables are constructed. Similarly, one might be concerned that some of the units in my sample drives the results. To alleviate these possible concerns, in this section I present different robustness test for the main estimated effects. I follow Eggers et al.'s (2023) typology of placebo tests and split my analysis into three parts: alternative (*i*) explanatory variables, (*ii*) outcome variables, and (*iii*) populations to test my estimates effects.

6.1 Alternative explanatory variables

One alternative explanation to the increase in the homicide rate of agricultural workers is that this population group is more targeted, even if they are not producing avocados. To rule this possibility out, I perform placebo tests for my explanatory variable using alternative crops that should not affect the intensity of conflict. In addition, I also use alternative measures of avocado suitability and external demand to show that the increase is driven by changes in the demand for avocados.

6.1.1 Suitability for alternative crops

I show that the increase in the homicide rate of agricultural workers is experienced in areas which are suitable for growing avocados, while areas which are suitable for growing other crops

structural break, since $E[\alpha_i]$ is not assumed to be zero (Millimet and Bellemare, 2023).

are not experiencing similar increases in homicides. To do this, I calculate a suitability index for growing different crops and interact it with the demand for avocados. Specifically, I look at the suitability for growing different fruit trees, namely apples, peaches, pears, oranges, and lemons. My results suggest that the increase in the homicide rate of agricultural workers is not related to the suitability of growing other crops but it is explained by the suitability for growing avocados (Figure 8). This result goes in line with the profitability of avocado production and its high-value export (see section 2). The only exception is for the areas more suited for growing lemons, that can be explained by the presence of both crops in areas with cartel presence (Miller, 2020).[15]

6.1.2 Alternative shift-share measures

It might be the case that my proposed measure of potential production and its function form are driving my results. To address these concerns, I modify my measure by modifying either the share part –alternative measures of suitability for growing avocado– or the shift part of the variable –alternative exogenous demand shocks. Specifically, I use the different measures of avocado suitability reported in Table 3 (see section 4.1.1) and the share of agricultural area devoted to avocado production in 2003, the first year I observe information at the municipal level. For the alternative shocks, I use the growth of the avocado industry in Mexico, the global production excluding Mexico, and the number of searches on Google trends. My results are robust to using alternative shares, sources of shocks, and to not taking the log of the demand shock. My estimates are robust in terms of sign and significance, although they present different point estimates coming from difference in the measure units (Tables D.1 to D.3 in Appendix D). The correlation between the demand for avocados in the United States and the different demand shocks is above .94, except with the Google search that is .80 which explains the loss in significance.

6.2 Alternative outcome variables

To investigate how sensible my results are to the classification of the victim of homicides, I use the criteria of occupation, and age and gender to investigate potential overlaps between the victims profiles. In addition, using the residence of the victims, I calculate them main outcome variables for those that lived in rural areas.

[15] For media coverage, for instance see https://www.npr.org/2022/02/19/1081948884/mexican-drug-cartels-are-getting-into-the-avocado-and-lime-business.

6.2.1 Alternative classification of homicide victims

To show that my results are not sensible to the classification of victims, I separately estimate effects by occupation, and age and gender (see Figure 7). Specifically, I separate the homicide rate for agricultural workers into males between the ages of 15 and 40 –the population group most likely to take part in cartel activities– and the rest of the agricultural workers. Similarly, I compute the homicide rate of all male between the ages 15 and 40, regardless of their occupation. I estimate equation 1 using the homicide rate of these three groups in Table 7. To ease comparisons, I report in Column (1) and (2) the estimates for the agricultural workers; and in (9) and (10), the (potentially) cartel related. My results suggests that the increase in homicides of agricultural workers comes particularly from males agricultural workers between the ages of 15 and 40 (Column (4)). This latter group explains the increase in the homicide rate of agricultural workers (Column (2)) and, also, in the homicide rate of males between the ages 15 and 40 (Column (8)). Homicides of agricultural workers outside the age range (Column (6)) are unaffected by avocado demand nor are the homicide rates of individuals in the age range who are not agricultural workers (Column (10)). This result is not surprising as other studies have link agricultural workers to criminal activities through the opportunity cost channel (Dube and Vargas, 2013; Guardado and Pennings, 2020). Another possibility is the rise of vigilantism in Mexico that has created self-defense groups to protect local production from criminal organizations (Althaus and Dudley, 2014; Wolff, 2020).[16]

6.2.2 Homicides for residents of rural areas

Using the recorded residence of the victims, I restrict my sample to homicide cases with victims living in rural areas as they are more likely to engage in agricultural activities. For instance, about half of the victims of homicide in a municipality lived in rural areas; whereas for agricultural workers, it was the majority of the victims. My results are robust to this classification and are reported in Table 8. In particular, the increase in the homicide rate of individuals in rural areas is solely explained by the increase in the homicide rate of agricultural workers whose place of residence was the rural area. Although the point estimate is smaller than that without this restriction, the size effect is around 16% when compared to the sample mean.

[16] In Appendix D, I presents estimates for the main occupations reported and show that agricultural workers explain the changes in the overall homicide rate.

6.3 Alternative populations

To rule out that my results are driven by outliers or clusters of municipalities, I exclude states, large cities measured by population, and extreme values in the reported homicides.

6.3.1 Excluding states

To show that my results are not driven by a particular cluster of municipalities, I run my estimates excluding from my sample each one of the 32 Mexican states at a time.[17] It may be the case that most of my variation in the suitability for growing avocados come from municipalities that have a higher intensity of conflict. For instance, this could be the case of Michoacan, the largest producer state of avocados in Mexico, which is also notable for the high levels of conflict intensity (Althaus and Dudley, 2014; De Haro, 2022; Wolff, 2020). I rule out this possibility and show that my results are robust to restricting every one of the 32 state restrictions. Figure 9 presents the estimates for the homicide rate in agricultural workers in panel a and for (possibly) cartel related in panel b. Surprisingly, a notable exception is the exclusion of Jalisco from my estimates, which increases the homicide rate of (possibly) cartel related individuals. I would have expected, if something, an opposite effect to the exclusion of Jalisco as it is both a producer of avocados and presents high conflict intensity. A possible explanation is cooperation between criminal organizations that reduces conflict intensity. I explore the role of cooperation in section 7.

6.3.2 Excluding large cities

I show that my results are not driven by municipalities that have high homicide rates. Mexico's conflict has claimed as many lives as war zones, including cities with homicide rates above 200 deaths per 100,000 people (Lessing, 2015; Rios, 2013). However, these violent cities are not small but rather middle to large sized cities. For instance, according to Rios (2013), the population in the top 5 most violent municipalities ranges from around 650 thousand (Acapulco) to just below 2 million inhabitants (Tijuana, the second largest city by population in Mexico). In Figure 10, I report my estimates restricting the sample to municipalities below different population thresholds and show that my estimates are not driven by the homicide rates of big cities.[18] However, note that for municipalities below 100 thousand inhabitants, the estimated effect doubles in size. Interestingly,

[17]Mexico is comprised of 32 federal entities: 31 states and the capital, Mexico City. States are the first level administrative division, which is further divided into municipalities. For simplicity, I refer to 32 Mexican states.

[18]Table D.5 in appendix further explores this exclusion.

the estimates on homicide rate of (possibly) cartel related individuals become more negative as the population decreases.

6.3.3 Outliers in homicides

I rule out the possibility of outliers in the number of homicides by dropping from my sample those observations whose number of homicides is in the top 1 percentile. Homicide information may be biased as location of occurrence is not necessarily the same as the location where it is registered. For instance, the average homicide rate coming from police reports is 26.2 (Table 1), while the homicide rate for the same period using information from death certificates is 19.5 deaths per 100,000 people. If the latter is related to the suitability for growing avocados or to conflict intensity, then they will be biasing my estimates. I exclude the observations where the number of homicides (in levels) is above the 99th percentile for the respective homicide rate in the outcome variable. I show that my estimates are robust in size and significance to this exclusion in Table D.6 in the appendix.

7 Mechanisms

My results so far suggest that the demand for avocados increases the homicides of agricultural workers in areas more suited to absorb that demand for avocados. These findings are in line with other studies recently carried with different agricultural commodities responding to production shocks, e.g., changes in prices (Cisneros et al., 2022; De Haro, 2022; Dube and Vargas, 2013; Estancona and Tiscornia, 2022). In this section, I explore the mechanisms plausibly driving the increase in the number of homicides as a response to the increasing demand for avocados. First, I study other forms of criminal and the role of cartels. Second, I empirically test the mechanisms of cooperation between producers and cartels, and competition between cartels. Finally, I study whether crop production changes living standards (Boone et al., 2022).

7.1 Conflict and criminal organizations

7.1.1 Criminal activities

Changes in the demand for avocados could affect other types of criminal activities, beyond homicides, such as kidnappings, threats, or extortion (Buonanno et al., 2015; Shirk and Wallman, 2015; Wolff, 2020). I explore whether the increase in homicides is accompanied by changes in these other activities. In this section, instead of using information from death certificates, I use data from police reports including data on homicides as a robustness check to the source of information. Table 9 reports the estimates for the criminal activities coming from police reports. I find that a one-standard-deviation increase in the areas more suited to absorb the demand for avocados increases the homicide rate by 5 additional deaths. Although different in magnitude, the size effect is also around 20 percent, similar to the effect using information from death certificates, as the mean homicide rate is 26 deaths per 100,000 people.[19]

When I turn my attention to other types of criminal activities, I find that a one standard deviation increase in the areas more suited to absorb the demand for avocados decreases the extortion rate in 1.64 cases per 100,000 people, while the same change does not affect the threat and kidnap rates per 100,000 people. These are surprising results as I would expect these three measures to have a positive point estimate. A possible explanation for these results, particularly in the case of extortion, is that individuals are less willing to file a report. This can be the case when cartels have a preference for killing over extorting, or when there exists a compromise between the two sides to overcome the *commitment problem* (Blattman, 2022), i.e., farmers and cartels agree on a rate of taxation acceptable to both parties. This would also explain the null effect on threats and kidnappings. Alternatively, cartels may decide to act–i.e., killing– if farmers are unwilling to pay the extortion. This will bring the homicide rate up and the extortion rate down. However, since I do not observe detailed information on who is being extorted, it is not possible to validate, or rule out, these explanations. I further explore the role of cooperation in section 7.2.

7.1.2 Presence of criminal organizations

I explore whether changes in the homicide rate are explained by changes in the presence of criminal organizations, or cartels. An unexpected consequence of the Mexican war on drugs was the proliferation and expansion of cartels throughout the country (Atuesta and Ponce, 2017; Atuesta and Pérez-Dávila, 2017; Calderón et al., 2015; Rios, 2013; Shirk and Wallman, 2015; Sobrino, 2020). Using data on cartel location coming from the Mapping Criminal Organizations project (Sobrino, 2020), I re-estimate equation 1 using separately both the presence of cartels as dependent variable, and the total number of cartels. I do this to capture extensive and intensive margins, respectively. In addition, I differentiate cartels between traditional –the 9 main Mexican cartels that have been present since the 1990s– and non-traditional cartels –newly formed cartels or splinters of traditional

[19] I explore differences in the sources of information in Appendix C.

cartels (see section 4).

Table 10 presents my estimates for the extensive and the intensive margin, including those places with zero cartels. My results suggest that a one-standard-deviation increase in the areas more suited to absorb avocados increases the probability of having a cartel present, both traditional and non-traditional, and it also increases the number of cartels present. Although I find a positive effect on the extensive margin, these are similar to those of intensive margin as the average number of cartels is less than one. I further explore the extensive margin in section 7.2.2.

To study whether cartels mediate the increasing homicide rate, I re-estimate equation 1, interacting my measure of potential production with an indicator variable of cartel presence in the municipality in the previous period, i.e., heterogeneous effects by "contemporaneous" cartel presence. Table 11 presents the estimates using the classification of cartels for the homicide rate of agricultural workers in the first 6 columns; while in the last 6 columns, for the homicide rate of (possibly) cartel related individuals. I relegate to the appendix the table with the estimates for the other two main outcomes (See Table E.1). My results suggest that the increase in the homicide rate of agricultural workers is not driven by the presence of criminal organizations. This is unexpected as I would have imagined that the presence of cartel will lead to more homicides. On the other hand, the results for the homicide rate of (possibly) cartel related individuals present a different picture. The presence of traditional cartels decreases their homicide rate; while the presence of non-traditional cartels increases the homicide rate. A possible explanation for these results rely on cooperation and competition, which I explore in the next section.

7.2 The role of cooperation and competition

7.2.1 Historical cartel presence

As a complementary analysis, I study whether there is a differential response in areas with prior presence of cartels, as a proxy for cooperation between farmers and criminal organizations. The lack of trust in government is important to understand the role of cooperation and vigilantism, as government officials were involved with drug trafficking organizations at the local level (Shirk and Wallman, 2015; Wolff, 2020). These criminal organizations acted like "stationary bandits" by charging locals for protection (Olson, 1993) and fighting the state not to conquer it but to constrain it (Lessing, 2015). Given that the presence of "contemporaneous" cartels might be due to the increasing demand for avocados, I use the "historical" presence of criminal organizations to explore the role of cooperation and report my results in Table 12. In particular, I assume that a municipality had cartel presence if there was at least one cartel in any year of the decade of 1990s.[20] An advantage of using historical rather than contemporaneous cartel presence is that, newly arriving criminal organizations might focus on rent-seeking rather than focusing on territorial control, where cooperation is more likely to happen.[21] Column (4) estimates suggest that presence of historical cartels fully attenuates the increase in the homicide rate of agricultural workers; however, it does not have an effect on the homicide rate of (possibly) cartel related individuals. This result is similar to that of Crost and Felter (2019), who find that an increase in the price of bananas leads to a decrease in violent incidents in insurgency areas within the Philippines.

7.2.2 Competition between criminal organizations

In this section I explore whether cartel competition explains the increase in the homicide rate using information about presence of multiple cartels, as a proxy for competition.[22] The proliferation of cartels led to vigilantism and fights for territorial control between criminal organizations to establish a monopoly of looting (Blattman, 2022; Lessing, 2015; Olson, 1993). In particular, other work has shown that newly formed cartels have relatively limited influence over drug markets and routes, therefore they battle to take control over a "profitable" territory (Atuesta and Pérez-Dávila, 2017; Battiston et al., 2022; Estancona and Tiscornia, 2022; Rios, 2013; Shirk and Wallman, 2015; Wainwright, 2016). For instance, Prieto-Curiel et al. (2023) estimate that more than half of the country's casualties result from fights between the smallest and the largest cartels; hence, the

[20]Note, before 2007 there were only traditional cartels (see Figure 3). Data on cartel presence from the Mapping Criminal Organizations project relies on text analysis of newspapers, which could be less accurate for the decade of 1990s.

[21]There are different explanations for cooperation. Blattman (2022) suggests that societies have managed peaceful competition when there is some *interdependence* between farmers and criminal organizations, or when they create some *rules* or social norms that both follow. Alternatively, Lessing (2020) suggests that the reduction in violence is associated with non-state actors exerting some way of governance over local communities. Indeed, in some instances, locals preferred crime organization leaders from the area to *foreign* crime organizations (Asfura-Heim and Espach, 2013; Wolff, 2020), as this allowed them to agree on a rate of taxation that was acceptable to both parties, even if this implied cartels lowering their 'taxes' as a mean to avoid confrontation (Miller, 2020).

[22]The presence of multiple cartels does not rule out cooperation between them. For instance, cartels allied to confront a common enemy, to obtain protection, or to strengthen debilitated groups. The effect of this cooperation on conflict varies with the conditions under which the cooperation takes place. For instance, there is a increase in the number of violent event when an emancipated faction join forces with a third cartel to clash with their former boss. However, there is larger increase in the number of violent events when cartels fight one another, specially following a fragmentation (Atuesta and Pérez-Dávila, 2017).

importance of differentiating the largest cartels –or traditional– and the smallest cartels. Using information on the number of cartels present in every municipality-year, I create an indicator variable for municipalities with only one cartel and another for municipalities with two or more, separately for traditional and non-traditional cartels, as a proxy for competition.[23] I interact these indicator variables with my measure of potential production and report my estimates in Table 13, focusing on the homicide rate of agricultural workers and the homicide rate of (possibly) cartel related individuals. Similar to cooperation, my results suggest that cartel presence in areas more suited to absorb the demand for avocados does not explain the increase in the homicide rate of agricultural workers. However, the presence of at least one non-traditional cartels is associated with an increase in the homicide rate of (possibly) cartel related individuals. Notably, the largest increase in violence happens when there is presence of two or more non-traditional cartels in areas more suited to absorb the demand for avocados, whereas there is no association when there is presence only of traditional cartels. This result is consistent with the expectation of small cartels competing over resources and territorial control.

7.3 Economic benefits

7.3.1 Labor market and structural transformation

Using data from the National Employment Survey (ENOE), I analyze whether the demand for avocados brought by changes in the labor market.[24] Previous studies have suggested that production booms could bring changes in the labor market, in particular that of export crops (Boone et al., 2022; Crost and Felter, 2019). These changes can come either through more employment or through more income (from wages). I use data on these variables and show that there are no changes in workers income, suggesting that the change in demand is not attracting more workers via higher

[23] I simplify my analysis by focusing on 2 or more cartels rather than multiple categories for municipalities with presence of multiple cartels. This simplification assume that the presence of two groups has the same effect as the presence of, say, 10 groups. Atuesta and Ponce (2017) suggest that the violence between cartels present an inverted-u shape with respect to number of criminal organizations due to fragmentation. However, this result only holds for confrontations and violence between groups and not necessarily against agricultural workers.

[24] The use of this survey have two caveats. First, the ENOE is not representative at the municipality level but rather at the state level and for 39 cities, underrepresenting the rural area. Second, the survey is collected quarterly but I am using yearly information. To do so, I average the four quarters of the year. By doing this, I may be covering some of the heterogeneity including the seasonality of crops. However, given that the avocados can be harvested and exported all year long, I am not that concerned on missing seasonal effects.

wages (Table 14). In other words, profits from avocado production are not passed to workers. On the other hand, in terms of employment, I find that the areas more suited to absorb the demand for avocado experience an increase in the unemployment rate. Although this is not expected, a possible explanation comes from the nature of the survey that under-represent workers in rural areas.

An alternative explanation could be that the municipalities are more broadly undergoing a structural transformation towards the agricultural sector.[25] To test this hypothesis, I calculate the share of workers in the main sectors, namely agriculture, construction, manufacturing, services, and commerce. My results suggest that areas more suited to absorb the demand for avocado experienced a reduction in the share of workers in the manufacturing sector (Table 15). In addition, the agricultural sector estimates are positive, although they are not significantly different from zero. These results need to be taken with caution since the Mexican war on drugs displaces skill intensive jobs as Aldeco et al. (2022); Salcedo (2021). Therefore, areas where there is an increase in the homicide rate also present a recomposition in terms of the labor force.

7.3.2 State capacity

The increase in demand for avocados and for avocado production, should be associated with an institutional response in the form of tax collection and or public spending. Previous studies have linked economic booms with more state capacity, measured as tax collection, or more public investment (for instance, Boone et al., 2022). Using fiscal reports on tax collection and expenses, I calculate the share of revenues coming from taxes and from production taxes, and the share of taxes from the latter to capture tax collection, as well as the share of expenses devoted to public investment and to personal expenses. I test this hypothesis by estimating equation 1 using these outcomes and report my results in Table 16. I find that an increase in the area more suited to absorb the demand for avocado is not associated with changes in public expenses; however, the same increase is associated with more revenues from taxes, particularly from production taxes. Notice, due to data availability, I do not have information about revenues from production taxes for all the municipalities in my sample. Hence, I take this last set of results as suggestive evidence for criminal going after the increasing revenues of the avocado business rather than going after farmers.

[25] For instance, Uribe-Castro (2021) suggests that the development of the coffee sector in Colombia reduced the supply of skill workers and slowed down structural transformation, affecting the manufacturing activity in the long-run.

8 Conclusion

I study the increase in avocado production and its unintended consequences on conflict intensity in Mexico. My empirical strategy estimates the impact of avocado production exploiting a combination of cross-sectional variation from a suitability index for growing avocados, and time variation coming from the increased demand for the fruit in the United States. My analysis goes beyond estimating the effects of a resource boom on conflict intensity. Mexico hosts a large number of criminal organizations that fight over the monopoly of looting and territorial control. I not only estimate the impact of the resource boom on violence but additionally study whether competition between criminal organizations and cooperation between criminal organizations and local farmers drives the changes in conflict.

I first show strong evidence of a positive relation between the areas more suited to absorb the demand for avocados and the homicide rate. The effect is strongest on deaths of agricultural workers. I show that contrary to standard beliefs, cartels are not driving this change in the homicide rate. I find that historical cartel presence, which proxies for the degree of cooperation among cartels, fully attenuates the increase in the homicide rate of agricultural workers; on the other hand, presence of two or more cartels –competition– shifts homicides from agricultural workers to individuals who are involved with cartels. I interpret this result as suggestive evidence in favor of the hypothesis that cartels fight over profitable territories.

My results shed light on the role of criminal organization to explain the benefits of increasing production of a high-value export crop. However, they should be taken with caution, as I cannot suggest that allowing criminal organizations to rule will reduce the number of homicides. Moreover, the increasing number of small cartels seems to be causing the majority of the deaths. Notice, I show contemporary effects of the effects of avocado production on conflict. Further research is needed to better understand whether in the long-run production of high-value export crops, such as avocados, could benefit the local economy and whether it is possible to terminate with small cartels, for instance, by adopting the production of avocados.

The extent of my analysis has some limitations. First, even though I find a positive relationship between cartel presence and avocado production, I cannot discern the exact nature of cartels' direct involvement in avocado production; however, there is anecdotal evidence of this phenomenon (Miller, 2020; Piccato, 2022). Second, this study does not address the possibility of cartels using avocado production as a means to smuggle drugs into the United States nor does it address the possibility of using avocados to launder money. For instance, Michoacan is Mexico's most important producer of avocados, its second most important producer of limes, and it is additionally heavily involved in the production and trafficking of illegal drugs. It has a unique location along the Pacific Coast where the port of Lazaro is the most important commercial gateway with Asia (Althaus and Dudley, 2014). Limited data availability prevents me from exploring those avenues of cartel interference in avocado production. Finally, because my analysis is limited to the effects of avocado production on conflict; I also cannot speak to the environmental effects of avocado production. Further research is needed to determine the impact of avocado production on land use as deforestation has been linked with both avocado production and criminal organization activity.

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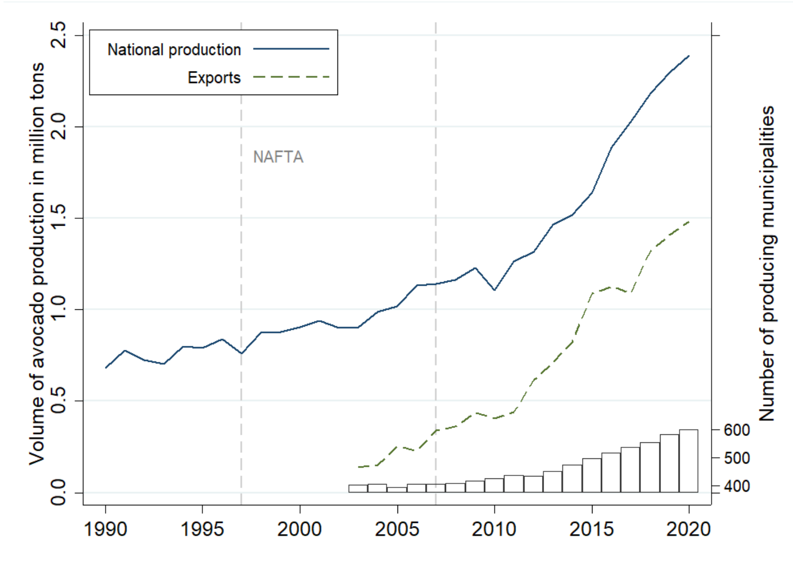
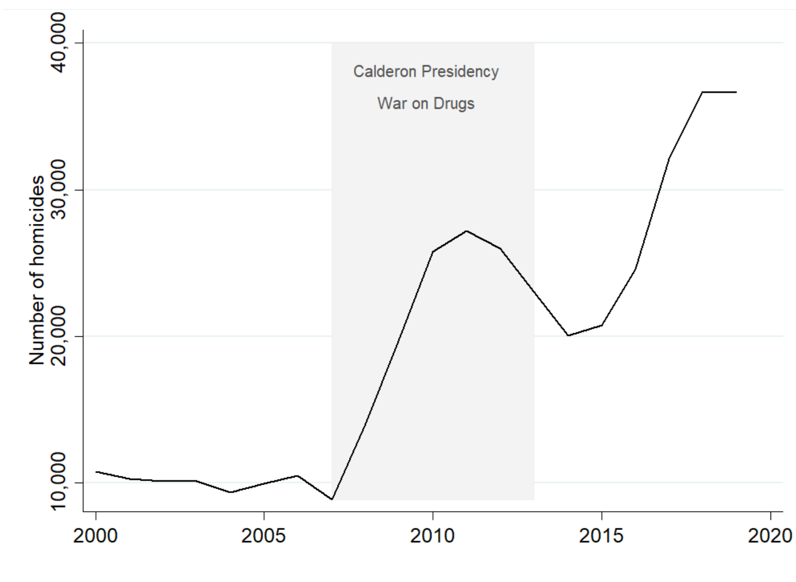
Figure 1: Avocado production and NAFTA



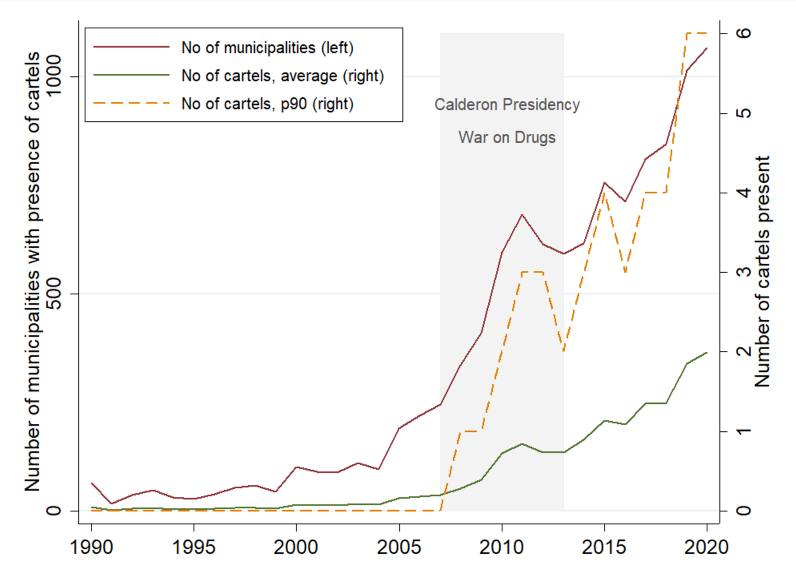
Note: Own calculation based on information from SIAP and SIAVI. Total production of avocado and exports are in million of tons. Dashed vertical lines represent changes in NAFTA regulation. Avocados were first exported in 1997 under restriction of destiny and season. In 2007, restrictions are lifted and avocados are allowed to be exported to all the states and all year long in United States. Bars summarizes the number of avocado producing municipalities (right axis). Municipal level data starts in 2003.

Figure 2: The War on Drugs and Homicides



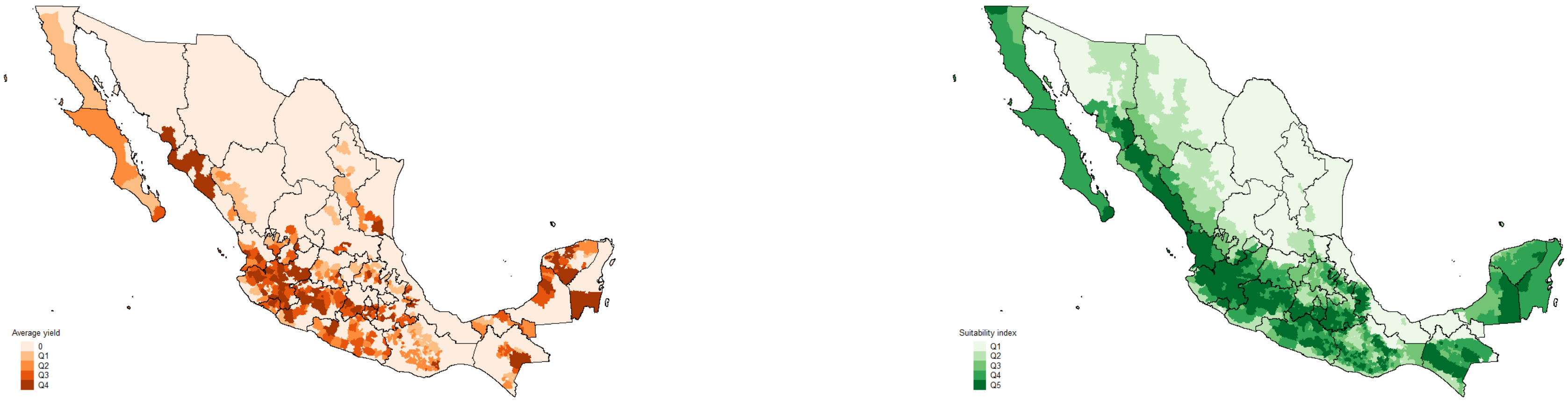
Note: Own calculation based on information from INEGI. Shaded area represent the years of Calderon presidency. The Mexican War on Drugs started in 2007, the first year of his presidency. Bars summarizes the number of municipalities with at least one homicide registered in that year (right axis).

Figure 3: Cartel presence and expansion over time



Note: Own calculation based on information from the Mapping Criminal Organizations project (Sobrino, 2020). The total number of municipalities with presence of cartels reported in the left vertical axis. The average number of cartels present in the municipalities reported in the right vertical axis. The dashed line represent the 90th percentile of the average presence of cartels.

Figure 4: Avocado presence, yield, and suitability index

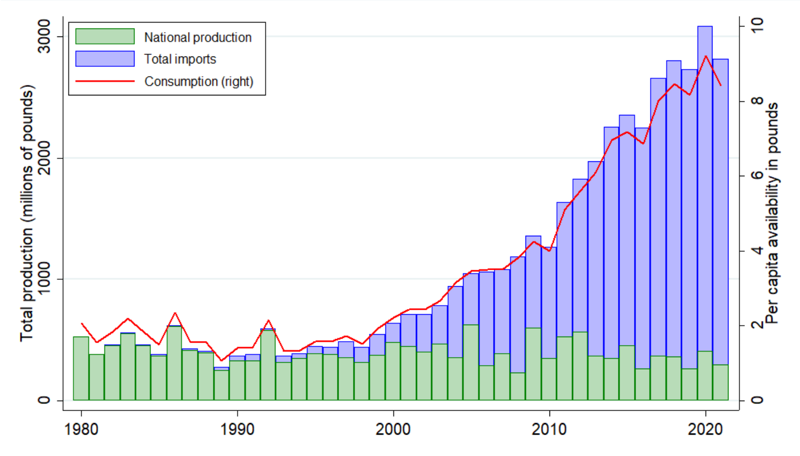


(a) Average yield

(b) Avocado suitability index

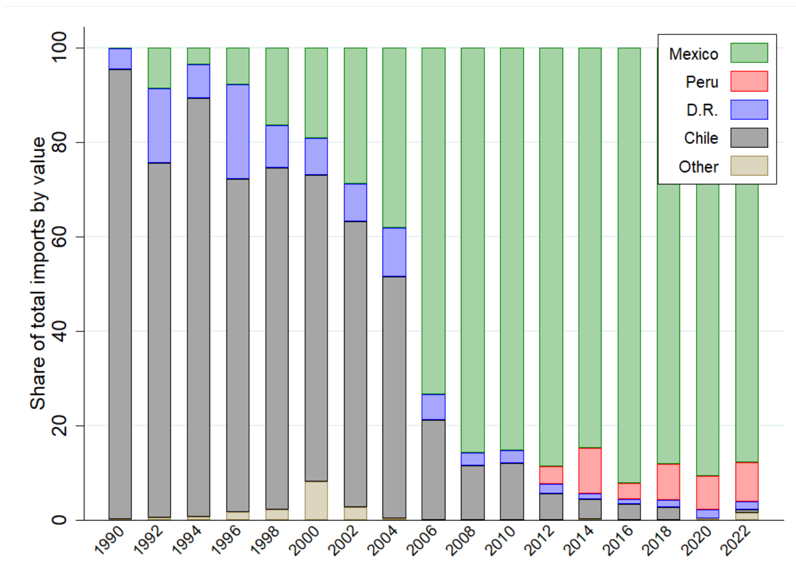
Note: Information from SIAP. Panel a presents the average yield of avocado in each one of the municipalities. Municipalities that do not produce avocado are label as "0" and producing municipalities are summarized by quantiles. Panel b presents the avocado suitability index as defined by equation 3 and it is summarized by quintiles. Darker shades of green indicates a higher suitability to grow avocado.

Figure 5: Production, imports, and availability of avocados in the United States



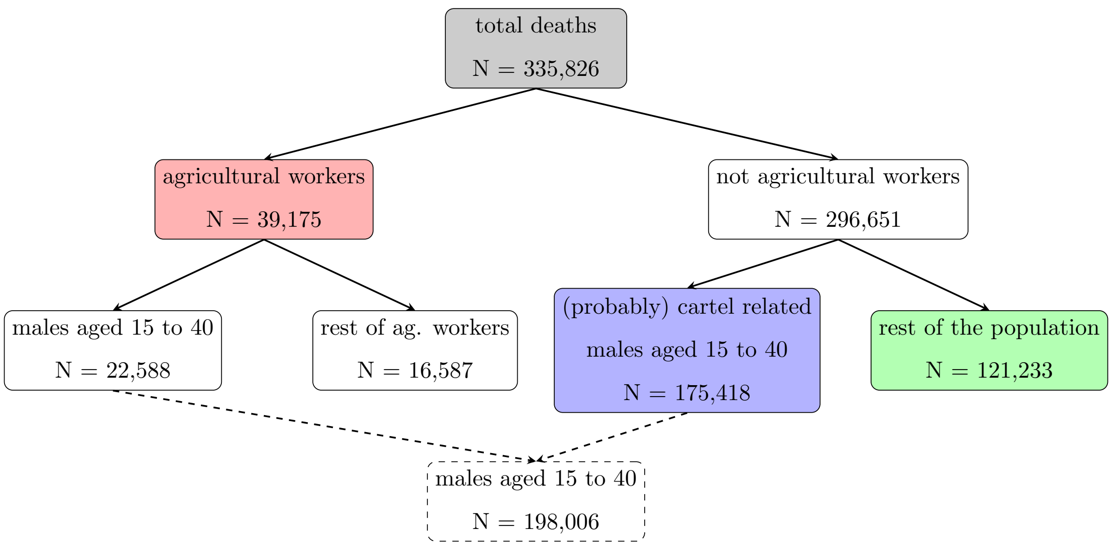
Note: Source: United States Department of Agriculture Economic Research Service (USDA-ERS). The green area represents the United States avocado production and the blue area represents the imported avocado production. Red line represents the availability per capita in pounds of avocado as proxy for demand for avocado in the United States.

Figure 6: Avocado imports in the United States by country of origin



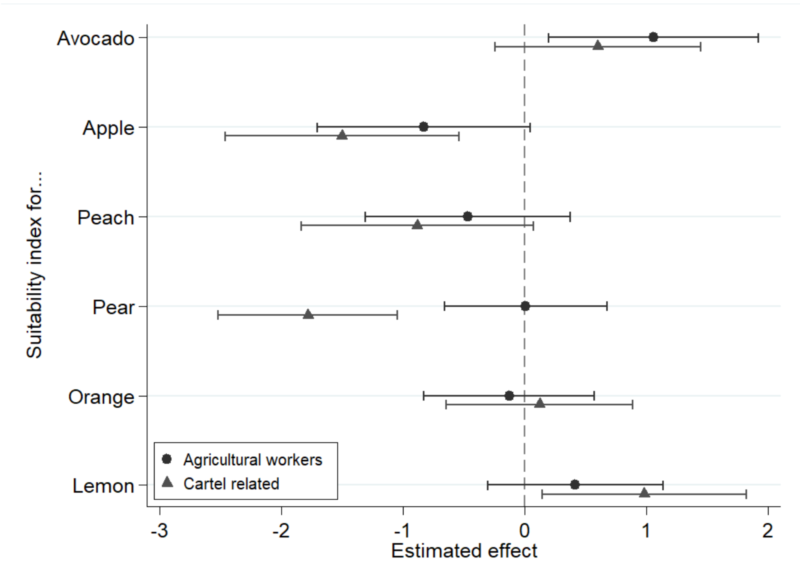
Note: Source: United States Department of Agriculture Foreign Agricultural Service's Global Agricultural Trade System (USDA-GAT). The share of imports is calculated for every year based on the value of total imports of each country.

Figure 7: Classification of homicides based on occupation, sex, and age



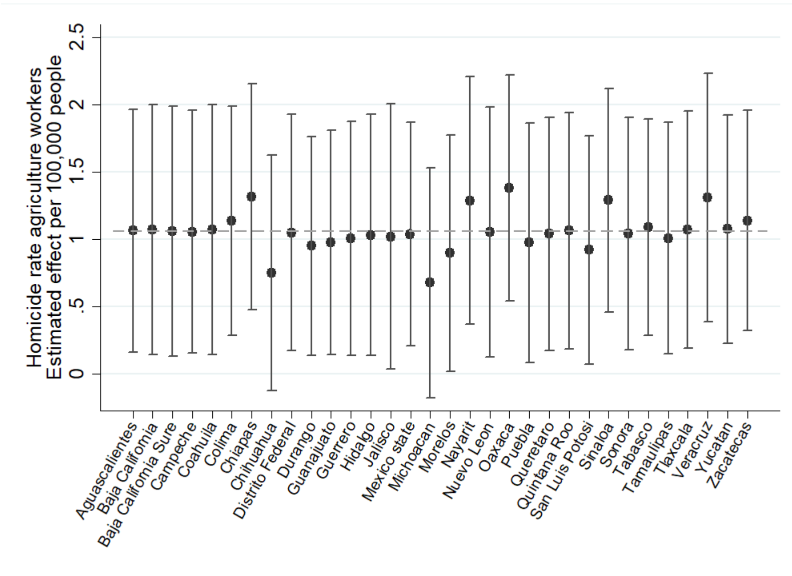
Note: The classification of homicides uses the information reported on the death certificates on occupation, age and gender. The first group consist of any agricultural worker, presented in red. The second group represent the probably cartel related deaths that consist of not agricultural workers, males between the ages of 15 to 40, presented in blue. The third group is the rest of the population, presented in green. The dashed group below represent all males between the ages of 15 to 40, regardless of their occupation.

Figure 8: Placebo test using suitability for growing other crops

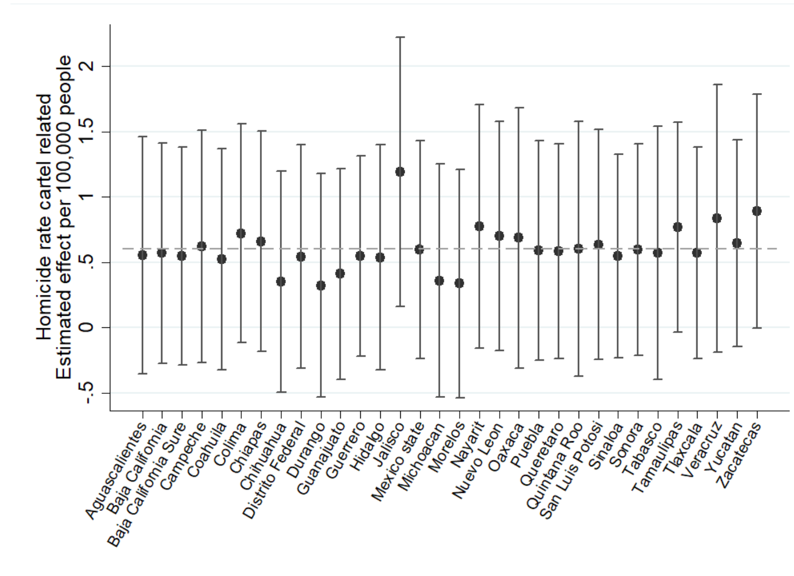


Note: Markers correspond to estimates of equation 1 where the explanatory variable is the interaction between the availability of avocados in the United States and a suitability index for growing the crop listed in the vertical axis. All estimates include municipality and time fixed effects, and control for the interaction of the municipal-level controls and year fixed effects. Block bootstrap standard error at the municipal level and 200 replications. Horizontal lines represent 95% confidence intervals .

Figure 9: Effects of potential to absorb avocado on homicide rate excluding each of the 32 states from the sample



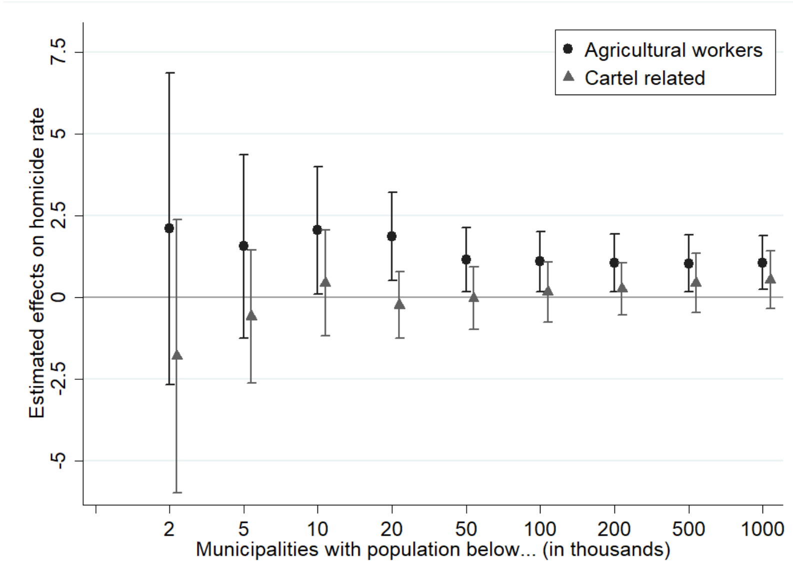
(a) Agricultural workers



(b) Cartel related

Note: Markers correspond to estimates coefficient of equation 1 excluding from the sample each one of the Mexican departments at a time, as reported on the horizontal axis. In Panel 9a presents the estimates on the homicide rate for agricultural workers and in Panel 9b presents the estimates on the homicide rate for potentially cartel related, i.e., non-agricultural male workers between the ages of 15 to 40. All the estimates include municipality and time fixed effects, and further control for the interaction of the municipal-level controls and year fixed effects. Horizontal dashed line reports the estimate using the full sample as reported in Table 4. Block bootstrap standard error at the municipal level and 200 replications. Vertical lines represent 95% confidence intervals.

Figure 10: Heterogeneous effects by population size



Note: Markers correspond to estimates of equation 1 using municipalities whose population in 2010 is below the value reported in the horizontal axis. All estimates include municipality and time fixed effects, and control for the interaction of the municipal-level controls and year fixed effects. Block bootstrap standard error at the municipal level and 200 replications. Vertical lines represent 95% confidence intervals .

Table 1: Descriptive statistics of the main variables and other panel variables

		(1)	(2)	(3)
	Years	Obs.	Mean	Std. Dev.
Panel A: Avocado suitability index and production				
Suitability x (log) US demand	2003 - 2019	41,752	0.478	0.37
Suitability x (log) US demand (standardized)	2003 - 2019	41,752	-0.000	1.000
Cultivated area (ha)	2003 - 2019	41,752	63.33	751.54
Quantity produced (thousand tons)	2003 - 2019	41,752	0.582	7.650
Value of production (million 2019 MXN)	2003 - 2019	41,752	10.122	144.05
Avocado incomde per capita (2019 MXN)	2003 - 2019	41,752	351.16	4,428.2
Panel B: Homicide data				
Homicide rate	2005 - 2019	36,794	16.96	34.0
Homicide rate agriculture workers	2005 - 2019	36,794	5.78	17.7
Homicide rate cartel related	2005 - 2019	36,794	6.00	15.2
Homicide rate rest of population	2005 - 2019	36,794	5.18	14.0
Panel C: Conflict data				
Homicide rate	2011 - 2019	22,104	26.25	41.5
Kidnapping rate	2011 - 2019	22,104	0.70	3.07
Extortion rate	2011 - 2019	22,104	2.26	6.19
Threat rate	2011 - 2019	22,104	28.17	58.7
Panel D: Cartel presence				
Presence of any DTO	2003 - 2019	41,684	0.212	0.4085
Presence of any traditional DTO	2003 - 2019	41,684	0.198	0.3987
Presence of any non-traditional DTO	2003 - 2019	41,684	0.096	0.2943
Total number of DTOs	2003 - 2019	41,684	0.710	2.13
Total number of traditional DTOs	2003 - 2019	41,684	0.484	1.25
Total number of non-traditional DTOs	2003 - 2019	41,684	0.227	1.08
Panel E: Labor market outcomes				
Unemployment rate	2005 - 2019	16,614	0.033	0.0260
Income (2019 x1000 MXN)	2005 - 2019	16,614	3.94	1.853
Income per hour (2019 MXN)	2005 - 2019	16,614	24.0	11.00
Income of agriculture (2019 x1000 MXN)	2005 - 2019	15,803	2.54	2.523
Income per hour of agriculture (2019 MXN)	2005 - 2019	15,803	15.7	21.08
Panel F: Economic composition				
Employment in agriculture	2005 - 2019	16,614	0.278	0.2563
Employment in construction	2005 - 2019	16,614	0.081	0.0630
Employment in indsutry	2005 - 2019	16,614	0.146	0.1157
Employment in services	2005 - 2019	16,614	0.316	0.1695
Employment in commerce	2005 - 2019	16,614	0.165	0.0847
Panel G: Fiscal capacity				
Revenues from taxes	2003 - 2019	33,916	0.037	0.0549
Taxes from production taxes	2003 - 2019	13,737	0.070	0.1694
Revenue from production taxes	2003 - 2019	13,737	0.002	0.0066
Expenses from public investment	2003 - 2019	35,337	0.349	0.1771
Expenses from personal expenses	2003 - 2019	35,902	0.267	0.1230

Note: Crime rates reported per 100,000 people. Availability of the data is reported in the column "Years."

Table 2: Descriptive statistics of the cross-sectional variables

	(1) Obs.	(2) Mean	(3) Std. Dev.
Panel I: Geographic characteristics			
Suitability index	2,456	0.297	0.216
Altitude	2,456	1,301	821.7
Water availability	2,456	1,049	581.4
Soil index	2,456	3.94	2.55
Panel II: Control variables			
Population in 2000	2,443	39,903	119,428
Social gap index 2000	2,442	0.000	1.000
Gini coefficient 2000	2,453	0.461	0.069
Distance to municipal main area (in degrees)	2,452	1.034	0.718
Presence of cartels 1990-2001	2,452	0.094	0.292

Note: Panel I presents descriptive statistics of the avocado suitability index and the variables used to construct it. Panel II presents the control variables.

Table 3: Avocado suitability index

	(1)	(2)	(3)	(4)
	Avocado	Avocado		I.H.S.
VARIABLES	(logit)	(OLS)	Yield	Yield
Water availability	0.003***	0.000***	0.003***	0.001***
	(0.001)	(0.000)	(0.000)	(0.000)
Water availability squared	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Soil index	0.256***	0.042***	0.453***	0.133***
	(0.064)	(0.011)	(0.083)	(0.028)
Soil index squared	-0.027***	-0.004***	-0.041***	-0.012***
	(0.007)	(0.001)	(0.009)	(0.003)
Altitude	0.004***	0.001***	0.004***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
Altitude squared	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	2,392	2,456	2,456	2,456
R-squared		0.171	0.187	0.182
Physiographic regions controls	✓	✓	✓	✓
Pseudo or adjusted R-squared	0.163	0.163	0.180	0.175

Note: Columns report the estimates from equation 2. Outcome variable is reported in the column header. Inverses hyperbolic sine (I.H.S.) transformation used instead of the logarithm due to the presence of zeros. Block bootstrap standard error at the municipal level and 200 replications are reported in parentheses. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Table 4: Effects of potential to absorb demand for avocado on homicides

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Homicide rate								Avocado value	
			Agricultural	Agricultural	Cartel	Cartel	Rest of	Rest of	per capita	per capita
	Homicides	Homicides	worker	worker	related	related	population	population	(1st-stage)	(1st-stage)
	Panel A: reduce form									
Suitability × US demand	1.366	1.960	1.612	1.060	0.052	0.603	-0.297	0.297	1.326	1.397
	(0.929)	(0.918)**	(0.428)***	(0.452)**	(0.462)	(0.441)	(0.372)	(0.311)	(0.236)***	(0.258)***
	[1.578]	[1.124]*	[0.640]**	[0.550]*	[0.728]	[0.490]	[0.463]	[0.357]	[0.275]***	[0.278]***
	Panel B: 2SLS IV regression (second-stage)									
Avocado value per capita	1.030	1.404	1.215	0.759	0.039	0.432	-0.224	0.213		
	(0.732)	(0.712)**	(0.389)***	(0.336)**	(0.343)	(0.321)	(0.275)	(0.251)		
	[1.116]	[0.813]*	[0.471]***	[0.364]**	[0.545]	[0.358]	[0.365]	[0.267]		
Observations	36,794	36,529	36,794	36,529	36,794	36,529	36,794	36,529	36,794	36,529
Number of municipalities	2,456	2,438	2,456	2,438	2,456	2,438	2,456	2,438	2,456	2,438
Mean dep. var.	16.96	16.96	5.78	5.78	6.00	6.00	5.18	5.18	0.35	0.35
Kleibergen-Paap F-stat.									29.09	29.65
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls × Year Fe		✓		✓		✓		✓		✓

Note: Each column reports estimates of equation 1. Panel A presents the reduce form estimates. Panel B present the second stage estimates of a 2SLS. Potential to absorb demand for avocado variable is standardized. All columns include municipality and year fixed effects. Even columns further control for the interaction of the municipal-level controls and year fixed effects. Column header reports the dependent variable and the bottom panel reports its mean in the sample. All the outcomes are rates per 100,000 people. Cartel related makes reference to non-agricultural male workers between the ages of 15 and 40. Block bootstrap standard error at the municipal level and 200 replications are reported in parentheses. Conley (1999) standard errors clustered using a 500 Km radius are reported in square brackets. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Table 5: Potential to absorb demand for avocado and actual production of avocado

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	in levels								in logs (IHS)			
	Area cultivated	Area cultivated	Volume produced	Volume produced	Value produced	Value produced	Value per capita	Value per capita	Area cultivated	Volumme produced	Value produced	Value per capita
Suitability × log(US demand)	130.45***	132.17***	1.27***	1.29***	38.47***	39.28***	1,257.4***	1,319.5***	0.671***	0.198***	0.594***	0.955***
	(23.85)	(24.83)	(0.25)	(0.26)	(8.85)	(9.09)	(235.5)	(258.0)	(0.061)	(0.020)	(0.043)	(0.117)
Observations	41,752	41,446	41,752	41,446	41,752	41,446	41,752	41,446	41,446	41,446	41,446	7,701
Number of municipalities	2,456	2,438	2,456	2,438	2,456	2,438	2,456	2,438	2,438	2,438	2,438	688
Mean Dep. Var.	63.33	63.33	0.58	0.58	8.13	8.13	351.2	351.2	0.759	0.093	0.260	4.363
F-stat	26.11	27.20	22.86	24.26	18.02	18.51	26.49	26.97	125.29	96.53	195.54	62.05
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls × Year Fe		✓		✓		✓		✓	✓	✓	✓	✓

Note: Each column reports estimates of equation 1. Potential to absorb demand for avocado variable is standardized. All columns include municipality and year fixed effects. Column (9), (11), and even columns further control for the interaction of the municipal-level controls and year fixed effects. Column header reports the dependent variable. In Columns (1) to (8), the dependent variables are in levels, while in Columns (9) to (12), they are in logs using the Inversie Hyperbolic Sine (I.H.S.) transformation due to the presence of zeros. Block bootstrap standard error at the municipal level and 200 replications are reported in parentheses. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Table 6: Robustness to time-varying unobserved heterogeneity using rolling estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
				RFD	RFD	RTFD	RTFD
	FE	FD	TFD	(cons)	(nocons)	(cons)	(nocons)
Panel A: Homicide rate							
Suitability × US demand	1.960**	7.361***	13.822***	8.845*	7.948	14.728***	14.544**
	(0.932)	(2.377)	(4.685)	(4.734)	(4.860)	(4.757)	(4.913)
Panel B: Homicide rate for agricultural workers							
Suitability × US demand	1.060**	2.732**	5.073*	4.195	3.807	6.225**	5.870*
	(0.439)	(1.300)	(2.631)	(2.539)	(2.453)	(2.849)	(2.811)
Panel C: Homicide rate for potentially cartel related							
Suitability × US demand	0.603	1.187	1.767	0.551	0.053	0.168	0.200
	(0.433)	(1.209)	(2.389)	(1.627)	(1.781)	(1.652)	(1.909)
Panel D: Homicide rate for the rest of the population							
Suitability × US demand	0.297	3.442***	6.982***	3.279	3.164	7.845***	7.903***
	(0.345)	(1.182)	(2.379)	(2.119)	(2.053)	(2.168)	(2.078)

Note:Each column reports estimates of equation 1. Column headers report the estimator used: Fixed Effects (FE), First Difference (FD), Twice-First Difference (TFD), the Rolling First Difference (RFD), and the Rolling Twice-First Difference (RTFD) (Millimet and Bellemare, 2023). Columns (5) and (7) rolling estimates include a constant term. Columns (6) and (8) rolling estimates do not include a constant term. Potential to absorb demand for avocado variable is standardized in all specifications. All columns include municipality and year fixed effects. Dependent variable in Panel A is homicide rate; in Panel B is the homicide rate of agricultural workers; in Panel C is the homicide rate for individuals potentially cartel related; and in Panel D the homicide rate for the rest of the population. Block bootstrap standard error at the municipal level and 200 replications are reported in parentheses. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Table 7: Effects of potential to absorb demand for avocado on homicides of males between the ages of 15 to 40

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Agricultural worker	Agricultural worker	Ag. workers males 15-40	Ag. workers males 15-40	Ag. workers rest	Ag. workers rest	males 15-40	males 15-40	Cartel related	Cartel related
Suitability × log(US demand)	1.612***	1.060**	1.225***	0.735**	0.387	0.325	1.276**	1.339**	0.052	0.603
	(0.428)	(0.452)	(0.280)	(0.310)	(0.239)	(0.229)	(0.611)	(0.621)	(0.462)	(0.441)
Observations	36,794	36,529	36,794	36,529	36,794	36,529	36,794	36,529	36,794	36,529
Number of municipalities	2,456	2,438	2,456	2,438	2,456	2,438	2,456	2,438	2,456	2,438
Mean Dep. Var.	6.047	6.047	3.252	3.252	2.796	2.796	10.099	10.099	6.847	6.847
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls × Year Fe		✓		✓		✓		✓		✓

Note: Each column reports estimates of equation 1. Potential to absorb demand for avocado variable is standardized. All columns include municipality and year fixed effects. Even columns further control for the interaction of the municipal-level controls and year fixed effects. Column header reports the dependent variable and the bottom panel reports its mean in the sample. All the outcomes are rates per 100,000 people. Males individuals between the ages of 15 to 40 includes both agricultural and non-agricultural workers. Cartel related makes reference to non-agricultural male workers between the ages of 15 and 40. Block bootstrap standard error at the municipal level and 200 replications are reported in parentheses. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Table 8: Effects of potential to absorb demand for avocado on homicides of rural residents

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Rural Homicides	Rural Homicides	Ag. worker Rural	Ag. worker Rural	Cartel related Rural	Cartel related Rural	Rest of population Rural	Rest of population Rural
Suitability × log(US demand)	0.611	0.704	1.068***	0.712**	-0.291	0.005	-0.166	-0.013
	(0.598)	(0.562)	(0.354)	(0.357)	(0.303)	(0.242)	(0.272)	(0.231)
Observations	36,794	36,529	36,794	36,529	36,794	36,529	36,794	36,529
Number of municipalities	2,456	2,438	2,456	2,438	2,456	2,438	2,456	2,438
Mean Dep. Var.	9.116	9.116	4.301	4.301	2.422	2.422	2.393	2.393
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Controls × Year Fe		✓		✓		✓		✓

Note: Each column reports estimates of equation 1. Potential to absorb demand for avocado variable is standardized. All columns include municipality and year fixed effects. Even columns further control for the interaction of the municipal-level controls and year fixed effects. Column header reports the dependent variable and the bottom panel reports its mean in the sample. All the outcomes are rates per 100,000 people. Cartel related makes reference to non-agricultural male workers between the ages of 15 and 40. Block bootstrap standard error at the municipal level and 200 replications are reported in parentheses. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Table 9: Effects of potential to absorb demand for avocado on criminal activities

	(1) Homicides	(2) Homicides	(3) Threats	(4) Threats	(5) Extortions	(6) Extortions	(7) Kidnappings	(8) Kidnappings
Suitability × log(US demand)	5.791*	5.159*	-1.192	0.448	-1.644***	-1.333**	-0.214	-0.251
	(3.157)	(2.934)	(4.130)	(3.670)	(0.548)	(0.534)	(0.238)	(0.218)
Observations	22,104	21,942	22,104	21,942	22,104	21,942	22,104	21,942
Number of municipalities	2,456	2,438	2,456	2,438	2,456	2,438	2,456	2,438
Mean Dep. Var.	26.250	26.250	28.175	28.175	2.260	2.260	0.701	0.701
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Controls × Year Fe		✓		✓		✓		✓

Note: Each column reports estimates of equation 1. Potential to absorb demand for avocado variable is standardized. All columns include municipality and year fixed effects. Even columns further control for the interaction of the municipal-level controls and year fixed effects. Column header reports the dependent variable and the bottom panel reports its mean in the sample. All the outcomes are rates per 100,000 people. Block bootstrap standard error at the municipal level and 200 replications are reported in parentheses. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Table 10: Effects of potential to absorb demand for avocado on cartel presence

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Presence of cartels						Number of cartles					
	any	any	traditional	traditional	non-traditional	non-traditional	any	any	traditional	traditional	non-traditional	non-traditional
Suitability × log(US dmand)	0.067***	0.085***	0.061***	0.082***	0.043***	0.055***	0.307***	0.398***	0.186***	0.242***	0.122**	0.155***
	(0.013)	(0.012)	(0.013)	(0.012)	(0.012)	(0.011)	(0.092)	(0.088)	(0.044)	(0.038)	(0.058)	(0.059)
Observations	41,684	41,378	41,684	41,378	41,684	41,378	41,684	41,378	41,684	41,378	41,684	41,378
Number of municipalities	2,452	2,434	2,452	2,434	2,452	2,434	2,452	2,434	2,452	2,434	2,452	2,434
Mean Dep. Var.	0.212	0.212	0.198	0.198	0.096	0.096	0.710	0.710	0.484	0.484	0.227	0.227
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls × Year Fe		✓		✓		✓		✓		✓		✓

Note: Each column reports estimates of equation 1. Potential to absorb demand for avocado variable is standardized. All columns include municipality and year fixed effects. Even columns further control for the interaction of the municipal-level controls and year fixed effects. Column header reports the dependent variable and the bottom panel reports its mean in the sample. In Columns (1) to (3), the dependent variable is a dummy variable that indicates presence of any cartel, traditional, and non-traditional cartels only, respectively. In Columns (4) to (6), the dependent variable is the number of cartels present in the municipality, of traditional, and of non-traditional. Block bootstrap standard error at the municipal level and 200 replications are reported in parentheses. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Table 11: Heterogeneous effects on homicides by "contemporaneous" cartel presence

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Dep. var: Homicide rate agricultural workers						Dep. var: Homicide rate cartel related					
	any	any	traditional	traditional	non-traditional	non-traditional	any	any	traditional	traditional	non-traditional	non-traditional
Suitability × US demand	1.803***	1.201**	1.865***	1.259**	1.470***	0.943*	-0.161	0.867*	-0.048	0.941*	-0.802*	0.039
	(0.499)	(0.558)	(0.490)	(0.549)	(0.441)	(0.497)	(0.507)	(0.488)	(0.504)	(0.483)	(0.453)	(0.447)
Suitability × US demand × cartel (t-1)	-0.213	-0.148	-0.303	-0.224	0.268	0.221	0.227	-0.285	0.109	-0.388*	1.612***	1.044***
	(0.210)	(0.196)	(0.203)	(0.189)	(0.231)	(0.204)	(0.237)	(0.228)	(0.251)	(0.228)	(0.355)	(0.306)
Observations	36,734	36,469	36,734	36,469	36,734	36,469	36,734	36,469	36,734	36,469	36,734	36,469
Number of municipalities	2,452	2,434	2,452	2,434	2,452	2,434	2,452	2,434	2,452	2,434	2,452	2,434
Mean Dep. Var.	5.779	5.779	5.779	5.779	5.779	5.779	5.999	5.999	5.999	5.999	5.999	5.999
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls × Year Fe		✓		✓		✓		✓		✓		✓

Note: Each column reports estimates of equation 1. Potential to absorb demand for avocado variable is standardized. All columns include municipality and year fixed effects. Even columns further control for the interaction of the municipal-level controls and year fixed effects. Column header reports the dependent variable, the type of cartel, and the bottom panel reports its mean in the sample. In Columns (1) to (6) the dependent variable is the homicide rate of agricultural workers, and in Columns (7) to (12) is the homicide rate of potentially cartel related, i.e., non-agricultural male workers between the ages of 15 and 40. All the outcomes are rates per 100,000 people. $cartel_{t-1}$ is a dummy variable that takes value of 1 if there was a cartel present in the previous years. Block bootstrap standard error at the municipal level and 200 replications are reported in parentheses. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Table 12: Heterogeneous effects on homicides by cartel presence in the 1990s

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Homicides	Homicides	Agricultural worker	Agricultural worker	Cartel related	Cartel related	Rest of population	Rest of population
Suitability × US demand	0.647	2.132**	1.907***	1.477***	-0.655	0.354	-0.606	0.301
	(0.951)	(1.019)	(0.428)	(0.502)	(0.450)	(0.440)	(0.375)	(0.401)
Suitability × US demand × cartel 90s	5.174**	-0.998	-2.086***	-2.621***	4.901***	1.545	2.359***	0.077
	(2.052)	(1.986)	(0.767)	(0.888)	(1.104)	(1.056)	(0.570)	(0.540)
Observations	36,734	36,469	36,734	36,469	36,734	36,469	36,734	36,469
Number of municipalities	2,452	2,434	2,452	2,434	2,452	2,434	2,452	2,434
Mean Dep. Var.	16.956	16.956	5.779	5.779	5.999	5.999	5.177	5.177
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Controls × Year Fe		✓		✓		✓		✓

Note: Each column reports estimates of equation 1. Potential to absorb demand for avocado variable is standardized. All columns include municipality and year fixed effects. Even columns further control for the interaction of the municipal-level controls and year fixed effects. Column header reports the dependent variable and the bottom panel reports its mean in the sample. All the outcomes are rates per 100,000 people. *cartel 90s* is a dummy variable that takes value of 1 if there was a cartel present at least one year between 1990 and 2000. Block bootstrap standard error at the municipal level and 200 replications are reported in parentheses. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Table 13: Heterogeneous effects on homicides by cartel presence of multiple cartels in the previous period

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Dep. var: Homicide rate agricultural workers						Dep. var: Homicide rate cartel related					
	any	any	traditional	traditional	non-traditional	non-traditional	any	any	traditional	traditional	non-traditional	non-traditional
Suitability × US demand	1.604***	1.000*	1.774***	1.159**	1.427***	0.916*	-0.549	0.509	-0.376	0.626	-0.917**	-0.091
	(0.495)	(0.519)	(0.483)	(0.500)	(0.458)	(0.477)	(0.507)	(0.476)	(0.503)	(0.467)	(0.458)	(0.437)
Suitability × US demand × one cartel_t − 1	0.120	0.158	-0.170	-0.091	0.356	0.316	0.418*	0.003	0.284	-0.109	1.013***	0.596**
	(0.269)	(0.279)	(0.243)	(0.249)	(0.295)	(0.290)	(0.233)	(0.219)	(0.225)	(0.207)	(0.295)	(0.295)
Suitability × US demand × two+ cartel_t − 1	-0.034	0.028	-0.202	-0.120	0.438	0.284	0.761***	0.138	0.611**	0.017	3.216***	2.412***
	(0.239)	(0.287)	(0.238)	(0.296)	(0.353)	(0.375)	(0.278)	(0.276)	(0.295)	(0.281)	(0.582)	(0.596)
Observations	36,794	36,529	36,794	36,529	36,794	36,529	36,794	36,529	36,794	36,529	36,794	36,529
Number of municipalities												
Mean Dep. Var.	5.779	5.779	5.779	5.779	5.779	5.779	5.999	5.999	5.999	5.999	5.999	5.999
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls × Year Fe		✓		✓		✓		✓		✓		✓

Note: Each column reports estimates of equation 1. Potential to absorb demand for avocado variable is standardized. All columns include municipality and year fixed effects. Even columns further control for the interaction of the municipal-level controls and year fixed effects. Column header reports the dependent variable, the type of cartel, and the bottom panel reports its mean in the sample. In Columns (1) to (6) the dependent variable is the homicide rate of agricultural workers, and in Columns (7) to (12) is the homicide rate of potentially cartel related, i.e., non-agricultural male workers between the ages of 15 and 40. All the outcomes are rates per 100,000 people. $onecartel_{t-1}$ is a dummy variable that takes value of 1 if there was only one cartel present in the previous years, and $two + cartel_{t-1}$ is a dummy that takes the value of 1 if there were two or more cartels present in the previous year. Block bootstrap standard error at the municipal level and 200 replications are reported in parentheses. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Table 14: Effects of potential to absorb demand for avocado on labor market outcomes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
							Ag. workers			
	Unemployment	Unemployment	(log) income	(log) income	income x hr	income x hr	(log) income	(log) income	income x hr	income x hr
Suitability × log(US demand)	0.003***	0.004***	0.023	0.026	0.824	0.745	0.035	0.018	1.806**	1.506
	(0.001)	(0.001)	(0.024)	(0.022)	(0.582)	(0.540)	(0.033)	(0.032)	(0.858)	(1.014)
Observations	16,614	16,541	16,611	16,538	16,614	16,541	15,449	15,379	15,803	15,730
Number of municipalities	1,793	1,779	1,793	1,779	1,793	1,779	1,783	1,769	1,788	1,774
Mean Dep. Var.	0.033	0.033	1.232	1.234	23.956	23.984	0.585	0.588	15.699	15.734
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls × Year Fe		✓		✓		✓		✓		✓

Note: Each column reports estimates of equation 1. Potential to absorb demand for avocado variable is standardized. All columns include municipality and year fixed effects. Even columns further control for the interaction of the municipal-level controls and year fixed effects. Column header reports the dependent variable and the bottom panel reports its mean in the sample. Block bootstrap standard error at the municipal level and 200 replications are reported in parentheses. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Table 15: Effects of potential to absorb demand for avocado on labor composition

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Primary		Secondary				Tertiary			
	Agriculture	Agriculture	Construction	Construction	Manufacturing	Manufacturing	Services	Services	Commerce	Commerce
Suitability × log(US demand)	0.018	0.017	0.001	-0.000	-0.017***	-0.017***	-0.001	0.000	-0.001	-0.000
	(0.012)	(0.012)	(0.003)	(0.003)	(0.004)	(0.005)	(0.008)	(0.009)	(0.004)	(0.004)
Observations	16,614	16,541	16,614	16,541	16,614	16,541	16,614	16,541	16,614	16,541
Number of municipalities	1,793	1,779	1,793	1,779	1,793	1,779	1,793	1,779	1,793	1,779
Mean Dep. Var.	0.278	0.278	0.081	0.081	0.146	0.147	0.316	0.316	0.165	0.165
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls × Year Fe		✓		✓		✓		✓		✓

Note: Each column reports estimates of equation 1. Potential to absorb demand for avocado variable is standardized. All columns include municipality and year fixed effects. Even columns further control for the interaction of the municipal-level controls and year fixed effects. Column header reports the dependent variable and the bottom panel reports its mean in the sample. Block bootstrap standard error at the municipal level and 200 replications are reported in parentheses. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Table 16: Effects of potential to absorb demand for avocado on fiscal capacity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Revenues from taxes	Revenues from taxes	Revenues from prod. taxes	Revenues from prod. taxes	Taxes from prod. taxes	Taxes from prod. taxes	Expenses from public inv.	Expenses from public inv.	Expenses from personal exp.	Expenses from personal exp.
Suitability × log(US demand)	0.003***	0.002*	0.001*	0.001*	0.005	0.004	-0.005	-0.005	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.006)	(0.006)	(0.005)	(0.005)	(0.003)	(0.004)
Observations	33,916	33,704	13,737	13,649	13,737	13,649	35,337	35,092	35,902	35,649
Number of municipalities	2,419	2,401	1,922	1,908	1,922	1,908	2,440	2,422	2,440	2,422
Mean Dep. Var.	0.037	0.037	0.002	0.002	0.070	0.070	0.349	0.349	0.267	0.267
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls × Year Fe		✓		✓		✓		✓		✓

Note: Each column reports estimates of equation 1. Potential to absorb demand for avocado variable is standardized. All columns include municipality and year fixed effects. Even columns further control for the interaction of the municipal-level controls and year fixed effects. Column header reports the dependent variable and the bottom panel reports its mean in the sample. Block bootstrap standard error at the municipal level and 200 replications are reported in parentheses. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Online Appendix

A Conceptual framework model

I guide my conceptual framework uses the model on Hirshleifer (1991) and extended by Hirshleifer (2001) and Dixit (2004). There are similar models for producer and grabbers that also depend on other characteristics, such as the quality of institutions (Mehlum et al., 2006)

The simplest economy of the model is a one-period static model with two participants, $i = 1, 2$, say a farmer and a cartel.[26] Each participant is endowed with one unit of resource, which may be her own labor time or some other productive asset. Each participant can allocate the resource into production effort Y_i or conflict effort by either defending her output against the other's aggression Z_i or in attacking the other's output X_i. Note, conflict here is the mere failure to cooperate, therefore the decision to allocate the resource to production entails the possibility of trade. The resource constraint is:

$$Y_i + Z_i + X_i \leq 1$$

.

Each participant seek to maximize its expected payoff generated by the two sides' productive efforts. The resource allocated to production yield an output $(Y_i)^\alpha$ where the parameter α is positive and indicates the return to scale in production. The probability of keeping each participant own share of production depend upon the conflict efforts given by

$$p_i = \frac{Z_i^\beta}{Z_i^\beta + \theta X_j^\beta}$$

,

where β is a parameter between 0 and 1 that represents the returns to scale to conflict, and the parameter θ measures the efficacy of the offense relative to the other participant j defense. The expected payoff, or aggregated income, is:

$$\Pi_i = Y_i^\alpha \frac{Z_i^\beta}{Z_i^\beta + \theta X_j^\beta} + Y_j^\alpha \frac{\theta X_i^\beta}{Z_j^\beta + \theta X_i^\beta}$$

[26] One could think on two groups of participants whose actions are coordinated, such that the two participants could also be a representative member of their respective group.

,

for $i = 1, 2$ and $j \neq i$. This specification involves two assumptions: (i) income is jointly produced and falls into a common pool or resources available for capture, and (ii) conflict activity does not damage the resource or the production process. Note, if neither participant decide to attack, each participant payoff will solely depend on her own production.

To solve the equilibrium of this game, once could assume a symmetric outcome where the two participants choose identical allocations (Dixit, 2004). However, this assumption would not be real in the present case of a farmer and a cartel as farmers might not be interested in getting the production of the cartel or attacking them. Nonetheless, farmers could also adop self-defense groups or vigilantism as a mean of protecting themselves from organized crime (Asfura-Heim and Espach, 2013; Rios, 2013). Furthermore, the setting implies a simultaneous decision, whereas it is possible that the farmer react to the cartel's decision (or vice versa). This type of asymmetric solutions are studied by Hirshleifer (2001), including the possibility of the Stackelberg situation were there is a "leader" that chooses first the conflict intensity.

To simplify the analysis, I assume a symmetric equilibrium. Under this assumption, the Nash equilibrium of this gae can be found after some algebra. The equilibrium quantitites are:

$$Y_i = \frac{\alpha(1+\theta)}{\alpha(1+\theta) + 2\beta\theta}$$

$$Z_i = X_i = \frac{\beta\theta}{\alpha(1+\theta) + 2\beta\theta}$$

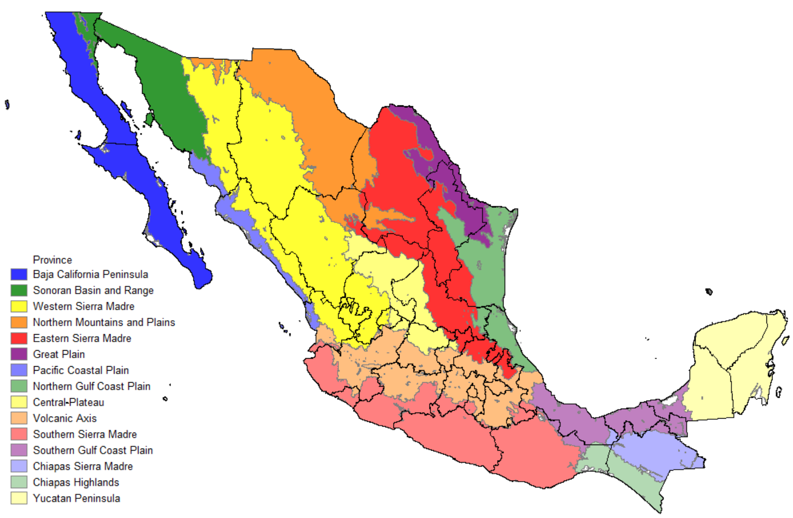
This is equilibirum is not economically efficient, as the ideal equilibrium would be for neither player to spend anything on agreesion (X_i). However, this possibility would not be a Nash equilibrium as deviations would give the participant a higher payoff. Similar to the prisoner's dilemma, if I decide to spend zero on defense, then the other participant could take all mmy production by spending just some units on her resource on attacking.

Intuitevely, the equilibrium allocation of the prductive use of resource (Y_i) changes for each participant positively if there is an improvement in the technology of production (α), as the use of one unit in production, would yield more output. On the other hand, if the returns to fighting (β) improves, the productive use of resources would decrease as now fighting give more returns. Similarly, if the technology of fighting favors defense over offense (θ), then fighting will yield a higher payoff.

B Physiographic regions in Mexico

Mexico is divided into 15 physiographic regions based on geological characteristics, presented in Figure B.1. These regions do not overlap with political or administrative divisions, as shown in the black line divisions. Note, there are states that belong to only one physiographic region, while there are others that have more than one. For instance, the states of Quintana Roo and Yucatán, located in the eastern-most part of the country, belong only to the region of Yucatan Peninsula; while the states Nuevo León and Tamaulipas in the north-eastern part of the country, belong to three physiographic regions: Great Plains, Eastern Sierra Madre, and Northern Gulf Coastal Plain.

Figure B.1: Mexico's physiographic regions and state division



Source: data from INEGI. The figure represents the 15 pysiographic regions of Mexico. Black lines represent the states.

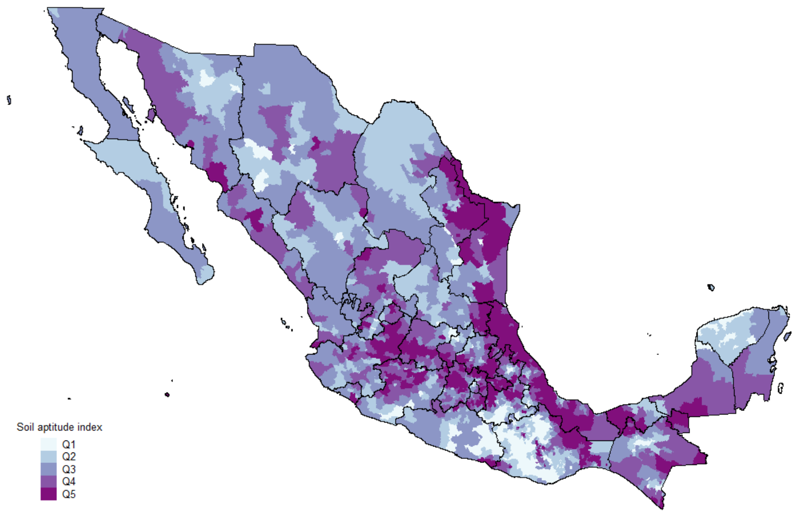
Soil quality for growing agricultural crops is reported in Figure B.2. This index summarizes the areas the are more apt to use for agricultural purposes.

C Classification of homicides

C.1 Classification of death certificates as homicides

I use data of the death certificates from the National Department of Health Information (SINAIS) to classify deaths as homicides. This classification follows the list of causes and corresponding ICD-10 codes from the World Health Organization (WHO). Homicides are classified under codes X85 to

Figure B.2: Soil index for agricultural crops



Source: data from INEGI. Soil index for growing agricultural crops. Darker shades reporesent soils that are more apt to use for agricultural purposes.

Y09, that correspond to Assault (homicide), and its sequalae, under code Y871. These correspond to 209 different causes, however the majority correspond to "assault by other and unspecified firearm discharge, street and highway." The top 10 causes represents almost 80% of the total cases and the top 2 causes represents around 92% of them. Table C.1 presents the code and description of the top 20 cases, the count and the percentage with respect to the total number of cases.

Table C.1: Summary and description of top 20 causes of homicides

Rank	Code	Description	Count	Percent (%)	Cum. (%)
1	X954	Assault by other and unspecified firearm discharge, street and highway	131,430	39.14	39.14
2	X959	Assault by other and unspecified firearm discharge, unspecified place	25,094	7.47	46.61
3	X950	Assault by other and unspecified firearm discharge, home	22,285	6.64	53.24
4	X994	Assault by sharp object, street and highway	20,425	6.08	59.33
5	X958	Assault by other and unspecified firearm discharge, other specified places	18,795	5.6	64.92
6	Y094	Assault by unspecified means, street and highway	16,818	5.01	69.93
7	X914	Assault by hanging, strangulation and suffocation, street and highway	8,547	2.55	72.48
8	X990	Assault by sharp object, home	8,531	2.54	75.02
9	Y099	Assault by unspecified means, unspecified place	7,817	2.33	77.34
10	X957	Assault by other and unspecified firearm discharge, farm	6,814	2.03	79.37
11	X999	Assault by sharp object, unspecified place	6,400	1.91	81.28
12	X955	Assault by other and unspecified firearm discharge, trade and service area	6,289	1.87	83.15
13	X910	Assault by hanging, strangulation and suffocation, home	5,517	1.64	84.79
14	Y098	Assault by unspecified means, other specified places	4,926	1.47	86.26
15	Y090	Assault by unspecified means, home	4,779	1.42	87.68
16	X998	Assault by sharp object, other specified places	4,634	1.38	89.06
17	X919	Assault by hanging, strangulation and suffocation, unspecified place	3,969	1.18	90.25
18	X918	Assault by hanging, strangulation and suffocation, other specified places	2,773	0.83	91.07
19	Y004	Assault by blunt object, street and highway	2,257	0.67	91.74
20	X934	Assault by handgun discharge, street and highway	1,751	0.52	92.27
		All other causes of homicides	25,975	7.73	100
		Total number of homicides	335,826	100.0	

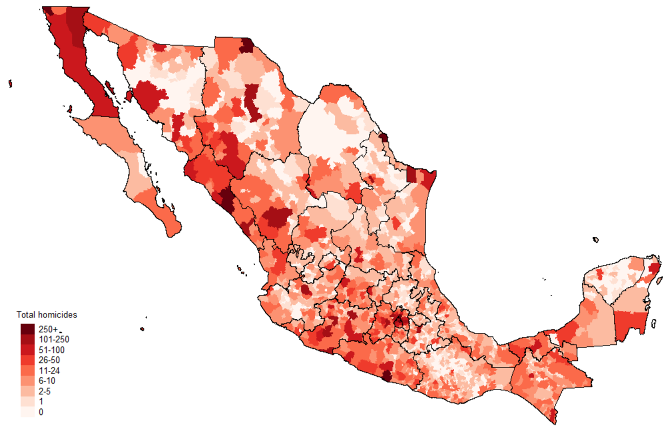
Using this information, I calculate the homicide rate for each year both as a unique value and as an average of the homicide rate for each municipality. Table C.2 presents these estimates. Note, there is a lot of variation in homicide rate. For instance, cities like Ciudad Juarez exhibited homicide rates of 216 victims per 100,000 inhabitants in 2010, a casualty rate that is comparable to that of war zones (Rios, 2013, p. 139). Figure C.1 presents the spatial distribution of the total number of homicides. Former president Felipe Calderon started the Mexican war on drugs at the end of 2006. President Enrique Peña Nieto, his successor, attempted to curve down the increase in conflict by sending national forces to take control back of the territories rather than relying on local police (Althaus and Dudley, 2014).

Table C.2: Homicide rate by year

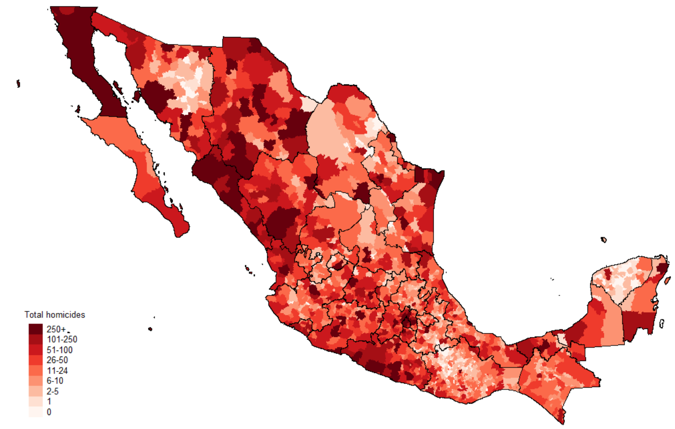
	National		Municipal data	
Year	Homicides	rate	Mean rate	S.D.
2,000	10,737	8.52	11.05	24.06
2,001	10,285	8.16	10.30	23.08
2,002	10,088	8.01	10.28	25.25
2,003	10,087	8.00	10.17	23.19
2,004	9,329	7.40	10.03	26.41
2,005	9,921	7.87	9.63	24.56
2,006	10,452	8.29	10.56	26.32
2,007	8,867	7.04	9.77	26.43
2,008	14,006	11.11	12.03	30.40
2,009	19,803	15.71	15.89	51.11
2,010	25,757	20.44	22.30	78.82
2,011	27,213	21.60	22.41	68.00
2,012	25,967	20.61	23.25	62.07
2,013	23,063	18.30	20.48	42.89
2,014	20,010	15.88	17.35	34.84
2,015	20,762	16.48	17.31	37.36
2,016	24,559	19.49	17.11	29.09
2,017	32,079	25.46	21.03	36.43
2,018	36,685	29.11	22.59	46.43
2,019	36,661	29.09	22.84	40.63
2,020	36,773	29.18	22.27	51.93

Note: Own calculation using homicide data coming from SINAIS. Rates are per 100,000 people and are calculated using population in 2020 census. National homicide rate is calculated dividing the number of homicides in the population. Homicide rate at the municipal level is calculated using the number of cases in each municipality and averaging them by year.

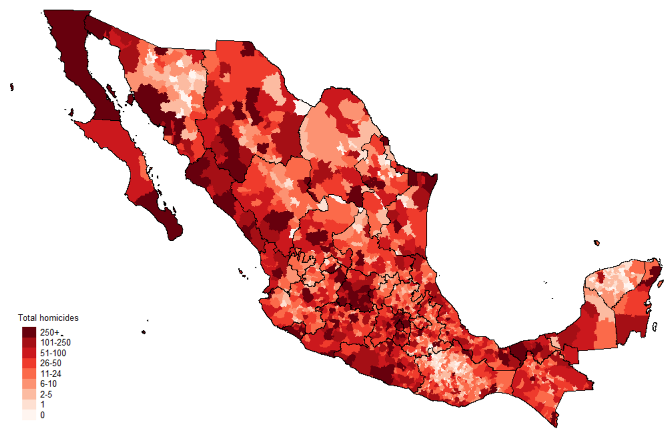
Figure C.1: Evolution and distribution of homicides in Mexico



(a) 2005 to 2006



(b) 2007 to 2012

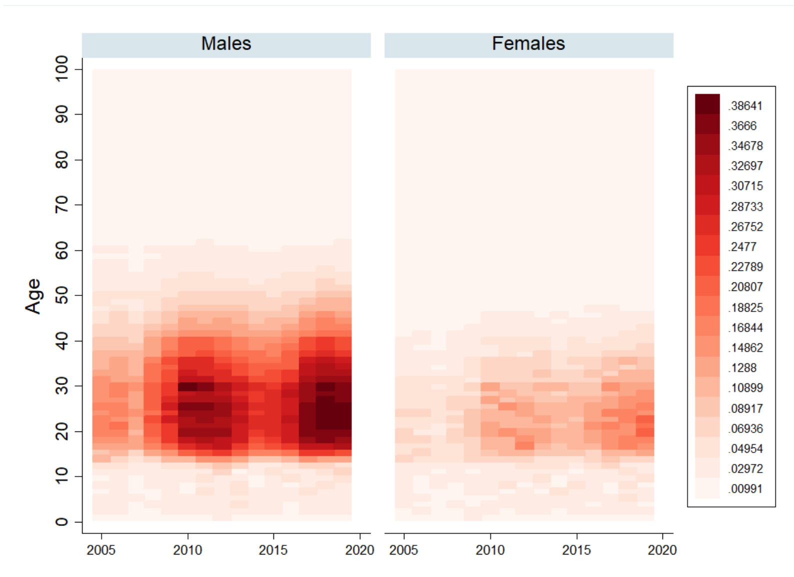


(c) 2013 to 2019

Note: Own calculation using homicide data coming from SINAIS. Total number of homicides from 2005 to 2006 presented in Panel a; from 2007 to 2012 in Panel b; and from 20013 to 2019 in Panel c. Former president Felipe Calderon started the Mexican war on drugs started at the end of 2006 and his presidential term ended at the end of 2012.

My classification of homicides based on victims' characteristics rely on the assumption that victims that belong to the group of males aged between 15 and 40 are more likely to join criminal activities. I provide some evidence in Figure C.2 that shows that the majority of homicides are concentrated in males between the ages 15 and 40 consistenly for every year in my sample. Similarly, Figure C.3 shows that males aged between 15 and 40 was the group of the population more affected by the Mexican war on drugs.

Figure C.2: Distribution of homicides by age and gender over time

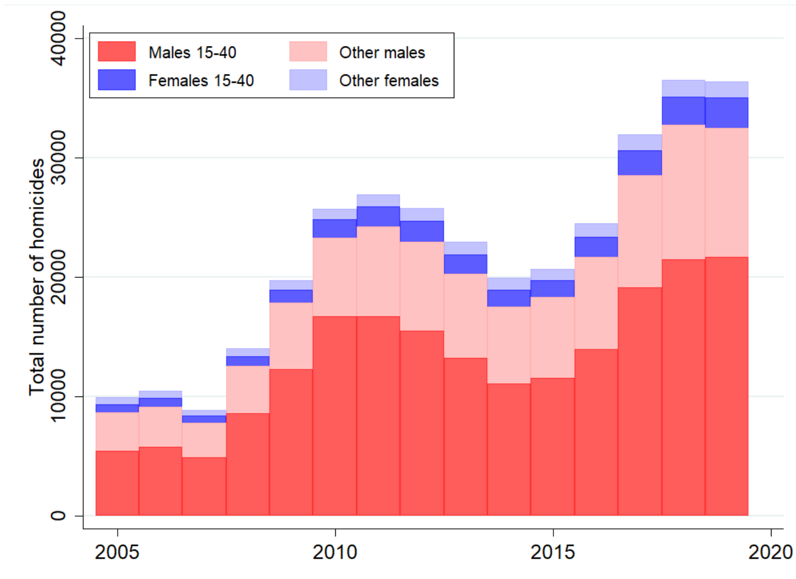


Note: Own calculation using homicide data coming from SINAIS.

I have two sources of information about homicides: death certificates and police reports. Although the two figures are not the same in terms of total number of cases, they follow each other closely. For instance, the total number of deaths between 2011 and 2019, the period in common, is 2,207 coming from death certificates and 2,392 coming from police reports. This is not an uncommon phenomena between sources of information, as described by Atuesta and Pérez-Dávila (2017). Figure C.4 presents in the left panel the observations at the municipality-year level. The majority follow the 45 degree line, suggesting that they are the same. However, there is more noise when comparing their respective homicide rates (Figure C.4, right panel).

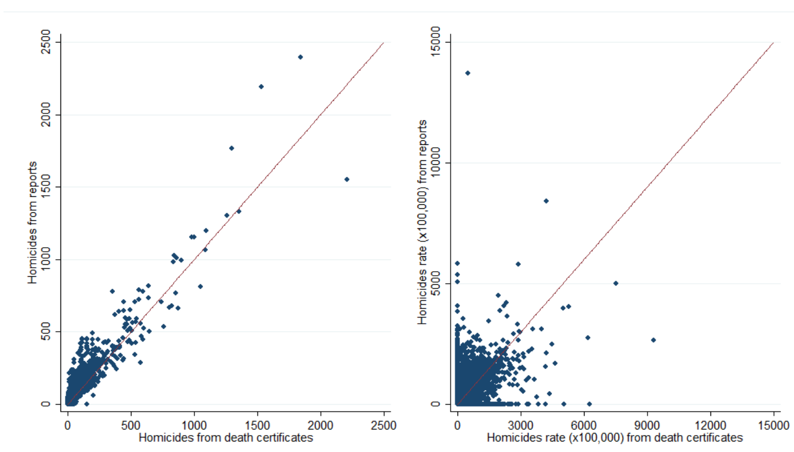
A possible explanation for this discrepancy is that the are not registered in the same place of occurrence. Indeed, death certificates include three different locations: occurrence, registration, and residence. The place of registration is where the death certificate is generated, the place of

Figure C.3: Distribution of homicides by age groups and gender over time



Note: Own calculation using homicide data coming from SINAIS. "Males 15-40" and "Females 15-40" count the number of male victims between the ages of 15 and 40, and the number of females between the same age group, respectively. "Other males" and "Other females" count the number of male victims outside the age group of 15 to 40, and the number of female victims outside that age group, respectively.

Figure C.4: Comparison of homicide rates between sources of information



Note: Panel on the left compares the homicides from the two sources of information. Panel on the right presents the comparison in homicide rates.

occurrence is where the death happened, and the place of residence is where the individual deceased had her usual residence. These three locations may differ one from the other if the location where the death happened is not the same as the usual location of the residence. There is almost perfect correlation between the place of residence and occurrence, yet these two are 70 percent correlated with the municipality where the death was registered.

D Additional robustness

D.1 Alternative explanatory variables

In this section I epxlore differences in my measure of potential produciton. In particular, my measure is defined as:

$$Z_{mt} = \hat{S}_m \times \log(D_t)$$

First, I present alternative measures for the share part $\hat{S}_m$, then I present alternative measures for the shift part $\log(D_t)$, with and without the logarithm.

D.1.1 Alternative sources of cross-sectional variation

One alternative to my measure of areas suited to absorb the demand for avocado is to use different measures of the avocado suitability index (see Section 4.1.1) or to use the area devoted to avocado production to the initial period (Ferri, 2022; Goldsmith-Pinkham et al., 2020; Jaeger et al., 2018). Specifically, I use the share of agricultural area devoted to avocado production in 2003, the first year I observe information at this level. To ease comparisons, I interact the new measures with the (log of the) US demand and standardize them to have zero mean and unit variance. My estimates are consistent across these different measures, in terms of sign and significance, including the share of area devoted to avocado production in 2003 (Table D.1). Differences in point estimates come from the variability of the suitability indices as they are no longer bounded between zero and one, implying that a one-standard-deviation increase does not represent the same changes in the potential production.

Table D.1: Robustness using different measures of the avocado suitability index

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Dependent variable: Homicide rate agricultural workers									
Suitability × log(US demand)	1.612***	1.060**								
	(0.428)	(0.452)								
Suitability (OLS)× log(US demand)			2.151***	1.538***						
			(0.393)	(0.441)						
Suitability (yield)× log(US demand)					2.293***	1.779***				
					(0.409)	(0.418)				
Suitability (IHS yield)× log(US demand)							2.322***	1.744***		
							(0.393)	(0.423)		
Share avocados 2003× log(US demand)									0.538**	0.449
									(0.246)	(0.274)
Observations	36,794	36,529	36,794	36,529	36,794	36,529	36,794	36,529	36,794	36,529
Number of municipalities	2,456	2,438	2,456	2,438	2,456	2,438	2,456	2,438	2,456	2,438
Mean Dep. Var.	5.779	5.779	5.779	5.779	5.779	5.779	5.779	5.779	5.779	5.779
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls × Year Fe		✓		✓		✓		✓		✓

Note: Each column reports estimates of equation 1. Potential to absorb demand for avocado variable is standardized in all specifications. All columns include municipality and year fixed effects. Even columns further control for the interaction of the municipal-level controls and year fixed effects. The dependent variable is the homicide rate of agricultural workers per 100,000 people and the bottom panel reports its mean in the sample. Suitability measures 1 to 4 come from the predictions of Table 3, in the same order. Share of avocados in 2003 is the share of cultivated land devoted to avocados in 2003. Block bootstrap standard error using clusters at the municipal level and 200 replications are reported parentheses. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

D.1.2 Alternative sources of temporal variation

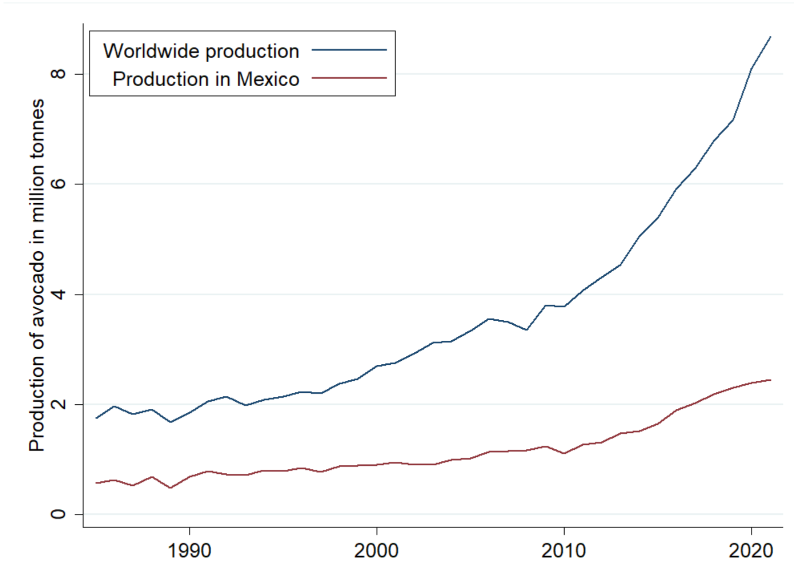
The shock factor in my measure of the areas suited to absorb the demand for avocado relies on the United States demand for the crop, which I argue is exogenous to the conflict intensity (see Section 3.2). Alternatively, I proxy the exogenous demand shock for Mexican avocados using the growth of its industry in Mexico (Figure D.1), to avoid the endogeneity coming from the idiosyncratic industry-location component (Adão et al., 2019; Borusyak et al., 2021; Goldsmith-Pinkham et al., 2020); the global production of avocados excluding Mexico;[27] or using the interest in avocados by looking at the number of searches on Google Trends to proxy for demand (Estancona and Tiscornia, 2022). Specifically, I use the number of searches for "Avocado Toast" in the United States and for "Avocado" in the world (Figure D.2).

I re-estimate equation 1 using these measures interacted with the avocado suitability index, and present my results in Table D.2. My estimates are consistent across specifications in terms of sign and significance. Similar to the alternative suitability indices, the difference in point significance comes from the difference in volume of avocado production. Similarly, I create measures of potential production interacting the avocado suitability index and the measures of demand shock in levels, i.e., without taking the log. My results are robust these alternative explanatory variables (Table D.3) although, the point estimates are smaller compared to their version in logs. The only exception is the measure Google searches for "avocado toast" in the United States, which is not statistically different from zero. A possible explanation for this result is that I am restricting the search to one use of avocados, yet it might not be the more demanded.[28]

[27]I assume that the interest in avocados, measured as growth in production, follows a similar trend to the interest in Mexican avocados. Using the global production excluding Mexico mimics the work of Dube and Vargas (2013) who examine changes in prices of coffee in Colombia by inspecting changes in the three other leading coffee exporting nations. Figure D.1 presents the world and the Mexican avocado production, and resonates with Huang et al. (2023), who discusses the increasing global demand for avocado consumption.

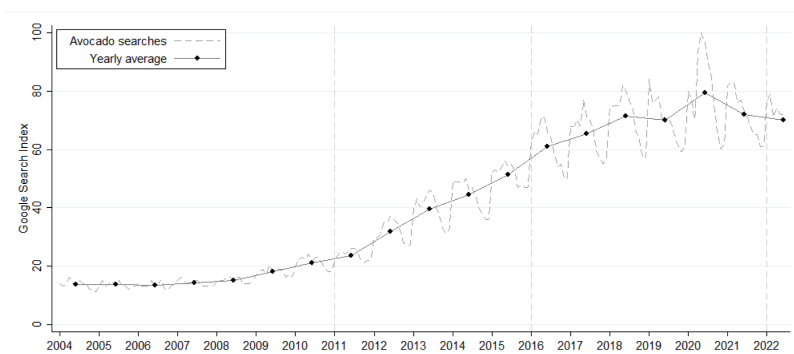
[28]For instance, guacamole is consumed extensively during Super Bowl Sunday and *Cinco de Mayo*, the Mexican holiday that is more widely celebrated in the United States. Avocado consumption these days is 100 million pounds and 90 million pounds of avocado respectively (Miller, 2020). Other uses include avocado oil, smoothies, or as part of salads.

Figure D.1: Production of avocado in the world and in Mexico



Note: Source: the Food and Agriculture Organization (FAO). Blue line represents the total avocado production in the world. Red line represents the production of avocado in Mexico. The difference between the two is the production of avocado in the world without Mexico.

Figure D.2: Global importance of avocado using Google search trends



Note: Source: Google Trends. The Google Search Index (vertical axis) is a normalized index of interest respect to the highest point (value 100). It is a measure of relative importance. Dashed vertical lines represents improvements applied on location and data collection. Dots represent the average value of the index calculated in a calendar year.

Table D.2: Robustness using different measures of growth in the demand for avocado

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Dependent variable: Homicide rate agricultural workers									
Suitability × log(US demand)	1.612***	1.060**								
	(0.428)	(0.452)								
Suitability × log(Mexican exports)			8.859***	5.623**						
			(2.661)	(2.771)						
Suitability × log(World production)					14.309***	8.524*				
					(4.273)	(4.458)				
Suitability × log(Google avocado)							1.565***	1.035**		
							(0.459)	(0.483)		
Suitability × log(Google toast in US)									0.574***	0.297*
									(0.160)	(0.168)
Observations	36,794	36,529	36,794	36,529	36,794	36,529	36,794	36,529	34,344	34,095
Number of municipalities	2,456	2,438	2,456	2,438	2,456	2,438	2,456	2,438	2,456	2,438
Mean Dep. Var.	5.779	5.779	5.779	5.779	5.779	5.779	5.779	5.779	5.779	5.779
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls × Year Fe		✓		✓		✓		✓		✓

Note: Each column reports estimates of equation 1. Potential to absorb demand for avocado variable is standardized in all specifications. All columns include municipality and year fixed effects. Even columns further control for the interaction of the municipal-level controls and year fixed effects. The dependent variable is the homicide rate of agricultural workers per 100,000 people and the bottom panel reports its mean in the sample. The explanatory variable is the interaction between avocado suitability index and the log of the measure of demand for avocado. US demand is the demand for avocado in the United States; Mexican exports is the total production of avocado for export; world production is the total production of avocados in the world excluding that of Mexico; google avocado is the google search index for the word avocado in the world; and google toast in US is the google search index for the word avocado toast in the US. Block bootstrap standard error using clusters at the municipal level and 200 replications are reported parentheses. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Table D.3: Robustness using different measures of demand for avocado

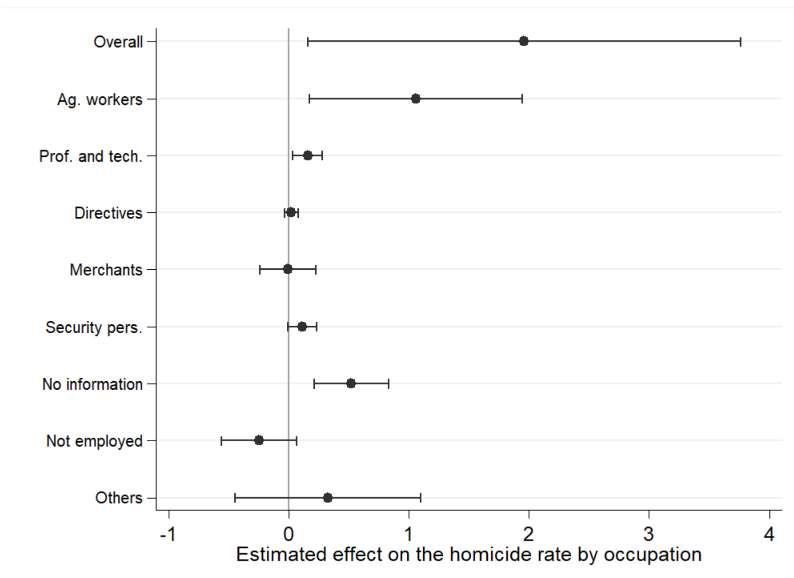
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Dependent variable: Homicide rate agricultural workers									
Suitability × US demand	0.855***	0.576**								
	(0.282)	(0.292)								
Suitability × Mexican exports			4.608***	2.974*						
			(1.736)	(1.749)						
Suitability × World production					7.434***	4.520				
					(2.754)	(2.812)				
Suitability × Google avocado							0.825***	0.553*		
							(0.303)	(0.310)		
Suitability × Google toast in US									0.313***	0.161
									(0.117)	(0.122)
Observations	36,794	36,529	36,794	36,529	36,794	36,529	36,794	36,529	34,344	34,095
Number of municipalities	2,456	2,438	2,456	2,438	2,456	2,438	2,456	2,438	2,456	2,438
Mean Dep. Var.	5.779	5.779	5.779	5.779	5.779	5.779	5.779	5.779	5.779	5.779
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls × Year Fe		✓		✓		✓		✓		✓

Note: Each column reports estimates of equation 1. Potential to absorb demand for avocado variable is standardized in all specifications. All columns include municipality and year fixed effects. Even columns further control for the interaction of the municipal-level controls and year fixed effects. The dependent variable is the homicide rate of agricultural workers per 100,000 people and the bottom panel reports its mean in the sample. The explanatory variable is the interaction between avocado suitability index and the measure of demand for avocado. US demand is the demand for avocado in the United States; Mexican exports is the total production of avocado for export; world production is the total production of avocados in the world excluding that of Mexico; google avocado is the google search index for the word avocado in the world; and google toast in US is the google search index for the word avocado toast in the US. Block bootstrap standard error using clusters at the municipal level and 200 replications are reported parentheses. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

D.2 Homicides by occupation reported

Using information from death certificates, I classify the homicides into three groups: agricultural workers, (possibly) cartel related, and rest of the population. In this section, I use the information on the victims' occupation to show that the change in the overall homicide rate is explained by changes in the homicide rate of agricultural workers and not of other type of workers. Specifically, I show for professional and technicians, directives, merchants, security personnel, and for those that there is no information specified and for those that are not working. Given a change in the classification of occupations in 2013, these were the only groups that are comparable. I put together the rest of the occupations and show them in a category of its own. Figure D.3 presents the estimates for these groups and Table D.4 reports them.

Figure D.3: Effects on homicide rate by victims' occupation



Note: Markers correspond to estimates of equation 1 where the explanatory variable are the homicide rates for the occupations reported in the vertical axis. All estimates include municipality and time fixed effects, and the interaction of the municipal-level controls and year fixed effects. Block bootstrap standard error using clusters at the municipal level and 200 replications. Horizontal lines represent 95% confidence intervals.

Table D.4: Effects on homicide rate by victims' occupation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		Homicide rate by occupation							
		Agricultural	Professional			Security	Without	Not	
	Homicides	workers	& technicians	Directives	Merchants	personnel	information	employed	other
Suitability × log(US demand)	1.960**	1.060**	0.159***	0.025	-0.003	0.112*	0.524***	-0.247	0.329
	(0.918)	(0.452)	(0.062)	(0.029)	(0.118)	(0.061)	(0.157)	(0.160)	(0.394)
Observations	36,529	36,529	36,529	36,529	36,529	36,529	36,529	36,529	36,529
Number of municipalities	2,438	2,438	2,438	2,438	2,438	2,438	2,438	2,438	2,438
Mean Dep. Var.	16.927	5.758	0.425	0.083	1.187	0.439	1.118	2.056	5.862
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls × Year Fe	✓	✓	✓	✓	✓	✓	✓	✓	✓

Note: Each column reports estimates of equation 1. Potential to absorb demand for avocado variable is standardized. All columns include municipality and year fixed effects, and the interaction of the municipal-level controls and year fixed effects. Column header reports the occupation and the bottom panel reports its mean in the sample. All the outcomes are rates per 100,000 people. Block bootstrap standard error using clusters at the municipal level and 200 replications are reported parentheses. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

D.3 Alternative populations of study

To rule out the role of municipalities with very small municipalities or big cities, I exclude from my sample municipalities above the 95th and below the 5th percentile. Table D.5 reports these estimates and show that they are robust to this exclusion. In addition, I show in Table D.6 that my results are robust to excluding the municipalities whose number of homicides is above the 99th percentile, to account for potential outliers in the reports.

Table D.5: Effects of potential to absorb demand for avocado on homicides excluding small and big municipalities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Homicides	Homicides	Agricultural worker	Agricultural worker	Cartel related	Cartel related	Rest of population	Rest of population
Suitability × log(US demand)	0.707	1.361	1.418***	0.889*	-0.241	0.314	-0.470	0.158
	(0.911)	(1.011)	(0.429)	(0.475)	(0.434)	(0.432)	(0.338)	(0.354)
Observations	33,141	32,876	33,141	32,876	33,141	32,876	33,141	32,876
Number of municipalities	2,210	2,192	2,210	2,192	2,210	2,192	2,210	2,192
Mean Dep. Var.	16.951	16.919	5.950	5.928	5.887	5.883	5.113	5.107
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Controls × Year Fe		✓		✓		✓		✓

Note: Each column reports estimates of equation 1. Potential to absorb demand for avocado variable is standardized. All columns include municipality and year fixed effects. Even columns further control for the interaction of the municipal-level controls and year fixed effects. Column header reports the dependent variable and the bottom panel reports its mean in the sample. All the outcomes are rates per 100,000 people. Cartel related makes reference to non-agricultural male workers between the ages of 15 and 40. Municipalities below the 5th percentile and above the 95th percentile of the population are excluded. Block bootstrap standard error using clusters at the municipal level and 200 replications are reported parentheses. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Table D.6: Effects of potential to absorb demand for avocado on homicides excluding potential outliers in levels

	(1) Homicides	(2) Homicides	(3) Agricultural worker	(4) Agricultural worker	(5) Cartel related	(6) Cartel related	(7) Rest of population	(8) Rest of population
Suitability × log(US demand)	0.885	1.593*	1.462***	0.977**	-0.271	0.352	-0.379	0.235
	(0.894)	(0.916)	(0.342)	(0.409)	(0.434)	(0.426)	(0.359)	(0.356)
Observations	36,425	36,160	36,392	36,127	36,425	36,160	36,423	36,158
Number of municipalities	2,452	2,434	2,455	2,437	2,452	2,434	2,452	2,434
Mean Dep. Var.	16.576	16.545	5.423	5.398	5.736	5.731	5.050	5.044
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Controls × Year Fe		✓		✓		✓		✓

Note: Each column reports estimates of equation 1. Potential to absorb demand for avocado variable is standardized. All columns include municipality and year fixed effects. Even columns further control for the interaction of the municipal-level controls and year fixed effects. Column header reports the dependent variable and the bottom panel reports its mean in the sample. All the outcomes are rates per 100,000 people. Observations in the top 1st percentile of the outcome in levels are excluded. Cartel related makes reference to non-agricultural male workers between the ages of 15 and 40. Block bootstrap standard error using clusters at the municipal level and 200 replications are reported parentheses. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

E Additional results

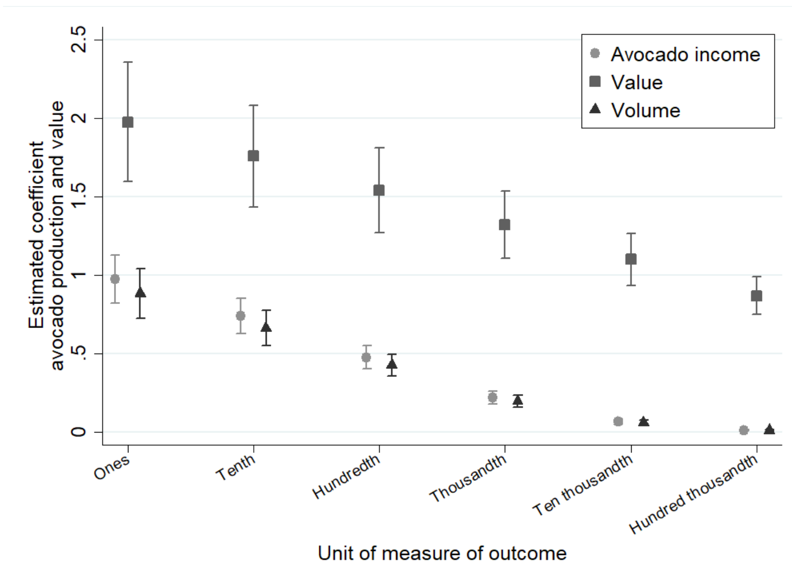
E.1 Sensitivity to functional form of avocado production

Table 5 presents in the last 4 columns the estimates on avocado production taking the inverse hyperbolic sine (I.H.S.), as opposed to taking the natural log given the presence of zeros. However, the I.H.S. transformation yields different estimations depending on the units of measure of the outcome. In particular, the transformation applied to large units for the outcome variable, say production in millions, will yield a distribution that will resemble to a discrete variable, as the I.H.S. transformation separates the zeros from the positive values. On the other hand, small units for the outcome will yield a continuous variable where the is no separation between the zeros and other values and whose interpretation is closer to a continuous variable (see McKenzie (2023) for a detailed discussion). Figure E.1 replicate the estimates of the last four columns of Table 5 and show that they are not sensitive to the unit of measure. Notice, values to the left of the horizontal axis resemble a discrete variable and captures the extensive margin; while values to the right resemble a continuous variable and captures the intensive margin.

E.2 Additional results on the role of competition and cooperation

Tables E.1 and E.2 present, respectively, the heterogeneous effects by presence of cartels in the previous period and by presence of multiple cartels in the previous period using as outcomes the overall homicide rate and the homicide rate of the rest of the population.

Figure E.1: Robustness to functional form of actual production



Note: Markers correspond to estimates of equation 1 using as dependent variable the inverse hyperbolic sine (IHS) of the avocado income per capita (circles), the value of avocado production (squares), and the volume of avocado production (triangles), divided by the unit reported in the horizontal axis. All estimates include municipality and time fixed effects, and further control for the interaction of the municipal-level controls and year fixed effects. Vertical lines represent 95% confidence intervals.

Table E.1: Heterogeneous effects on homicides by cartel presence in the previous period

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Dep. var: Overall homicide rate						Dep. var: rest of the population					
	any	any	traditional	traditional	non-traditional	non-traditional	any	any	traditional	traditional	non-traditional	non-traditional
Suitability × US demand	1.333	2.694**	1.568	2.853**	-0.085	1.003	-0.308	0.626	-0.249	0.652	-0.753**	0.021
	(1.087)	(1.170)	(1.074)	(1.153)	(0.936)	(1.004)	(0.431)	(0.472)	(0.426)	(0.458)	(0.370)	(0.411)
Suitability × US demand × cartel_t − 1	0.056	-0.766	-0.219	-0.996**	2.799***	1.809***	0.042	-0.333*	-0.025	-0.384**	0.920***	0.544***
	(0.498)	(0.476)	(0.503)	(0.470)	(0.662)	(0.570)	(0.196)	(0.192)	(0.195)	(0.186)	(0.209)	(0.197)
Observations	36,734	36,469	36,734	36,469	36,734	36,469	36,734	36,469	36,734	36,469	36,734	36,469
Number of municipalities	2,452	2,434	2,452	2,434	2,452	2,434	2,452	2,434	2,452	2,434	2,452	2,434
Mean Dep. Var.	16.956	16.956	16.956	16.956	16.956	16.956	5.177	5.177	5.177	5.177	5.177	5.177
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls × Year Fe		✓		✓		✓		✓		✓		✓

Note: Each column reports estimates of equation 1. Potential to absorb demand for avocado variable is standardized. All columns include municipality and year fixed effects. Even columns further control for the interaction of the municipal-level controls and year fixed effects. Column header reports the dependent variable, the type of cartel, and the bottom panel reports its mean in the sample. In Columns (1) to (6) the dependent variable is the overall homicide rate in the municipality, and in Columns (7) to (12) is the homicide rate of of the population that is not agricultural worker nor potentially cartel related, i.e., non-agricultural male workers between the ages of 15 and 40. All the outcomes are rates per 100,000 people. $cartel_{t-1}$ is a dummy variable that takes value of 1 if there was a cartel present in the previous years. Block bootstrap standard error using clusters at the municipal level and 200 replications are reported parentheses. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.

Table E.2: Heterogeneous effects on homicides by cartel presence of multiple cartels in the previous period

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Dep. var: Overall homicide rate						Dep. var: rest of the population					
	any	any	traditional	traditional	non-traditional	non-traditional	any	any	traditional	traditional	non-traditional	non-traditional
Suitability × US demand	0.541	1.945*	0.981	2.282**	-0.207	0.894	-0.549	0.509	-0.376	0.626	-0.917**	-0.091
	(1.027)	(1.000)	(1.022)	(0.980)	(0.922)	(0.917)	(0.507)	(0.476)	(0.503)	(0.467)	(0.458)	(0.437)
Suitability × US demand × one cartel_$t-1$	0.564	-0.083	0.092	-0.493	1.751***	0.988	0.418*	0.003	0.284	-0.109	1.013***	0.596**
	(0.560)	(0.523)	(0.537)	(0.522)	(0.628)	(0.604)	(0.233)	(0.219)	(0.225)	(0.207)	(0.295)	(0.295)
Suitability × US demand × two+ cartel_$t-1$	1.049*	0.055	0.630	-0.296	5.107***	3.623***	0.761***	0.138	0.611**	0.017	3.216***	2.412***
	(0.571)	(0.586)	(0.583)	(0.571)	(1.065)	(1.129)	(0.278)	(0.276)	(0.295)	(0.281)	(0.582)	(0.596)
Observations	36,794	36,529	36,794	36,529	36,794	36,529	36,794	36,529	36,794	36,529	36,794	36,529
Number of municipalities												
Mean Dep. Var.	16.956	16.956	16.956	16.956	16.956	16.956	5.999	5.999	5.999	5.999	5.999	5.999
Municipality FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Controls × Year Fe		✓		✓		✓		✓		✓		✓

Note: Each column reports estimates of equation 1. Potential to absorb demand for avocado variable is standardized. All columns include municipality and year fixed effects. Even columns further control for the interaction of the municipal-level controls and year fixed effects. Column header reports the dependent variable, the type of cartel, and the bottom panel reports its mean in the sample. In Columns (1) to (6) the dependent variable is the overall homicide rate in the municipality, and in Columns (7) to (12) is the homicide rate of of the population that is not agricultural worker nor potentially cartel related, i.e., non-agricultural male workers between the ages of 15 and 40. All the outcomes are rates per 100,000 people. $onecartel_{t-1}$ is a dummy variable that takes value of 1 if there was only one cartel present in the previous years, and $two + cartel_{t-1}$ is a dummy that takes the value of 1 if there were two or more cartels present in the previous year. Block bootstrap standard error using clusters at the municipal level and 200 replications are reported parentheses. * is significant at the 10% level, ** is significant at the 5% level, *** is significant at the 1% level.