

Guaconomics: Avocado Price Shocks and Crime Rates in Mexico

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Abstract: Avocado exports from Mexico to the United States have burgeoned since 1997. However, Mexican politicians are increasingly concerned about the recent involvement of drug cartels in avocado production. Using data from 460 Mexican municipalities over the period 1997 to 2019, this paper exploits exogenous weather changes in U.S. avocado production areas to show that increased Mexican avocado producer prices differentially decreased homicide in Mexican municipalities more climatically suited to grow avocados, likely due to increased agricultural employment. However, there are interesting time heterogeneous effects as a result of the increased presence of drug cartels in the avocado industry. In particular, after the War on Drugs began in 2006, higher prices differentially increased homicide as well as other crime indicators such as property crime and cattle theft.

Keywords: Development, International Trade, Agriculture

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1 Introduction

In 2022 and 2024, the USDA banned avocado imports from Mexico due to security concerns regarding Mexico’s drug cartels. The USDA has had growing concerns about the Mexican drug cartel involvement with the avocado industry due to drug cartel threats to U.S. avocado sanitation inspectors when export shipments do not pass phytosanitary inspection (Reuters, 2024; NBC News, 2022). 80 percent of avocados the US consumes come from Mexico. With the noticeable increase in cartel affiliation of Mexico’s avocado industry, news outlets such as Forbes have begun to ask if US buyers are financing the cartel conflict in Mexico (Flannery, 2023). To address this public concern, this is the first paper to provide a rigorous causal estimate of the impact of exogenous avocado price shocks on crime in Mexico.

This paper uses an instrumental variable and difference-in-differences empirical strategy exploiting time variation in avocado prices from weather shocks in California’s avocado belt. I develop a novel municipality-level avocado suitability index applying methods from agricultural science (Dubrovina and Bautista, 2014; Tapia et al., 2007; Witten et al., 2005; Gardiazabal, 2004; Rossiter, 1994; Lovatt, 1990; Lomas, 1988; Martínez, 1988). The index accounts for both a municipality’s soil and climate conditions. When interacting Mexican avocado producer prices with the avocado suitability index via a difference-in-differences strategy, I determine whether avocado prices result in differential crime impacts on municipalities more agro-climatically suited for avocado production.

This study utilizes a panel data set of 460 Mexican municipalities spanning 1997-2019 to assess the impact of avocado price changes on Mexican homicide. The sample includes municipalities in Michoacán, Mexico’s leading avocado-producing state and the only state with year-round production, and its bordering states ¹. The empirical analysis indicates that a doubling in Mexican avocado producer prices decreases the impact of a unit increase of the suitability index on homicide by approximately 18.3 percent. Increased agricultural job opportunities from the growth in avocado production help explain the negative relationship between producer price and homicide in Mexico. ².

There are time heterogeneous effects between avocado prices and Mexico’s crime. In December of 2006, Mexico’s president initiated the Mexican government’s War on Drugs.

¹Geographically, this consists of the following Mexican states: Michoacán, Jalisco, the state of Mexico, Colima, Guerrero, Guanajuato, and Querétaro.

²The USDA Avocado 2019/2020 Annual report states that Mexico exported 186,958 metric tons of avocado to the U.S. Jalisco and the state of Mexico accounted for 9.2 percent and 4.5 percent, respectively. As of 2020, Michoacán was the only state in Mexico with phytosanitary clearance to export avocados to the United States.

The War on Drugs consisted of the Mexican government aggressively fighting against the nation's drug cartels. This analysis finds that from 2007 to 2019, an increase in avocado prices led to increased homicide, the opposite of the finding from the 1997-2019 sample period. Additional data from Sistema Nacional de Seguridad Pública includes municipal-level crime in Mexico from 2011-2017 such as general property crime, cattle theft, homicide by gunfire, rape, reported threats, highway robberies, and kidnappings. The results indicate that from 2011-2017, avocado producer price increases led to higher levels of general property crime, cattle theft, and homicide by gunfire. The related literature supports the argument that these time heterogeneous effects heavily stem from cartels more aggressively diversifying their economic portfolios and gaining control of agricultural products such as avocados after the war on drugs began in 2006 to fund their violence.³

Few papers focus on how avocado trade with the U.S. and Mexico impacts crime. That is because there is currently no baseline method to test how avocado production has a causal relationship with crime in Latin America. Erickson and Owen (2020) show through a one-time trade shock that an avocado production quantity increase led to lower homicide in Michoacán and Jalisco. On the other hand, Herrera and Martinez-Alvarez (2022) focuses on a broader group of Mexican agricultural export commodities and shows that access to primary sector revenues is associated with higher levels of violence among Mexican municipalities. This paper deviates from previous analysis by using a rigorous causal empirical method to show how avocado price variation impacts Mexican crime at the municipality level over different periods. This paper also deviates from the broader literature by drawing from agricultural science to develop a suitability index, which allows the analysis of an exogenous measure of how suitable a municipality is to grow avocados.

This paper contributes to the literature on income shocks and conflicts.⁴ Papers have focused on income inequality and labor wages (Briceño-León et al., 2008). Many studies find that higher income may increase conflict by promoting predation over resources (Hirshleifer, 1991; Grossman, 1999; Fearon, 2005; Mitra and Ray, 2014; Qain and Nunn, 2011). Other research has found that higher income may decrease crime due to the increased opportunity cost of fighting (Becker, 1968; Grossman, 1991; Collier and Hoeffler, 1998; Fearon and Laitin, 2003; Miguel et al., 2004; Besley and Persson, 2011; Do and Iyer, 2010; Hidalgo

³Castillo (2014) points out that drug trafficking is no longer the main source of income for some criminal organizations in Mexico. Many drug cartels in Mexico make more from legal goods than they do illicit products such as marijuana and opioids.

⁴Violence in Mexico comes from many sources among international trade. For example, Dell et al. (2019) shows that loss of manufacturing jobs from competition with China increased cocaine trafficking and violence in Mexico. Criminal groups exercise risk-reduction and alternative investment risk strategies when the government threatens their traditional revenue sources.

et al., 2010; Gwande et al., 2012).

This article is related to studies that use cross-sectional variation in crop suitability, such as Dube et al. (2016), Nunn and Qian (2014), Qian (2008), and Qain and Nunn (2011), which focus on corn, wheat, tea, and orchard cultivation, and potato suitability. This paper interacts cross-sectional variation in the agro-climatic avocado suitability index of Mexican municipalities with avocado prices. The primary control for price is Mexico's real avocado producer price based on the methods of Nunn and Qian (2014). The most advanced system to assess agro-climatic suitability comes from FAO (FAO, 1983). However, this system requires extensive data for avocado suitability that does not currently exist for the studied region.

Similar to the research on income shocks and conflict, research on commodity prices and conflict demonstrates both negative and/or positive effects depending on the commodity and country. The relative strength of the opportunity cost and predation channels of a commodity may stem from labor intensity (Dal Bó and Dal Bó, 2011). Numerous studies show a negative relationship between conflict and export price (Brückner and Ciccone, 2010; Berman and Couttenier, 2015; Bazzi and Blattman, 2011). Another side of the literature shows a positive relationship between conflict and price (Maystadt et al., 2014; Besley and Persson, 2009) . However, work such as Dube and Vargas (2013) shows both effects can take place in the same empirical setting. To my knowledge, this paper is the first to show that U.S. weather shocks in California's avocado-producing region impact crime in Mexico. This analysis helps clarify the complicated nature of avocado production in Mexico and the varying effects of trade with the U.S. The findings warrant caution about the disturbing development of increased avocado production in Mexico, a nation torn by violence.

The remainder of this paper is organized as follows: Section 2 includes background on drug cartel violence in Mexico and avocado production and trade between the U.S. and Mexico; Section 3 describes the data of the analysis; Section 4 explains the empirical strategy; Section 5 discusses the results; and section 6 concludes.

2 Background

This section provides a background on three categories of this paper. First, the increase of crime in Mexico. Second, the evolution of Mexico's cartels. Third, the development of the avocado industry in Mexico and the U.S. over the past 30 years.

2.1 Increased Crime in Mexico

The effects of international trade openness can vary depending on a country's peculiarities. Trade openness can play an important role in creating jobs, increasing wages in both poor and rich countries, and improving working conditions (Newfarmer and Sztajerowska, 2012; Brühlhart et al., 2012). The Becker model shows that increased wages decrease the utility of committing a crime, making people less inclined to participate in illegal activity (Becker, 1968). These concepts combined indicate trade openness is likely to decrease crime, and related literature supports this notion (Prasad, 2012). However, little is known about the effects of trade openness and crime when drug cartels are involved. Powerful criminal organizations threaten to overwhelm local law enforcement institutions in a variety of regions, such as Latin America and Central Asia (USDS, 2012).

Mexico is the number one trading partner with the U.S. (Institution, 2024). One of Mexico's most important agricultural products is avocados. According to the USDA 2019/2020 Annual Report, Mexico is the top avocado supplier to the U.S., with 87 percent of the market share in 2018. Herrera and Martinez-Alvarez (2022) shows that drug cartels actively exploit natural resources. Drug cartels diversify their economic portfolios into export-agricultural sectors such as avocado production. They diversify their portfolios because competition and state repression prompt them to look for non-traditional sources of income and to build up their violence-making capacities. Extracting rents from key industries allows drug cartels to establish territorial control in local communities. Unfortunately, drug cartel violence plagues Mexico.

Through their Security, Justice and Peace department, Mexico announced in 2019, "The five most violent cities in the world are all Mexican: Tijuana, Juarez, Uruapan, Irapuato, and Ciudad Obregon". Figure 1 displays data from the World Bank that juxtaposes the intentional homicide rate per 100,000 people in Mexico and the world average from 2000 to 2019. In 2019, Mexico's homicide rate per 100,000 people was more than 300 percent larger than the world average. While policymakers become increasingly weary about the potential harms of drug cartel affiliation with avocado production, it is still unclear what the actual effect of the avocado market growth is on crime in Mexico.

2.2 Mexican Drug Cartels

The rising U.S. demand for marijuana in the 1960s dramatically increased the Mexican drug trade. Both Mexico and Colombia worked together to traffic cocaine from South America (Astorga, 2005; Toro, 1995). In the 1980s, underlying political conditions in Mexico led to restrained violence. In the absence of political competition, the PRI political party

consolidated the patron-client relationship between drug traffickers, the police, and local elected officials, enabling cartels to operate in particular locations with relative impunity (O’Neil, 2009). The entry of political parties in local elections in the 1990s undermined these arrangements and led to territorial expansion and inter-cartel fights (Bartra, 2012; O’Neil, 2009; Osorio, 2012).

While Mexico’s crime increased in the 1990s, it skyrocketed in the 2000s. In December 2006, President Felipe Calderón launched an aggressive military campaign against the drug cartels known as Mexico’s War on Drugs. This political action resulted in dramatic and haphazard spikes in violence throughout the nation (Berman and Couttenier, 2015). The drug war has inflicted rising violence in both urban areas and rural areas with engaged drug crop cultivation (Escalante, 2009). Fighting among cartels in Michoacán has been linked to attempts to control production areas and routes (Maldonado Aranda, 2012). Beittel (2015) states that with the growth of more major criminal organizations in Mexico, more brutal homicide rates continue to increase. The Mexican people publicly become aware of larger volumes of homicide through beheadings, public hanging of corpses, killing innocent bystanders, torture, devastating car bombs, and even assassinations of journalists and government officials.

2.3 The Evolution of Avocado Prices

The increase in avocado prices can be heavily attributed to the change in public perception of avocados as healthy. Carman (2019) provides a rich history of U.S. demand for avocados. The U.S. per capita consumption of avocados averaged 1.51 pounds in the 1990s. During the 1990s, California dominated the U.S. avocado market; fresh imports typically accounted for less than 1 percent of total U.S. consumption. U.S. consumption per capita skyrocketed to 8 pounds in 2018. The change in U.S. demand stems from successful marketing and public perception of avocados. The California Avocado Commission (CAC) began to fund diet and nutritional research to proactively inform the public of the health benefits of eating avocados. This research led the U.S. public to perceive avocados as a component of a healthy diet.

Progressive trade openness has also impacted avocado prices. In 1994, the North American Free Trade Agreement (NAFTA) was enacted. In February 2007, the U.S. opened avocado trade with Mexico in all 50 states. Initially, the USDA only permitted avocado imports from the state of Michoacán. In 2016, the USDA amended the Mexican Hass Avocado Import Program to allow all states that met phytosanitary guidelines to export their avocados to the U.S.

Figure 2 shows both the logged real producer price and logged Non FAS converted real import price of avocado from Mexico to the U.S.⁵ Data for nominal producer price and import price come from the Food and Agriculture Organization of the United Nations (FAO, 2024) and the USDA’s Global Agricultural Trade System (GATS) (United States Department of Agriculture, 2024).⁶ Both the import price and Mexican producer price follow similar trends. There is a large spike in the Mexican producer price from 1996-1999, likely due to NAFTA’s enactment in 1994 and the U.S. opening avocado trade in 1997. From 2003 to 2007 there is a gradual increase in both price measures. This is likely due to further trade openness between the U.S. and Mexico in these years. The price increase in 2007 was likely caused by California experiencing an unexpected January frost that destroyed nearly three-quarters of the state’s avocado supply that year (NPR, 2007). The visible increase in import prices from 2015 to 2019 is due to heat waves in 2015, 2016, and 2018 that damaged California’s avocado supply (Gambino, Lauren, 2015; Ferguson, Gillian, 2016; California Avocado Commission, 2018). This price increase is also likely due to the amendment of the 2016 Mexican Hass Avocado Import Program.

3 Data

This section discusses 3 different data sets this paper utilizes and the construction of the novel avocado suitability index. The National Institute of Statistics and Geography’s (INEGI) municipal mortality data stretches back to 1990. Because of the richness of this data, the main analysis focuses on the impact of avocado price variation on homicide from 1997 to 2019. In addition, I use census data from INEGI’s 1990 and 2000 Census and Countings to evaluate how increased avocado production and trade impacted Mexico’s agricultural jobs. Lastly, this paper explores time heterogeneous effects that avocado prices have on crime in Mexico. Mexico’s Secretariado Ejecutivo del Sistema Nacional de Seguridad Pública (SESNSP) contains municipal-level crime data for a larger number of crime categories from 2011 to 2017. I utilize SESNSP’s data to explore the issue further when evaluating the time heterogeneous effects of avocado prices.

⁵FAS converted import prices includes costs such as export packaging, loading charges, and transportation to the port. Non-FAS converted import prices refer to various other Incoterms such as FOB (Free On Board), CIF (Cost, Insurance, and Freight), or DDP (Delivered Duty Paid), each with different responsibilities and costs for the buyer and seller.

⁶Based on the work of Nunn and Qian (2014), I convert all nominal prices to real prices by using U.S. CPI and making 1996 the base year (Federal Reserve Bank of Minneapolis, 2024)

3.1 Main Analysis Data

Data for municipal-level homicide come from INEGI's Registered Death Statistics. The data includes every recorded death's time, location, and cause in Mexico from 1990 to the present.⁷ To measure homicide, the analysis adds all deaths from INEGI that resulted from homicide at an annual and municipal level from 1997 to 2019. The analysis uses this sample because Mexico began exporting avocados to the U.S. in 1997, and data after 2019 would be heavily biased from the COVID-19 pandemic. To ensure that the data only compares rural municipalities, the sample does not include all municipalities with a population above 100,000 people.

INEGI's General Census of Population and Housing for the years 1990, 2000, and 2010 has data on each municipality's population, the percent of the population that has completed primary education, and the number of economically active persons.⁸ The analysis matches the census data with the following decades' homicide values at the municipal level.⁹

Cross-sectional weather data on the 1980-2010 municipal temperature in Celsius and precipitation in inches averages comes from Mexico's Servicio Meteorológico Nacional (SMN).¹⁰ SMN's data comprises of municipalities' weather station averages from 1980-2010. For the analysis, I take the annual average temperature and precipitation of all municipal weather stations for these 30 years. For municipalities with no weather station data, I take the average of weather stations within all contiguous municipalities.

Annual-level variables include real Mexican producer price (USD/Ton), real FAS converted (USD/KG) and real Non-FAS converted import price (USD/Ton), average California temperature deviations (degrees), average California precipitation deviations (inches), and average minimum January temperature deviations (degrees).¹¹ I convert all nominal price data into real price by using U.S. CPI, where 1996 is the base year. Producer price comes from the FAO, while import prices are from GATS.¹²

⁷INEGI's death records are publicly available on their website and can be found at the following website: <https://en.www.inegi.org.mx/programas/edr/>

⁸INEGI Conducts their General Census of Population and Housing every ten years. Their census micro-level data is publicly available on their website: <https://en.www.inegi.org.mx/programas/ccpv/2000/>

⁹For example, the analysis matches the 1990 census data with homicide observations at the municipal level for the years 1997-1999, the 2000 census data for the years 2000-2009, and the 2010 census data for the years 2010-2019.

¹⁰Data for all weather stations come from CONAGUA and are publicly available through Gobierno de Mexico: <https://smn.conagua.gob.mx/es/informacion-climatologica-por-estado?estado>.

¹¹Producer price represents the amount of money paid to Mexican farmers in USD/Ton. FAS-converted import prices account for transportation costs, insurance during transit, and import duties.

¹²Mexico's nominal avocado producer prices are publicly available on FAO's website: <https://www.fao.org/faostat/en/>. In addition, annual avocado import prices from Mexico to the U.S. are publicly available on the following website: <https://apps.fas.usda.gov/gats/ExpressQuery1.aspx>

California’s average weather data comes from the National Centers for Environmental Information (NCEI). Avocados in California are heavily at risk from overheating in April-July. In addition, avocado trees are highly vulnerable to precipitation in April-July. For both average temperature and precipitation, the analysis averages all avocado-producing counties data from April-July. California avocados are the most at risk of frosts in January. To measure the minimum average January temperature, the analysis takes the average minimum temperature of that month among all California avocado-producing counties each year. To calculate weather deviations, the analysis takes the difference between this region’s 1900-2000 weather average and the annual weather average. Table 1 shows the summary statistics for my main analysis. When the study combines these variables, the panel data includes 460 municipalities spanning 1997-2019 and 10,285 observations.¹³ The sample area includes Michoacán and all of its contiguous states.

3.2 Index

FAO produces agricultural suitability indices for many crops, but not for avocados. In general, there is no well-recognized avocado suitability index that exists. Thus, I create a novel avocado suitability index for all municipalities in Michoacán and states bordering Michoacán. I use agricultural science methodology by closely following the work of Dubrovina and Bautista (2014) to develop the avocado suitability index. The avocado suitability index focuses on two components of a municipality’s suitability for avocado trees: soil and climate.

Within the index, both soil and climate in a municipality have values of high suitability (3), suitability (2), low suitability (1), and no suitability (0). Figures 3 and 4 display decision trees that break down what components determine how suitable a municipality’s soil and climate are for avocado tree growth. In addition, an in depth description of the index is in Appendix A. The following equation shows how the index is defined among each municipality i . Both Soil and Climate range from 0 to 3 based on the categories previously mentioned.

$$Index_i = \sqrt{Soil_i + Climate_i} \tag{1}$$

The index calculates the geometric mean of the soil and climate values to account for the interactive nature the two have on avocado tree growth suitability. The summary statistics of the index are in Table 1. Figure 5 displays the geographical location of this

¹³County-level weather data are publicly accessible on the following website: <https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/county/mapping>.

paper's sample and the distribution of avocado suitability index values.

3.3 Mechanism Data

INEGI's 1990 and 2000 General Census of Population and Housing both record the number of primary sector workers at the municipal level. INEGI's primary sector includes workers in agriculture, livestock, forestry, hunting, and fishing. However, their census data after 2000 only records general employment.

The censuses include data on population, male population, economically active persons, primary education completion, homes with non-dirt flooring, homes with running water, and homes with electricity. The sample includes all municipalities in Michoacán and municipalities in states contiguous with Michoacán. I also combine the 1980-2010 average temperature and precipitation data from SMN to control for weather. To ensure that my analysis only compares rural municipalities, the sample does not include all municipalities with a population above 100,000 people. The summary statistics for this data set are in Table A2 of the appendix.

3.4 Data to Test Time Heterogeneity

To test the effects of avocado price variation after the war on drugs began, the analysis utilizes crime data from SESNSP. The data includes municipal-level recordings of general property crime, cattle theft, reported threats, homicide by gunfire, rape, highway robbery, and kidnappings. Some observations for these crimes do not exist for certain municipalities in a given year within the data. I omit observations with any of the 7 crime indicators missing from my sample. This is so that the study uses the same sample when testing all seven crime indicators. The data spans 2011-2017, includes 438 municipios, and 2,316 observations. The summary statistics for this data are in Table A3 of the appendix.¹⁴

4 Methodology

The paper's empirical strategy closely follows Dube et al. (2016) and uses both an instrumental variable and difference-in-differences approach. The study evaluates whether changes in the price of avocados result in differential effects on homicide in municipalities more agro-climatically suited to growing avocados. Figure 5 shows the avocado suitability

¹⁴I use SESNSP data from 2011-2017 because they apply the same methodology for that period. Their micro-level crime data is publicly accessible on the following website: <https://www.gob.mx/sesnsp/acciones-y-programas/datos-abiertos-de-incidencia-delictiva>

measure. The figure displays that the sample of municipalities has substantial variation in avocado suitability. This helps ensure that the effects of avocado price fluctuations are not driven by one specific geographic area.

An issue with directly using Mexican producer prices is that they may be endogenous to the outcomes of interest. Many factors, such as international trade relations, domestic issues, and economic factors unequivocally lead to bias in the results. To address the concern of endogeneity, this study employs an instrumental variables strategy that exploits weather shocks in California’s avocado-producing belt. In the second half of the 1990s, California produced approximately 95 percent of the avocados grown in the U.S. and 10 percent of the world’s production (USDA, 999a). In 2018, Mexico was the top supplier of avocados to the U.S. with 87 percent of the U.S. market share. From July 2019 to June 2020, Mexico exported 186,958 metric tons of avocado to the U.S.¹⁵

The analysis focuses on three weather instruments that measure all of California’s avocado-producing counties represented in the USDA’s National Agricultural Statistics Service California Field Office. The study uses county and monthly data from NOAA to construct weather indices that average conditions among California avocado-producing counties. This analysis first records NOAA’s 1900-2000 average April-July temperature, April-July average precipitation, and average minimum January temperature. For each year, the analysis constructs $USTEMP_t$ with two steps. First, the study records the average temperature of the annual California avocado-producing county from April to July. Next, the analysis takes the difference of the annual county temperature average with the 1900-2000 average temperature. The analysis follows the same procedure for $USPREC_t$ and $USMIN_t$, which are U.S. precipitation and January minimum temperature deviations, respectively. To calculate $USPREC_t$, the study takes the difference of the annual April-July California average precipitation values with the average 1900-2000 April-July precipitation values. For $USMIN_t$, the analysis takes the difference of the annual January minimum temperature California average values with the average 1900-2000 January minimum temperature values.¹⁶ This paper utilizes 2-year lags of these three instruments for avocado price year $t-1$ because the effects of California weather shocks destroying avocado trees have a delayed impact on Mexican producer prices.¹⁷

¹⁵To meet U.S. demand, the U.S. imports Mexican avocados year round. When dealing with import contracts, avocado importers should arrange for inspection and certification at least one day prior to entry at Port inspection offices and at least two days prior to entry at the Field Operations Section.” (USDA, 2024)

¹⁶For example, if the 1900-2000 April-July average temperature among avocado-producing municipalities is 75 degrees and the average April-July temperature of avocado-producing counties in a specific year is 80 degrees, then $USTEMP_t$ equals 5 for that given year.

¹⁷For the entirety of the analysis, the 2-year lag for the weather instruments are in relation to price. If

The homicide variable consists of count data. Of the 10,285 homicide observations, 3,926 have a 0 value. Furthermore, the mean of the homicide variable is 3.94, while the variance is approximately 67.371. With the over-dispersion of the homicide data and the inflation of zero observations, the paper’s preferred method is a zero-inflated negative binomial regression. Let Y_{it} represent homicide in municipality i and year t . The basic second-stage specification is shown in Equation 2:

$$Y_{i,t} = \beta_0 + \beta_1(Index_i \cdot \widehat{\ln(Price_{t-1})}) + \beta_2 Index_i + \beta_3 X'_{i,t} + \beta_4 Niño_{i,t} + \alpha_{2,i} + \gamma_{2,t} + \varepsilon_{i,t} \quad (2)$$

The coefficient of interest is the interaction term $Index_i * Price_{t-1}$. The preferred measure assesses lagged producer price because people often need time to adjust to their income situations before making choices to commit crime.¹⁸ $X'_{i,t}$ is a vector of INEGI census controls that accounts for municipal logged population, logged number of economically active persons over the age of 15, and percent of the population that has completed primary education in 1990, 2000, and 2010. The analysis matches municipal homicide observations from 1997-1999 with the 1990 census to control for these census variables. In addition, the analysis matches municipal homicide observations from 2000-2009 with the 2000 census data and homicide observations from 2010-2019 with the 2010 census data. Niño is a dummy variable that equals 1 if an observation takes place during El Niño, 0 otherwise.¹⁹ $\alpha_{2,i}$ and $\gamma_{2,t}$ represent state and year-fixed effects. The first stage equation explaining $Index_i * Price_{t-1}$ is shown in equation 3:

$$\begin{aligned} Index_i \cdot \ln(Price)_{t-1} = & \beta_0 + \beta_1(Index_i \cdot USTEMP_{t-3}) \\ & + \beta_2(Index_i \cdot USPREC_{t-3}) \\ & + \beta_3(Index_i \cdot USMIN_{t-3}) \\ & + \beta_4 Index_i + \beta_5 X'_{i,t} + \beta_6 Niño_{i,t} \\ & + \alpha_{1,i} + \gamma_{1,t} + \varepsilon_{i,t} \end{aligned} \quad (3)$$

In equation 3, $\alpha_{1,i}$ and $\gamma_{1,t}$ depict first-stage state and year fixed effects, respectively.

price represents t , the weather instruments will be from $t-2$. If the price represents $t-1$, then the weather instruments will be from $t-3$.

¹⁸Note that equation 2 does not include the base term of price separately. This is because $Price_{t-1}$ is absorbed by the year-fixed effects

¹⁹El Niño years include 1997-1998, 2002-2003, 2004-2005, 2006-2007, 2009-2010, 2014-2016, 2018-2019. (Donegan, 2019; NOAA, 2019; The Independent, 2023)

After planting an avocado tree, it can take 3 to 4 years before yielding fruit. It can take 5 to 13 years after sowing an avocado seed for the tree to mature enough to produce fruit (California Avocado Commission, 2024). Dube et al. (2016) instruments one year lag of U.S. weather shocks on maize prices because corn is sown and harvested in the same season. In some cases, planted corn can emerge as quickly as 18-21 days after being sown (Ritchie et al., 1993). Damage to avocado trees will likely have prolonged impacts in later years on Mexican producer prices because of the time it takes to grow avocados.

Figures 6-8 juxtapose standardized logged producer price with t-2 California avocado producing county temperature, precipitation, and January minimum temperature from 1997-2019. Figure 6 shows a close relationship between U.S. average temperature deviations and Mexican producer prices. The figure often shows an opposite trend between the two throughout much of the period. Figures 7 and 8 juxtapose standardized logged producer prices with standardized U.S. precipitation deviations and standardized January minimum deviations, respectively. Again, it is visually apparent that there is a close relationship between producer prices and two-year lagged U.S. precipitation and January minimum temperature deviations.

5 Results

5.1 Avocado Prices and Homicide

This section examines the relationship between avocado prices and homicide in Mexico. Table 2 displays the zero-inflated negative binomial regression results of equations 2. All regressions include state and year-fixed effects and all robust standard errors are clustered at the municipality level. Columns 1-4 show the results of the zero-inflated negative binomial (ZINB) estimations. Column 1 shows that the coefficient of the index and price interaction term is -0.139 with a p-value below 0.05. However, column 2 shows the two-stage results with the California weather instruments and is the paper's preferred specification of the empirical results. The study bootstraps all robust standard errors clustered at the municipality level with 1000 replications. The coefficient is -0.183 and has a p-value below 0.01. The estimate indicates that a doubling in price decreases the impact of a unit increase of the suitability index on homicide by approximately 18.3 percent. The F-statistic has a high value of 1.1e+07, which indicates that the instruments are strong.²⁰ This result is similar to the F-statistics in Dube et al. (2016) and indicates that the instruments are highly

²⁰The first stage results for Table 2 are in Table A10 of the appendix. Table A10 shows that all instruments are statistically significant for the interaction of the index and producer prices.

relevant to the producer price.²¹ This magnitude is significant because the producer price range experiences more than a 100 percent increase in the sample period. These results indicate that there is a strong negative association between producer price and homicide in Mexico.

One limitation of count models is their sensitivity to fixed effects. The zero-inflated negative binomial regressions does not converge in the multi-stage bootstrapping process with municipality fixed effects because such a model setup is too complex. There may be a concern of spatial heterogeneity with only state-fixed effects. Columns 3 and 4 show the one-stage results of the analysis with municipality and year fixed effects without and with right-hand controls, respectively. In both columns, the results are strongly statistically significant with a coefficient value of -0.190, which is only slightly higher than the magnitudes of columns 1 and 2.²²

While the ZINB regression is the best-suited model for this analysis, there are limitations to using count models and bootstrapping errors. Unfortunately, econometric literature has few consistent answers on the best way to execute instruments with count modeling. To assuage concerns regarding the zero-inflated negative binomial estimates, Table 3 provides 5 alternative empirical methods that yield robust results and support the findings of Table 2. Columns 1-4 show the results of alternative count models and include state and year-fixed effects. Columns 1 and 2 display the results using a two-stage negative binomial regression. The results are strongly statistically significant. Column 2 includes right-hand controls and has a coefficient value of -0.559. This is much higher than the results of Table 2; however, this model does not account for the heavy inflation of zeros in the homicide data. Columns 3 and 4 show the IV-Poisson regressions. Column 4 includes right-hand controls, and the coefficient value is -0.965 and strongly statistically significant. In the past, a popular count model with instruments was the Poisson regression. Unfortunately, a strong assumption of the Poisson model is that the mean and variance of the dependent variable are the same. The homicide variable has over-disbursion; thus, the Poisson regression would lead to biased estimates.

²¹The F-statistics in the empirical analysis are relatively high. The F-statistics are this high in the literature because of what happens when clustering robust standard errors in a two-stage model for an interaction term. In this paper's case, using state-fixed effects instead of municipality-fixed effects also increases the F-Statistic

²²For columns 1 and 2, when applying instruments to the model with state fixed effects, the coefficient increases a little. The two-stage coefficient is slightly higher than the one-stage results. This is likely because the results of column 1 face a downward bias toward 0. If the count model could have converged a two-stage model with municipality and year fixed effects, the coefficient would likely be slightly higher than -0.190. This suggests that the magnitude of column 2 is marginally under-reporting the magnitude of the interaction term and providing conservative estimates.

Columns 5-10 apply 2SLS and probit modeling with municipality and year fixed effects. Columns 5 and 6 of Table 3 display the 2SLS results of using $\log(\text{homicide}+1)$ as the dependent variable. There are limits to adding 1 and logging count data, however doing so allows one to see what the results look like with a standard 2SLS approach and account for municipal spatial heterogeneity. Once again, the results are strongly statistically significant. Column 6 includes right-hand controls and has a coefficient value of -0.328. This is slightly higher than the zero-inflated negative binomial value of -0.183. Thus, the $\log(\text{homicide}+1)$ approach displays slightly inflated estimates, but similar results to Table 2.

Columns 7 and 8 display the 2SLS results of logging homicide. This method results in only 6,359 observations as opposed to 10,285 observations in the main analysis. Column 8 includes the results with right-hand controls, and the coefficient value is -0.606. The results remain weakly statistically significant with a p-value below 0.10, likely due to the loss of prediction power from fewer observations. However, this finding displays the intensive margin effect. In other words, among the observations with homicide, crime decreases among municipalities more agro-climatically suited to growing avocados.

Columns 9 and 10 display the IV-Probit model results and the effects of the analysis's extensive margin. For these columns, homicide is a dummy variable equal to 1 if an observation has crime and 0 if an observation has no crime. Column 10 includes right-hand controls with a coefficient value of -0.537 and a p-value below 0.05. This suggests that the probability of a municipality going from no crime to some crime decreases for municipalities more agro-climatically suitable for avocado production. Columns 7-10 indicate that both the intensive and extensive margin of the analysis help drive the results of Table 2.

The negative relationship between the interaction term and homicide matches the findings of a large body of literature showing commodity price shocks having negative relationships with price (Brückner and Ciccone, 2010; Berman and Couttenier, 2015; Bazzi and Blattman, 2011). The findings of Table 2 are likely the result of a labor dynamic. The analysis utilizes data from INEGI's 2000 and 1990 Census to evaluate the difference of different sector employment between 2000 and 1990 at the municipal level. The census data allows the study to control for the 2000 and 1990 differences between population, economically active persons, primary education completion, homes with flooring, homes with running water, and homes with electricity. The analysis also controls for the 1980-2010 municipal average temperature and precipitation from SMN's weather station data. The study omits all municipalities with a population above 100,000 so that the data only compares rural regions. The final sample includes 908 observations. The benefit of taking the differences between 2000 and 1990 is that NAFTA took place in 1994, and the U.S. opened up the avocado trade with Mexico in 1997. This sample will likely heavily reflect the impact that

avocado trade openness initially had on agricultural employment in Mexico.

I employ the following difference-in-differences equation to test the association between the avocado suitability index and the difference in different job sectors between 2000 and 1990:

$$Jobs_{i,t} = \beta_0 + \beta_1(Treat_t * Index_i) + \beta_2Treat_t + \beta_3X'_{i,t} + \beta_4Treat_t + \alpha_i + \varepsilon_{i,t} \quad (4)$$

α_i represents municipality fixed effects. Jobs represent the number of jobs people have in a particular employment sector. These two census years include data for primary, secondary, and tertiary employment.²³ Treat is a dummy equal to 1 if an observation took place in 2000 and 0 for 1990 observations. Index represents the same index of Equation 2. The coefficient of interest is the interaction of Treat and Index. X' is a vector of right-hand census and weather controls at the municipal level.

Equation 4's results are in Table 3. All robust standard errors are clustered at the municipality level. Columns 1 and 2 show the correlation between the interaction term and agricultural jobs without and with right-hand controls, respectively. The coefficient values for columns 1 and 2 are 0.046 and 0.035, with p-values below 0.01. The strong positive statistical association between agricultural employment and the interaction term suggests that avocado trade openness between the U.S. and Mexico led to more primary sector employment opportunities for Mexico among their municipalities more agro-climatically suitable for avocado production. These results suggest that the decrease in crime, shown in Table 2, may stem from people having an increased ability to find stable employment and not need to resort to crime. Columns 3-6 show that there is no statistically significant association between the interaction term of interest and secondary or tertiary employment. These results suggest that the change in crime among municipalities more agro-climatically suitable for avocados likely does not stem from manufacturing or jobs in the service industry.

5.2 Robustness Checks

The results of Table 2 hold to a range of robustness checks. The analysis tests the results using different instruments to test the robustness of the two-stage approach. The results of applying alternative instruments are in Table 5. Weather variables can often take on non-

²³Primary employment predominantly consists of agricultural and land work-based jobs. The secondary sector represents the manufacturing sector. Lastly, the tertiary sector depicts employment among the service and tourism industry

linear patterns.²⁴ Column 1 shows the results of when the study squares the three weather instruments. The results are statistically significant, with a coefficient of -0.544, which is a bit higher than the magnitude of the original weather instruments. The F-statistic is 2.6e+07, indicating that the nonlinear weather instruments are strong.

Nunn and Qian (2014) uses a U.S. lagged wheat price interaction term on foreign aid to assess how foreign aid impacts civil conflict in recipient countries. Based on their method, I test my model using an alternative IV strategy that interacts lagged producer price ($Price_{t-2}$) with the avocado suitability index. The result is in column 2 of Table 5. The coefficient is -0.232 and is statistically significant, with a p-value below 0.05. In addition, the F-statistic is 6.9e+07, which indicates that this instrument is also strong.

To further explore the relevance of the 7 potential instruments from different approaches, the analysis utilizes LASSO machine learning to provide an alternative method that determines what instruments are relevant to include. LASSO retains all 7 instruments, which provides more empirical evidence that the instruments in this paper are strong and relevant to the analysis. Column 3 displays the results of adding all seven instruments in the two-state zero-inflated negative binomial model. The coefficient is -0.145 and is significant. The F-statistic is 1.9e+08, much larger than the results of columns 1 and 2. The reformed first stage equation for column three of Table 5 is the following:

$$\begin{aligned}
Index_i \cdot \ln(Price)_{t-1} = & \beta_0 + \beta_1(Index_i \cdot USTEMP_{t-3}) \\
& + \beta_2(Index_i \cdot USPREC_{t-3}) \\
& + \beta_3(Index_i \cdot USMIN_{t-3}) \\
& + \beta_4(Index_i \cdot USTEMP_{t-3}^2) \\
& + \beta_5(Index_i \cdot USPREC_{t-3}^2) \\
& + \beta_6(Index_i \cdot USMIN_{t-3}^2) \\
& + \beta_7(Index_i \cdot \ln(Price)_{t-2}) \\
& + \beta_8 Index_i + \beta_8 X'_{i,t} + \beta_9 Niño_{i,t} \\
& + \alpha_{1,i} + \gamma_{1,t} + \varepsilon_{i,t}
\end{aligned} \tag{5}$$

Table A11 in the appendix shows the first-stage results of Equation 5. The coefficient value when the analysis includes all 7 instruments is -0.145. The coefficient of the interaction term in the main analysis that only includes the three weather instruments is -0.183.

²⁴Dube et al. (2016) also explores squared U.S. weather shock instruments for maize price.

Thus, the magnitude of the interaction term remains relatively stable when including all 7 instruments.

In addition to testing the impact of producer prices on homicide, the main results are robust to using FAS converted and Non-FAS converted import prices instead of producer prices. The results with import prices are in Table A1 of the appendix. One concern in the analysis is whether the results mostly come from the state of Michoacán. From 1997-2019, Michoacán was the only state permitted to export their avocados to the U.S. To mitigate these concerns, the study omits Michoacán from the sample and the results remain robust. The results of the analysis without Michoacán are in Table A7 of the appendix.

One limitation of developing a novel index is there is no previous work that has developed an avocado suitability index in Mexico that takes into account both soil and climate. To provide further evidence of the robustness of testing the interactive effect of soil and climate, the analysis develops an alternative index calculation shown in equation 6:

$$Index_i = Soil_i \cdot Climate_i + Soil_i + Climate_i + 2 \quad (6)$$

The results of the analysis remain consistent and strongly statistically significant when using this second index measure and are shown in Table A9 of the appendix. The robustness of using both interaction functions to develop the index provide stronger evidence that the analysis provides strong findings that measure the impact of avocado agro-climatic suitability.

The main analysis of this paper uses two-year weather lags on avocado prices because California avocado tree damage from weather has a lagged effect on the prices Mexican farmers receive. The results of using 1 year weather lagged effects are statistically insignificant. However, employing 3-year weather lag instruments provides robust and statistically significant results. Table A12 in the appendix shows the results of 1 and 3 year lagged weather instruments.

The two largest avocado-producing states in Mexico are Michoacán and Jalisco. The results of the paper hold when expanding the sample to include all states contiguous with Michoacán and Jalisco. The sample in this case increases from 10,285 to 13,456 observations and the results are in Table A5 of the appendix.

5.3 Time Heterogeneity

In 2006, Mexico's government began its War on Drugs. Mexico's government started aggressively cracking down and fighting drug cartels. This sparked a horrifying backlash from drug cartels that led to increased levels of crime. To fund territorial contestation, drug cartels began diversifying their portfolios by taking over export agricultural products such as avocados. This paper next tests whether the relationship between the interaction term and crime remain negative from 2007 to 2019.

Table 6 shows the results of Table 2 when the model omits the years before 2007 from the sample. The sample contains 5,740 observations, and the relationship between avocado prices and crime changes. All 4 columns show a positive and statistically significant relationship between avocado producer price and homicide. The study's preferred method is in column 2, which includes the 2-stage zero-inflated negative binomial regression results with right-hand controls and state and year fixed effects. The coefficient value is 0.367. This indicates that a doubling in producer price increases the impact of a unit increase of the suitability index on homicide by approximately 36.7 percent. This is approximately double the magnitude of the ZINB estimate when all the model includes all the years of the data, but with the opposite sign. These results provide empirical evidence that after Mexico's War on Drugs began, avocado producer price increases led to more homicide.

The heterogeneous change in the relationship between avocado prices and homicide matches the literature showing how commodity price shocks can lead to increased crime. The mechanism behind this change is the War on Drugs, which made cartels have to more aggressively diversify their portfolios to the avocado industry to fund their fighting. A large body of literature discusses the growing concern of drug cartel presence among licit commodity production (García-Ponce and Lajous, 2014; Bergman, 2018; Nellemann et al., 2016; Zabyelina and van Uhm, 2020; Calderón et al., 2020; Felbab-Brown, 2019; Guerrero-Gutiérrez, 2011; Durán-Martínez, 2017; Flores-Macías, 2018). Magaloni et al. (2020) highlights the War on Drugs in Mexico intensified competition among cartels, which incentivized drug trafficking organizations to expand their revenue-generating activities to new economic sectors besides illicit commodities. A significant body of work supports the fact that drug trafficking and political backlash against drug cartels have led to massive increases in crime (Dell, 2015; Leenen and Cervantes-Trejo, 2014; Gamlin, 2015). Thus, criminal organizations in Mexico require secure sources of income to build up their violence-making capabilities as they face fierce competition and state crackdowns (Correa-Cabrera, 2017; Jones, 2016).

This study explores the relationship of avocado producer prices with more crime cat-

egories using data from SESNSP, which includes municipal and annual observations for general property crime, cattle theft, reported threats, homicide by gunfire, rape, highway robberies, and kidnapping from 2011-2017. The results for general property crime, cattle theft, homicide by gunfire, and rape are in Table 7. Columns 1 and 2 display the relationship between avocado producer prices and property crime; the coefficients are 0.407 and 0.561, respectively. These statistically significant results show a positive relationship between property crime and avocado producer prices. Reports have stated drug cartels often steal Mexican farmers' land and begin planting avocado trees (Romero and Mega, 2023). Such reports discuss how when farmers ask the cartels to leave their land, they receive threats toward them and their families from the cartels.

Columns 3 and 4 of Table 7 show the relationship between cattle theft and the interaction term. The coefficients are 0.446 and 0.927, respectively, and are statistically significant. The positive relationship between cattle theft and producer prices intuitively makes sense. If drug cartels are brazen enough to steal people's land openly, then it is highly likely they would be willing to steal their cattle.

The response variable of columns 5 and 6 is homicide by gunfire, while the response variable for columns 7 and 8 is rape. The interaction term is strongly statistically significant when regressed on homicide by gunfire, which is consistent with the results of Table 6. However, there is no statistically significant relationship between the interaction term and rape. Table A13 in the appendix shows the results for reported threats, highway robberies, and kidnappings. While there is a statistically significant relationship between reported threats and the interaction term, there is no statistically significant effect when utilizing a two-stage analysis. In addition, the results showed no statistically significant relationship between the interaction term and highway robberies and kidnappings.

The lack of statistical significance between producer price and either rape or highway robberies intuitively makes sense as these are not crimes closely related to agriculture. However, the lack of significance in the relationship between avocado producer prices and kidnappings is somewhat surprising. Media outlets such as the New York Times have reported victims discussing how they were kidnapped and beaten due to disputes between drug cartels and Mexican farmers. While the results of kidnapping may be true, this crime data is limited to the amount of abductions people report. Likely, many victims do not report kidnapping cases due to fear of what drug cartels will do.

6 Conclusion

The effects of international trade openness can vary depending on different country characteristics. Trade openness can play an important role in creating jobs, increasing wages in both poor and rich countries, and improving working conditions (Newfarmer and Sztajerowska, 2012; Brülhart et al., 2012) (Brulhart, 2012). The Becker model shows that increased wages decrease the utility of committing a crime, making people less inclined to participate in illegal activity (Becker, 1968). These concepts combined indicate trade openness is likely to decrease crime, and related literature supports this notion (Prasad, 2012). However, little is known about the effects of trade openness and crime when drug cartels are involved. Powerful criminal organizations threaten to overwhelm local law enforcement institutions in a variety of regions, such as Latin America and Central Asia (USDS, 2012).

Numerous media outlets have discussed the growing concern of Mexico’s avocado production and cartel involvement (Steel and Ember, 2023; Swanson, 2022; Flannery, 2023; Staff, 2023; Economist, 2016) (The Economist, 2016). A growing concern among politicians and the general public is whether the massive growth of the avocado industry and its involvement with drug cartels has led to more crime in Mexico. Many news outlets have asked harrowing questions, such as whether U.S. avocado demand is actively funding drug cartels. This paper creates a novel municipality-level avocado suitability index using agricultural science methods in order to assess a causal mechanism between avocado prices and crime in Mexico. This article is the first to rigorously explore the causal relationship between avocado prices and crime in Mexico. This is also the first paper to provide empirical evidence that lagged U.S. weather shocks in California’s avocado-producing counties impact crime in Mexico through avocado prices.

This paper offers empirical evidence showing the gray relationship between avocado prices and crime in Mexico. By creating a novel avocado suitability index at the municipal level, this study evaluates whether avocado price changes result in differential effects on homicide in municipalities more agro-climatically suited to growing avocados. When assessing the period 1997-2019, the analysis shows that avocado prices have a negative relationship with homicide. The estimates suggest that a doubling in avocado producer prices decreases the impact of a unit increase of the avocado suitability index on homicide by approximately 18.3 percent. This is a significant magnitude as the Mexican avocado producer price increases by more than 100 percent over this period. This analysis empirically shows that avocado trade openness between the U.S. and Mexico is strongly associated with increased municipality-level agricultural jobs. This likely explains part of the reason for this negative relationship.

On the other hand, this paper shows that after Mexico's war on drugs began in 2006, increases in avocado producer prices led to increased homicide, general property crime, and cattle theft in Mexico. These results are a sobering indication that since 2006, drug cartels have funded their territorial contestation and violence by diversifying their economic portfolios to include the avocado industry. Unfortunately, cartel violence in this period seems to have a bigger impact on crime than the increased employment and wage opportunities of the avocado industry. These findings are essential for U.S. and Mexican policymakers to be aware of as trade with the two countries continues to grow and they both attempt to find a way to address the instability of drug cartel control in Mexico.

Understanding how to address the drug cartel conflict in Mexico is a highly complex task. The answer is not as easy as stopping trade between the two countries or specifically stopping the purchase of avocados, as this will only lead drug cartels to focus on other commodities. Future research should continue to focus on how commodity price shocks from trade impact crime among different nations. Drug cartels in Latin America are heavily involved in numerous industries such as iron, ore, and many other export agricultural products. It is important for research to discover how these products' trade relationships and price variations between different countries may or may not impact crime. Sadly, this paper finds that the delicious guacamole so many enjoy comes at more than just a monetary cost.

References

- Astorga, L. (2005). El siglo de las drogas: El narcotráfica, del porfiriato al nuevo milenio. *México, DF: Plaza y Janés*.
- Bartra, R. (2012). La hidra mexicana: el retorno del pri. *Letras Libres, January*.
- Bazzi, S. and C. Blattman (2011). *Economic shocks and conflict: the (Absence of?) Evidence from commodity prices*. Center for Global Development.
- Becker, G. S. (1968). Crime and punishment: An economic approach. In *The economic dimensions of crime*, pp. 13–68. Springer.
- Beittel, J. S. (2015). Mexico: Organized crime and drug trafficking organizations. *Congressional Research Service 3*.
- Bergman, M. (2018). Illegal drugs, drug trafficking and violence in latin america.
- Berman, N. and M. Couttenier (2015). External shocks, internal shots: the geography of civil conflicts. *Review of Economics and Statistics 97*(4), 758–776.
- Besley, T. and T. Persson (2009). Repression or civil war? *American Economic Review 99*(2), 292–297.
- Besley, T. and T. Persson (2011). The logic of political violence. *The quarterly journal of economics 126*(3), 1411–1445.
- Briceño-León, R., A. Villaveces, and A. Concha-Eastman (2008). Understanding the uneven distribution of the incidence of homicide in latin america. *International journal of epidemiology 37*(4), 751–757.
- Brückner, M. and A. Ciccone (2010). International commodity prices, growth and the outbreak of civil war in sub-saharan africa. *The Economic Journal 120*(544), 519–534.
- Brühlhart, M., C. Carrère, and F. Trionfetti (2012). How wages and employment adjust to trade liberalization: Quasi-experimental evidence from austria. *Journal of International Economics 86*(1), 68–81.
- Calderón, L. Y., K. Heinle, R. E. Kuckertz, O. R. Ferreira, and D. A. Shirk (2020). Organized crime and violence in mexico: 2020 special report. *Justice in Mexico, University of San Diego (<https://justiceinmexico.org/wp-content/uploads/2020/07/OCVM-2020.pdf>)*.
- California Avocado Commission (2018). Avocado Heat Damage Follow-up.
- Carman, H. F. (2019). The story behind avocados’ rise to prominence in the united states. *Are Update 22*, 9–11.
- Castillo, E. (2014). Mexico drug cartel makes more dealing iron ore. *The Associated Press*.
- Collier, P. and A. Hoeffler (1998). On economic causes of civil war. *Oxford economic papers 50*(4), 563–573.

- Commission, C. A. (2024). How to grow your own avocado tree.
- Correa-Cabrera, G. (2017). *Los Zetas Inc. criminal corporations, energy, and civil war in Mexico*. University of Texas Press.
- Dal Bó, E. and P. Dal Bó (2011). Workers, warriors, and criminals: social conflict in general equilibrium. *Journal of the European Economic Association* 9(4), 646–677.
- Dell, M. (2015). Trafficking networks and the mexican drug war. *American Economic Review* 105(6), 1738–79.
- Dell, M., B. Feigenberg, and K. Teshima (2019). The violent consequences of trade-induced worker displacement in mexico. *American Economic Review: Insights* 1(1), 43–58.
- Do, Q.-T. and L. Iyer (2010). Geography, poverty and conflict in nepal. *Journal of peace research* 47(6), 735–748.
- Donegan, B. (2019, March). El niño conditions strengthen, could last through summer. *The Weather Company*. Archived from the original on 15 March 2019. Retrieved 15 March 2019.
- Dube, O., O. García-Ponce, and K. Thom (2016). From maize to haze: Agricultural shocks and the growth of the mexican drug sector. *Journal of the European Economic Association* 14(5), 1181–1224.
- Dube, O. and J. F. Vargas (2013). Commodity price shocks and civil conflict: Evidence from colombia. *Review of Economic Studies* 80(4), 1384–1421.
- Dubrovina, I. and F. Bautista (2014). Analysis of the suitability of various soil groups and types of climate for avocado growing in the state of michoacán, mexico. *Eurasian soil science* 47, 491–503.
- Durán-Martínez, A. (2017). *The politics of drug violence: Criminals, cops and politicians in Colombia and Mexico*. Oxford University Press.
- Economist, T. (2016). The link between avocados and crime. *The Economist*.
- Elms, R. Avocado annual. https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Avocado%20Annual_Mexico%20City_Mexico_12-01-2019.
- Erickson, M. and L. Owen (2020). Blood avocados: Cartel violence over licit industries in mexico. In *University of Washington Political Economy Forum. Last modified June*, Volume 9, pp. 2020.
- Escalante, F. (2009). Territorios violentos. nexos, diciembre. URL <http://www.nexos.com.mx>.
- FAO (1983). *FAO Guidelines: Land Evaluation for Rainfed Agriculture*, Volume 52 of *Soils Bulletin*. Rome: FAO.
- FAO (2024). FAOSTAT: Production Data.

- Fearon, J. D. (2005). Primary commodity exports and civil war. *Journal of conflict Resolution* 49(4), 483–507.
- Fearon, J. D. and D. D. Laitin (2003). Ethnicity, insurgency, and civil war. *American political science review* 97(1), 75–90.
- Federal Reserve Bank of Minneapolis (2024). Consumer Price Index (1913-).
- Felbab-Brown, V. (2019). Mexico’s out-of-control criminal market. *Foreign policy at Brookings working paper. Brookings, Washington.*
- Ferguson, Gillian (2016). Avocados: The Green Gold.
- Flannery, N. P. (2023). Are us avocado buyers financing the cartel conflict in mexico? *Forbes.*
- Flores-Macías, G. (2018). The consequences of militarizing anti-drug efforts for state capacity in latin america: Evidence from mexico. *Comparative Politics* 51(1), 1–20.
- Gambino, Lauren (2015). California drought and heat wave linked to climate change, the guardian.
- Gamlin, J. (2015). Violence and homicide in mexico: a global health issue. *The Lancet* 385(9968), 605–606.
- García-Ponce, O. and A. Lajous (2014). How does a drug cartel become a lime cartel. *The Washington Post* 20.
- Gardiazabal, F. (2004). Riego y nutrición en paltos. *Sociedad Gardiazabal Y Magdahl Ltda. 2º Seminario Internacional De Paltos. Quillota*, 1–21.
- Grossman, H. I. (1991). A general equilibrium model of insurrections. *The American Economic Review*, 912–921.
- Grossman, H. I. (1999). Kleptocracy and revolutions. *Oxford economic papers* 51(2), 267–283.
- Guerrero-Gutiérrez, E. (2011). Security, drugs, and violence in mexico: A survey. In *7th North American Forum, Washington DC*. sn.
- Gwande, K., D. Kapur, and S. Satyanath (2012). Natural resource shocks and conflict in india’s red belt. *Work in progress.*
- Herrera, J. S. and C. B. Martinez-Alvarez (2022). Diversifying violence: Mining, export-agriculture, and criminal governance in mexico. *World Development* 151, 105769.
- Hidalgo, F. D., S. Naidu, S. Nichter, and N. Richardson (2010). Economic determinants of land invasions. *The Review of Economics and Statistics* 92(3), 505–523.
- Hirshleifer, J. (1991). The technology of conflict as an economic activity. *The American Economic Review* 81(2), 130–134.
- INEGI (2000). Xii general census of population and housing 2000.
- INEGI (2024a). Edaphology.

- INEGI (2024b). Registered deaths statistics (edr).
- Institution, B. (2024). Who is america's top commercial partner? hint: It's not china.
- ISRIC - World Soil Information (2024). Isric - world soil information.
- Jones, N. P. (2016). *Mexico's illicit drug networks and the state reaction*. Georgetown University Press.
- Leenen, I. and A. Cervantes-Trejo (2014). Temporal and geographic trends in homicide and suicide rates in mexico, from 1998 through 2012. *Aggression and violent behavior* 19(6), 699–707.
- Lomas, J. (1988). An agrometeorological model for assessing the effect of heat stress during the flowering and early fruit set on avocado yields. *J. Am. Soc. Hortic. Sci* 113(1), 172–176.
- Lovatt, C. J. (1990). Factors affecting fruit set/early fruit drop in avocado. *California Avocado Society Yearbook* 74, 193–199.
- Magaloni, B., G. Robles, A. M. Matanock, A. Diaz-Cayeros, and V. Romero (2020). Living in fear: the dynamics of extortion in mexico's drug war. *Comparative Political Studies* 53(7), 1124–1174.
- Maldonado Aranda, S. (2012). Drogas, violencia y militarización en el México rural: el caso de michoacán. *Revista mexicana de sociología* 74(1), 5–39.
- Martínez, B. (1988). Comportamiento del aguacate hass, bajo diferentes condiciones ecológicas. *UMSNH Facultad de Agrobiología. Uruapan, Mich.*
- Maystadt, J.-F., G. De Luca, P. G. Sekeris, and J. Ulimwengu (2014). Mineral resources and conflicts in drc: a case of ecological fallacy? *Oxford Economic Papers* 66(3), 721–749.
- Miguel, E., S. Satyanath, and E. Sergenti (2004). Economic shocks and civil conflict: An instrumental variables approach. *Journal of political Economy* 112(4), 725–753.
- Mitra, A. and D. Ray (2014). Implications of an economic theory of conflict: Hindu-muslim violence in india. *Journal of Political Economy* 122(4), 719–765.
- National Centers for Environmental Information (NCEI) (2024). Climate at a glance: County mapping.
- NBC News (2022). U.s. suspends mexican avocado imports after threat to inspector. *NBC News*.
- Nellemann, C., R. Henriksen, A. Kreilhuber, D. Stewart, M. Kotsovou, P. Raxter, E. Mrema, and S. Barrat (2016). *The rise of environmental crime: a growing threat to natural resources, peace, development and security*.
- Newfarmer, R. and M. Sztajerowska (2012). Trade and employment in a fast-changing world. *Policy priorities for international trade and jobs* 7.
- NOAA (1997). Very strong 1997-98 pacific warm episode (el niño).

- NPR (2007). Frost strikes california’s citrus, avocado crops.
- Nunn, N. and N. Qian (2014). Us food aid and civil conflict. *American economic review* 104(6), 1630–1666.
- O’Neil, S. (2009). The real war in mexico: How democracy can defeat the drug cartels. *Foreign Aff.* 88, 63.
- Osorio, J. (2012). Democratization and drug violence in mexico. *Notre Dame: University of Notre Dame*, unpublished typescript.
- Persson, T. (2008). The incidence of civil war: Theory and evidence. *NBER working papers series 2008*(online), w14585–w14585.
- Prasad, K. (2012). Economic liberalization and violent crime. *The Journal of Law and Economics* 55(4), 925–948.
- Qain, N. and N. Nunn (2011). The impact of potatoes on old world population and urbanization.
- Qian, N. (2008). Missing women and the price of tea in china: The effect of sex-specific earnings on sex imbalance. *The Quarterly journal of economics* 123(3), 1251–1285.
- Reuters (2024). Us suspends avocado imports from mexican state due to security incident, local media says. *Reuters*.
- Ritchie, S., J. Hanway, and G. Benson (1993). How a corn plant develops. Special Report 48 (revised), Iowa State University of Science and Technology, Cooperative Extension Service, Ames, IA.
- Romero, S. and E. R. Mega (2023). Mexico avocado deforestation.
- Rossiter, D. G. (1994). Lecture notes: Land evaluation. *Cornell University, College of Agriculture and Life Sciences, Department of Soil, Crop and Atmospheric Sciences* 29.
- Secretariado Ejecutivo del Sistema Nacional de Seguridad Pública (2024a). Datos Abiertos de Incidencia Delictiva.
- Secretariado Ejecutivo del Sistema Nacional de Seguridad Pública (2024b). Datos abiertos de incidencia delictiva.
- Security, J. and Peace. Bulletin ranking 2019 of the 50 most violent cities in the world. <http://www.seguridadjusticiaypaz.org.mx/sala-de-prensa/1590-boletin-ranking-2019-de-las-50-ciudades-mas-violentas-del-mundo>.
- Servicio de Información Agroalimentaria y Pesquera (2024). Cierre agrícola.
- Servicio Meteorológico Nacional (2024). Información climatológica por estado.
- Staff, N. (2023). The violent underbelly of the avocado industry. *NPR*.
- Steel, E. and S. Ember (2023). Avocados, mexico, and the journalists who cover them.
- Sutherland, S. (2017, February). La niña calls it quits. is el niño paying us a return visit? *The Weather Network*. Archived from the original on 18 February 2017. Retrieved 17

February 2017.

Swanson, A. (2022). U.s. suspends avocado imports from mexico.

Tapia, V. L. M., G. A. Larios, and C. J. Anguiano (2007). Ambiente y fenología del aguacate. In *Tecnología para la producción de aguacate en México* (2 ed.), pp. 36–53. Uruapan, Michoacán, México: INIFAP.

Toro, M. C. (1995). *Mexico's "war" on Drugs: Causes and Consequences*, Volume 3. Lynne Rienner Publishers.

United States Department of Agriculture (2024). Global Agricultural Trade System (GATS).

USDA (1999a). Crop profile for avocados in california.

USDA (2024). Section 8e requirements for avocados. Accessed: 2024-09-01.

USDA National Agricultural Statistics Service (2024). California agricultural commissioner reports.

USDS (2012). *International Narcotics Control Strategy Report. Volume I*. United States Department of State.

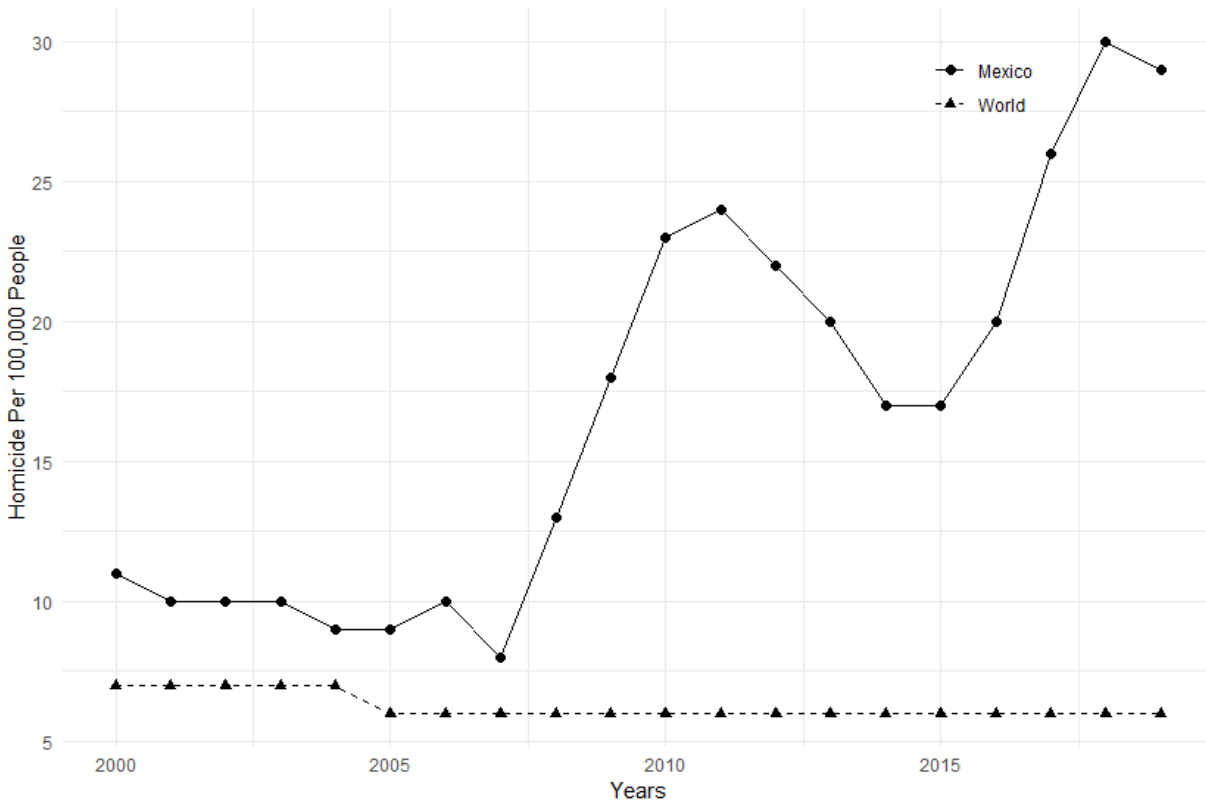
WBO (2024). Intentional homicides (per 100,000 people). <https://data.worldbank.org/indicator/VC.IHR.PSRC.P5?locations=MX-1W>.

Witten, I. H., E. Frank, M. A. Hall, C. J. Pal, and M. Data (2005). Practical machine learning tools and techniques. In *Data mining*, Volume 2, pp. 403–413. Elsevier Amsterdam, The Netherlands.

Zabyelina, Y. and D. van Uhm (2020). *Illegal mining: Organized crime, corruption, and ecocide in a resource-scarce world*. Springer Nature.

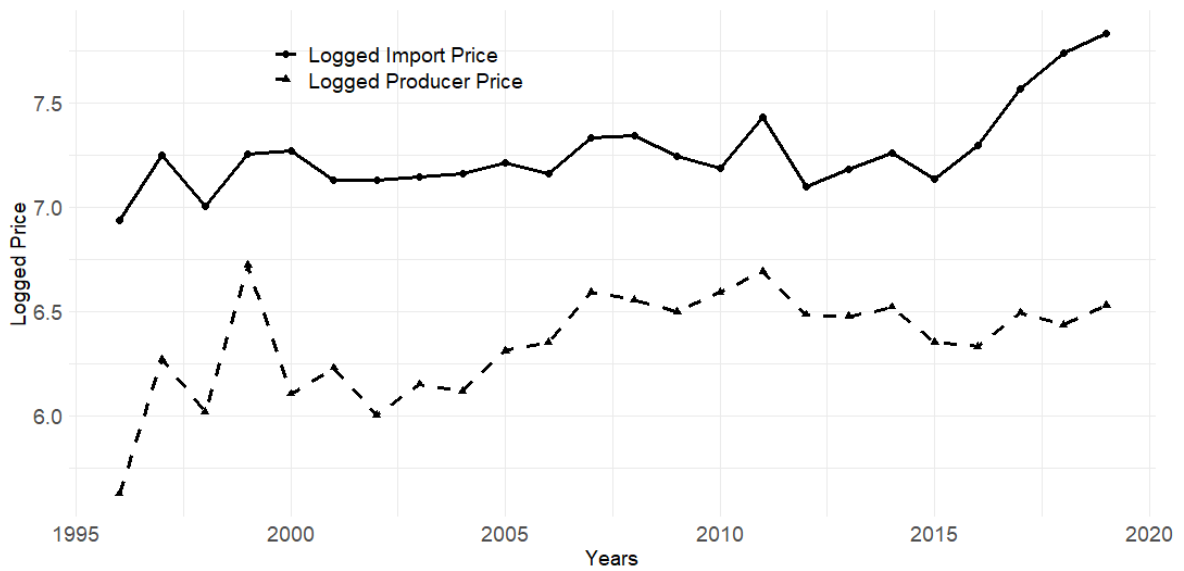
7 Figures and Tables

Figure 1: Homicide Per 100,000 People from 2000 to 2019



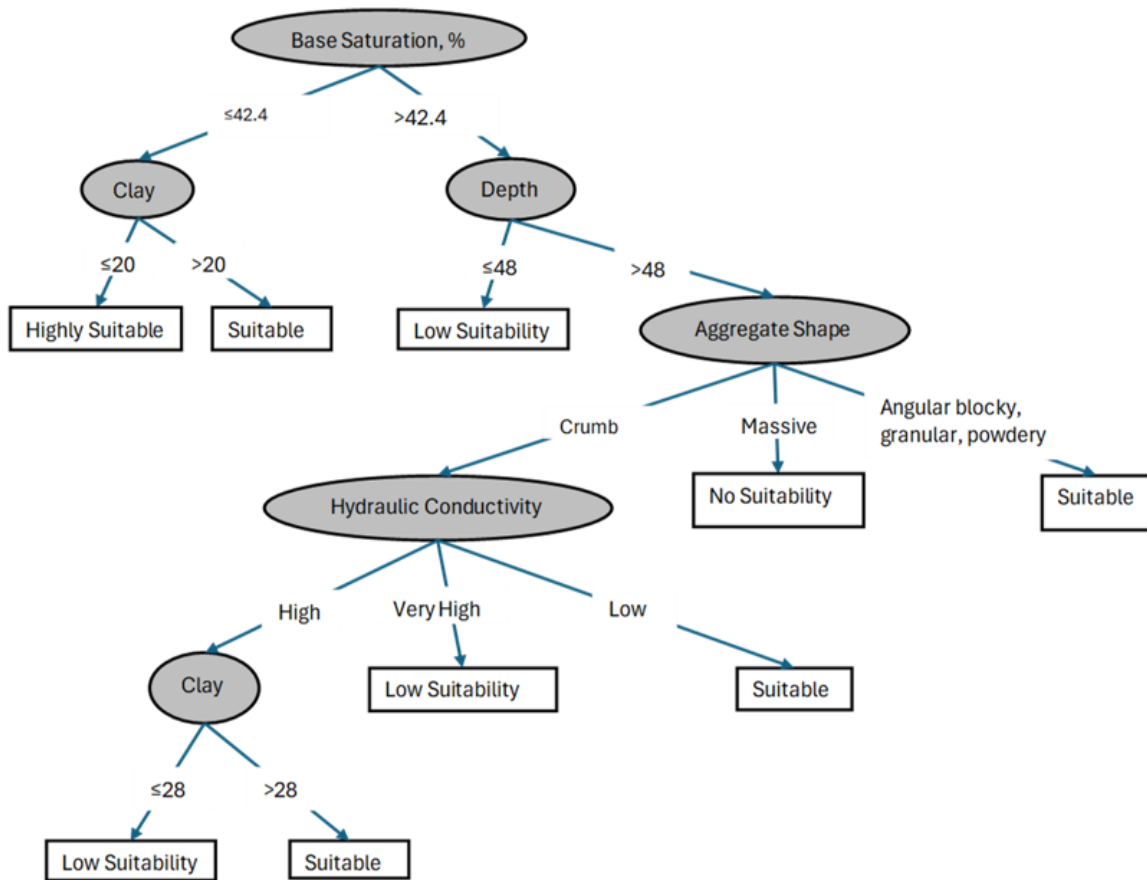
This figure shows the WBO homicide rate per 100,000 people from 2000 to 2019. The solid line with circles represents Mexico's homicide rates over time. The dashed line with triangles shows the world homicide rates over time.

Figure 2: Avocado Producer and Import Prices Over Time



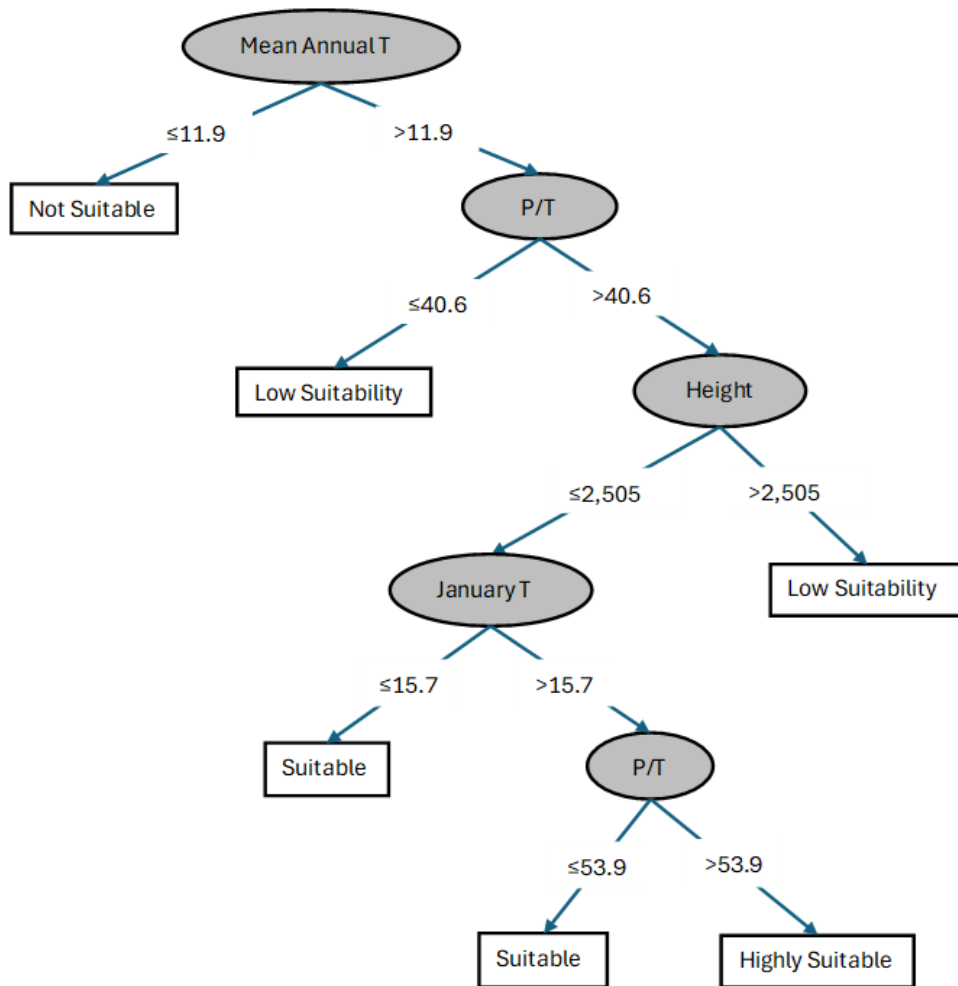
The solid line with circles represents logged real Non FAS import price in USD/Ton from GATS data. The dashed line with triangles shows logged real Mexican producer prices in USD/Ton from FAO data.

Figure 3: Avocado Soil Suitability Tree



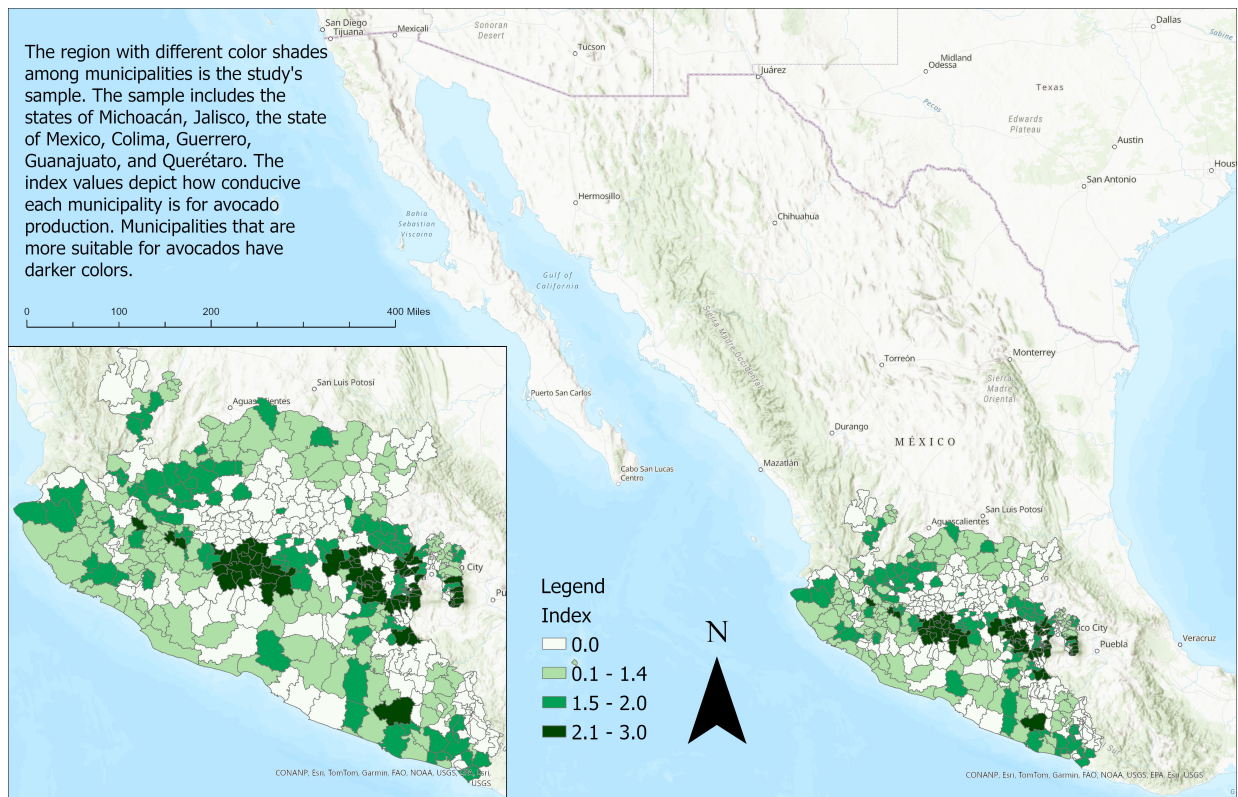
This image represents the avocado soil suitability methodology from Dubrovina and Bautista (2014). Base saturation and clay are in percentage terms, and depth is in centimeters.

Figure 4: Avocado Climate Suitability Tree



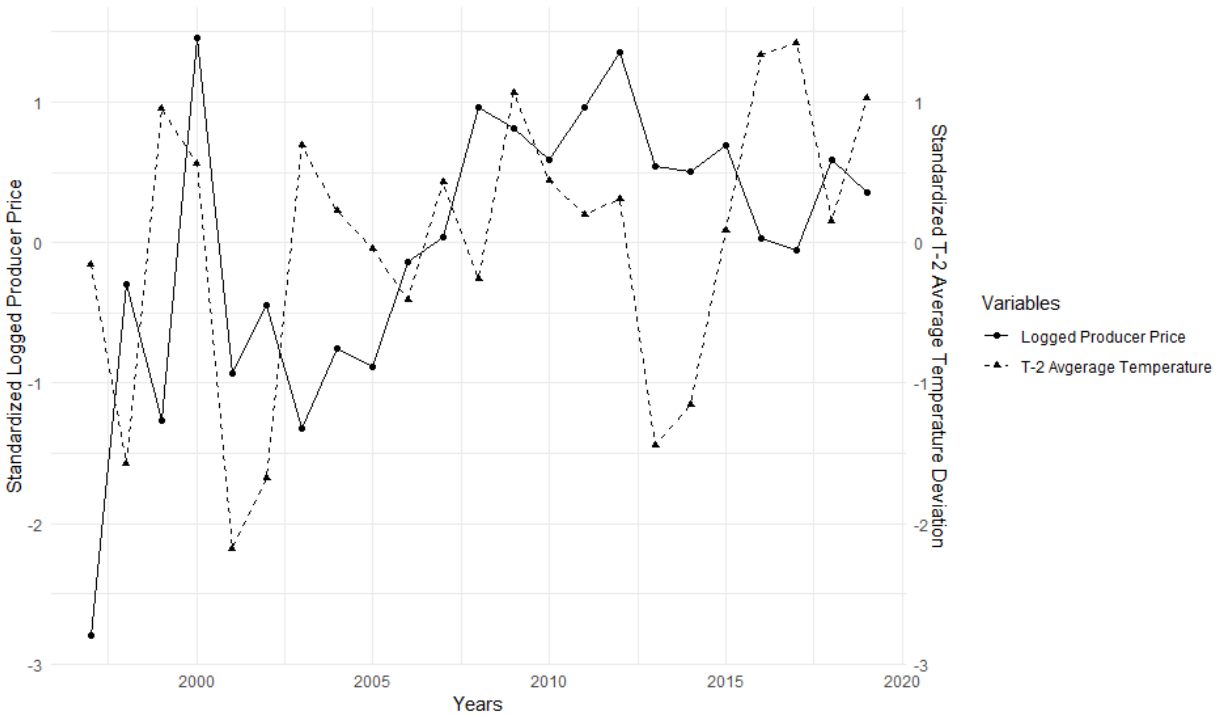
This image represents the avocado soil suitability methodology from Dubrovina and Bautista (2014). Mean annual t is in Celsius, P/T is the ratio of precipitation in inches divided by mean annual temperature, height represents altitude in meters, and January stands for the average temperature in January.

Figure 5: Map of Avocado Index



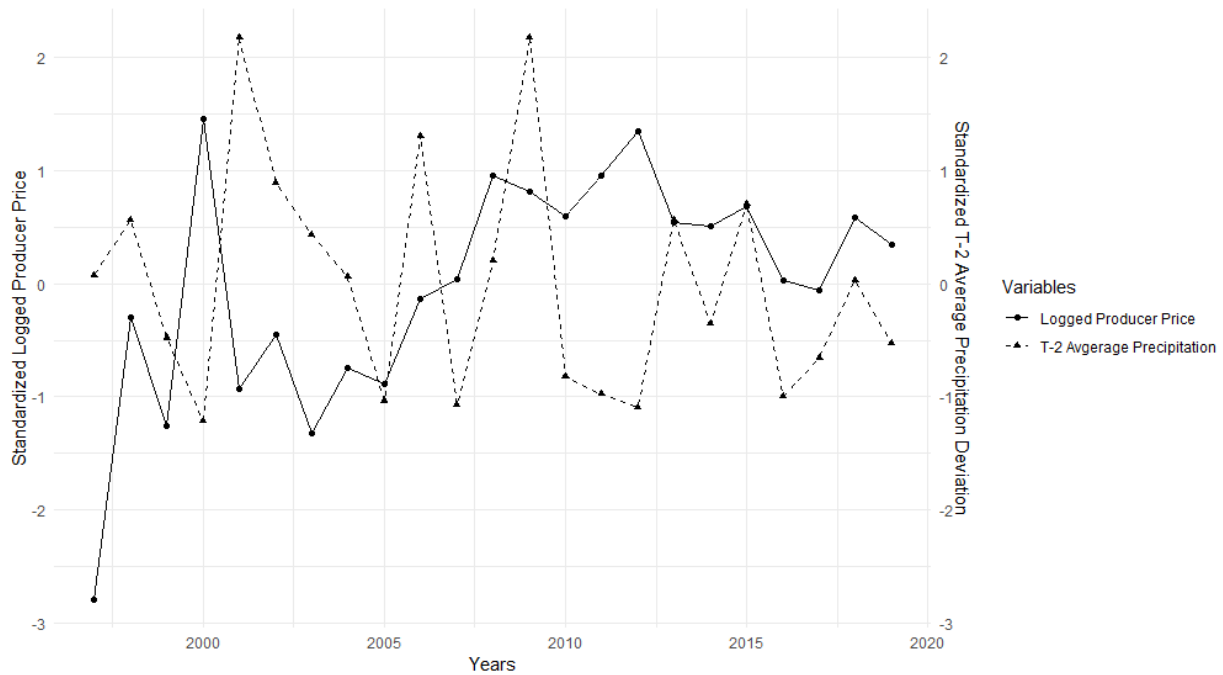
This map spatially shows the distribution of the data sample's avocado suitability index values. The inset map at the bottom left shows a zoomed-in map of the sample. The sample includes Michoacán and all of its bordering states. White represents municipalities that are not suitable for avocado trees, while the darker the green in a municipality the more suitable it is for avocados. The darkest green spot in the center is Michoacán's avocado-producing belt.

Figure 6: Producer Price and T-2 Average Temperature Deviation Comparison



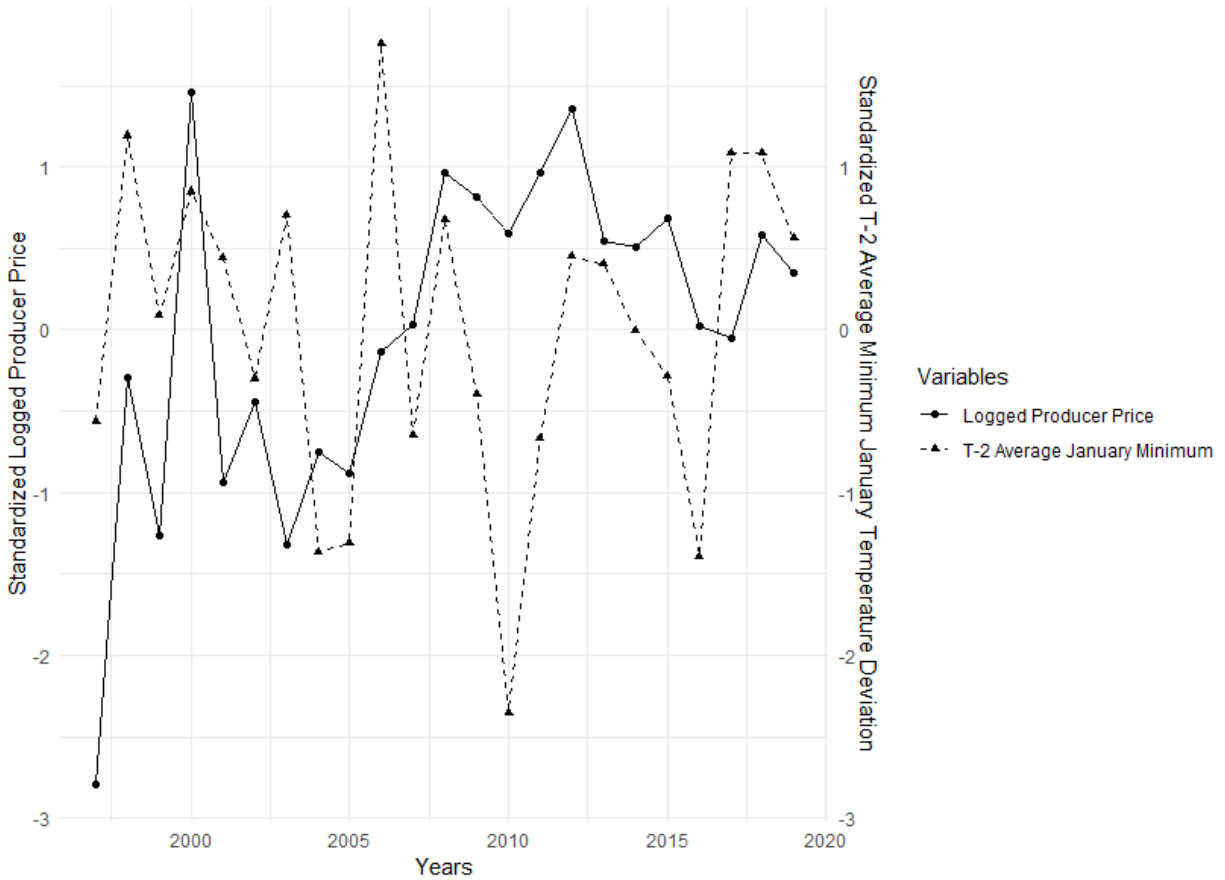
The solid line with circles represents the standardized logged real Mexican producer price (USD/Ton) from 1997 to 2019. The dashed line with triangles shows the standardized two-year lag of the average temperature deviation (in degrees) from producer price among California’s avocado-producing region. To calculate the U.S. weather deviations, I take the difference of a year’s California avocado-producing county’s average temperature from April-July with NOAA’s 1900-2000 mean temperature from April-July. California’s county average temperature data comes from NCEI and producer prices come from FAO.

Figure 7: Producer Price and T-2 Average Precipitation Deviation Comparison



The solid line with circles represents the standardized logged real Mexican producer price (USD/Ton) from 1997 to 2019. The dashed line with triangles shows the standardized two-year lag of the average precipitation (in inches) deviation from producer price among California’s avocado-producing region. To calculate the U.S. precipitation deviations, I take the difference of a year’s California avocado-producing county’s average precipitation from April-July with NOAA’s 1900-2000 mean temperature from April-July. Data for California county precipitation comes from NCEI and producer prices come from FAO.

Figure 8: Producer Price and T-2 Average Minimum January Temperature Deviation Comparison



The solid line with circles represents the standardized logged real Mexican producer price (USD/Ton) from 1997 to 2019. The dashed line with triangles shows the standardized two-year lag of the average annual minimum temperature in January (in degrees) deviation from producer price among California’s avocado-producing counties. To calculate the U.S. average minimum January temperature deviations, I take the difference of a year’s California avocado-producing county’s average January minimum temperature with NOAA’s 1900-2000 mean average January minimum temperature. Data for California county average minimum January temperature comes from NCEI and producer prices come from FAO.

Table 1: Summary Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
<i>Panel-level municipal variables</i>					
Homicides	10,285	3.940	8.208	0	155
Homicide Rate Per 1,000 People	10,285	0.147	0.243	0	3.898
El Niño	10,285	0.352	0.478	0	1
Population	1,380	26,950.76	21,508.45	2,082	99,870
Economically Active Persons	1,380	8,507.998	7,517.544	463	40,277
Primary Education Completion	1,380	3,547.56	2,875.09	218	14,609
<i>Cross-sectional municipal variables</i>					
Index 1 (Geometric Mean)	460	1.125	0.944	0	3
Index 2 (Product Function)	460	7.032	3.497	3	17
Mexico 1980 - 2010 Temperature Avg. (Celcius)	460	19.620	4.050	10	29.5
Mexico 1980 - 2010 Precipitation Avg. (Celcius)	460	874.144	272.170	302.8	2,267.9
<i>Annual-level variables</i>					
Real Mexico Producer Price (USD/Ton)	23	603.258	118.463	404.940	828.262
Real FAS Converted Import Price (USD/KG)	23	1.387	0.174	1.059	1.920
Real Not FAS Converted Import Price (USD/MT)	23	1,471.068	330.14	1,100.321	2,512
Lagged Avg. Temp. Deviation (Degrees)	23	1.83	1.547	-1.61	4.085
Lagged Avg. Prec. Deviation (Inches)	23	-0.022	1.050	-1.33	2.31
Lagged Avg. Minimum Temp Deviation(Degrees)	23	2.491	2.259	-2.9	6.53

Note: See data section for definitions of variables.

Table 2: Main Results

	(1)	(2)	(3)	(4)
	Homicide	Homicide	Homicide	Homicide
$\text{Index}_i \cdot \text{Ln}(\text{Producer Price})_{t-1}$	-0.139** (0.069)	-0.183*** (0.049)	-0.190*** (0.067)	-0.190*** (0.068)
Estimation Method	ZINB	IV-ZINB	ZINB	ZINB
State FE	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	Yes
Municipality FE	No	No	Yes	Yes
Right Hand Controls	Yes	Yes	No	Yes
Zero Observations	3,926	3,926	3,926	3,926
F-Stat (1st Stage)	-	1.1e+07	-	-
N	10,285	10,285	10,285	10,285

Note: All columns display zero-inflated negative binomial regressions. Columns 1,3, and 4 include robust standard errors clustered at the municipal level in parenthesis. Column 2 includes bootstrapped robust standard errors clustered at the municipal level with 1000 replications in parenthesis. Variables not shown and included in regressions with right-hand controls include log population, percent of the population with primary education completion, logged population that is 15 years or older and economically active, and a dummy accounting for what years El Niño takes place. The F-statistic in each multistage regression refers to the Angrist-Pischke F-statistic of excluded instruments. In column 2, the interaction term of the avocado suitability index and logged real producer price is instrumented with the interaction of the avocado suitability index and two-year lagged (in relation to price) weather conditions in the U.S. (average temperature, precipitation, and minimum January temperature). *** is significant at the 1 percent level, ** is significant at the 5 percent level, and * is significant at the 10 percent level.

Table 3: Results with Different Methods

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Homicide	Homicide	Homicide	Homicide	Homicide	Homicide	Homicide	Homicide	Homicide	Homicide
Index _t · Ln(Producer Price) _{t-1}	-0.450** (0.226)	-0.559*** (0.190)	-0.915*** (0.285)	-0.965*** (0.257)	-0.317*** (0.116)	-0.328*** (0.115)	-0.385* (0.212)	-0.606* (0.160)	-0.503* (0.261)	-0.537** (0.261)
Estimation Method	IV-NB	IV-NB	IV-Poisson	IV-Poisson	2SLS	2SLS	2SLS	2SLS	IV-Probit	IV-Probit
Right Hand Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
State FE	Yes	Yes	Yes	Yes	No	No	No	No	No	No
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
F-Stat (1st Stage)	2.8e+07	1.1e+07	2.8e+07	1.1e+07	5.5e+04	1.3e+04	257.400	258.901	2.8e+07	1.1e+07
N	10,285	10,285	10,285	10,285	10,285	10,285	6,359	6,359	9,436	9,436
Pseudo R ²	0.064	0.117	0.221	0.4109	-	-	-	-	-	-
R ²	-	-	-	-	0.596	0.599	0.509	0.515	-	-

Note: Bootstrapped robust standard errors clustered at the municipal level with 1000 replications are in parenthesis. Variables not shown and included in regressions with right-hand controls include log population, percent of the population with primary education completion, logged population that is 15 years or older and economically active, and a dummy accounting for what years El Niño takes place. Columns 1-2 display the main multistage results for a negative binomial regression, columns 3-4, show the multistage Poisson regressions, columns 5-6 display 2SLS results for when the dependent variable is log(homicide+1), columns 7-8, represent the results of when the dependent variable is log(homicide), and Columns 9-10 display the 2-stage probit results. For all columns, the interaction term of the avocado suitability index and logged lag real producer price is instrumented with the interaction of the avocado suitability index and two-year lagged (in relation to price) weather conditions in the U.S. (average temperature, precipitation, and minimum January temperature). *** is significant at the 1 percent level, ** is significant at the 5 percent level, and * is significant at the 10 percent level.

Table 4: Mechanism

	(1)	(2)	(3)	(4)	(5)	(6)
	Agriculture Emp.	Agriculture Emp.	Manufacturing Emp.	Manufacturing Emp.	Services Emp.	Services Emp.
Treat _t * Index _t	0.046*** (0.018)	0.035*** (0.012)	0.0008 (0.023)	0.015 (0.020)	0.016 (0.015)	0.007 (0.011)
Right Hand Controls	No	Yes	No	Yes	No	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
R ²	0.977	0.990	0.978	0.987	0.992	0.996
N	908	908	908	908	908	908

Note: Robust standard errors clustered at the municipal level are shown in parentheses. Variables not shown and included in regressions with right-hand controls include log population, economically active persons, primary education completion, homes with non-dirt flooring, homes with running water, and homes with electricity. Additional right-hand controls not shown include the 1980-2010 average municipal level temperature and precipitation. Columns 1 and 2 evaluate the association of the avocado suitability index with the change in agricultural employment from 1990 to 2000. The dependent variables in columns 3-4 and 5-6 are manufacturing and services employment, respectfully. All left-hand variables are logged.

Table 5: Results for Different IVs

	(1)	(2)	(3)
	Homicide	Homicide	Homicide
Index \cdot Ln(ProducerPrice) $_{t-1}$	-0.544*** (0.211)	-0.232** (0.113)	-0.145* (0.078)
Index $_i \cdot$ USTemp $^2_{t-3}$	Yes	No	Yes
Index $_i \cdot$ USPrec $^2_{t-3}$	Yes	No	Yes
Index $_i \cdot$ USMin $^2_{t-3}$	Yes	No	Yes
Index $_i \cdot$ Log(ProducerPrice) $_{t-2}$	No	Yes	Yes
Index $_i \cdot$ USTemp $_{t-3}$	No	No	Yes
Index $_i \cdot$ USPrec $_{t-3}$	No	No	Yes
Index $_i \cdot$ USMin $_{t-3}$	No	No	Yes
Year FE	Yes	Yes	Yes
State FE	Yes	Yes	Yes
Right Hand Controls	Yes	Yes	Yes
F-Stat	2.6e+07	6.9e+07	1.9e+08
N	10,285	10,285	10,285

Note: All columns display zero-inflated negative binomial regressions. Bootstrapped robust standard errors clustered at the municipal level with 1000 replications are in parenthesis. Variables not shown and included in regressions with right-hand controls include log population, percent of the population with primary education completion, logged population that is 15 years or older and economically active, and a dummy accounting for what years El Niño takes place. The F-statistic in each multistage regression refers to the Angrist-Pischke F-statistic of excluded instruments. Column 1 includes squared weather IVs while column 2 includes a lagged producer price IV. LASSO machine learning shows all 7 IVs are relevant to the model. Column 3 shows the results of including all 7 IVs. *** is significant at the 1 percent level, ** is significant at the 5 percent level, and * is significant at the 10 percent level.

Table 6: Heterogeneous Effects - Main Results for 2007-2019

	(1)	(2)	(3)	(4)
	Homicide	Homicide	Homicide	Homicide
Index _{<i>i</i>} · Ln(<i>ProducerPrice</i>) _{<i>t</i>-1}	0.454*** (0.168)	0.367*** (0.095)	0.391*** (0.150)	0.397*** (0.149)
Estimation Method	ZINB	IV-ZINB	ZINB	ZINB
State FE	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	Yes
Municipality FE	No	No	Yes	Yes
Right Hand Controls	Yes	Yes	No	Yes
Zero Observations	3,926	3,926	3,926	3,926
F-Stat (1st Stage)	-	5.2e+09	-	-
N	5,740	5,740	5,740	5,740

Note: All columns display zero-inflated negative binomial regressions. Columns 1,3, and 4 include robust standard errors clustered at the municipal level in parenthesis. Column 2 includes bootstrapped robust standard errors clustered at the municipal level with 1000 replications in parenthesis. Variables not shown and included in regressions with right-hand controls include log population, percent of the population with primary education completion, logged population that is 15 years or older and economically active, and a dummy accounting for what years El Niño takes place. The F-statistic in each multistage regression refers to the Angrist-Pischke F-statistic of excluded instruments. In column 2, the interaction term of the avocado suitability index and logged real producer price is instrumented with the interaction of the avocado suitability index and two-year lagged (in relation to price) weather conditions in the U.S. (average temperature, precipitation, and minimum January temperature). *** is significant at the 1 percent level, ** is significant at the 5 percent level, and * is significant at the 10 percent level.

Table 7: Results for Crime from 2011-2017

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Property	Property	Cattle Theft	Cattle Theft	Gun	Gun	Rape	Rape
Index _i · Ln(ProducerPrice) _{t-1}	0.407*** (0.127)	0.561** (0.233)	0.446** (0.214)	0.927* (0.474)	0.689*** (0.261)	1.532*** (0.470)	0.172 (0.177)	0.605 (0.370)
Estimation Method	NB	IV-NB	ZINB	IV-ZINB	ZINB	IV-ZINB	ZINB	IV-ZINB
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Right Hand Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-Stat	-	2.2e+07	-	2.2e+07	-	2.2e+07	-	2.2e+07
N	2,316	2,316	2,316	2,316	2,316	2,316	2,316	2,316
Pseudo R ²	0.188	0.187	-	-	-	-	-	-

Note: Columns 1-2 show results for negative binomial regressions. Columns 3-8 display zero-inflated negative binomial regressions. Odd number columns include robust standard errors clustered at the municipal level in parenthesis. Even numbered columns include bootstrapped robust standard errors clustered at the municipal level with 1000 replications in parenthesis. The response variables are number of reported property crimes, cattle theft, homicide by gun fire, and sexual assault. Variables not shown and included in regressions with right-hand controls include log population, percent of the population with primary education completion, logged population that is 15 years or older and economically active, and a dummy accounting for what years El Niño takes place. The F-statistic in each multistage regression refers to the Angrist-Pischke F-statistic of excluded instruments. For even numbered columns, the interaction term of the avocado suitability index and logged real producer price is instrumented with the interaction of the avocado suitability index and two-year lagged (in relation to price) weather conditions in the U.S. (average temperature, precipitation, and minimum January temperature). *** is significant at the 1 percent level, ** is significant at the 5 percent level, and * is significant at the 10 percent level.

8 Appendix A

Avocado tree roots are susceptible to soil types. They require both a large volume of water and low hydraulic conductivity. To compute the suitability of a municipality's soil, I take advantage of INEGI's detailed edaphology data to find out the predominant soil in each municipality.²⁵ Applying soil characteristics discussed in Dubrovina and Bautista (2014) and ISRIC World Soil Information, I can classify whether the soil is one of the following: Highly suitable, Suitable, Low Suitability, and No Suitability.

Figure 3 displays characteristics that constitute a soil's avocado suitability. A combination of a base saturation percentage below 42.4 percent and a clay content below 20 percent results in the most suitable soil type for avocado trees.²⁶ Other important factors impacting a soil's avocado tree suitability are its depth, aggregate shape, hydraulic conductivity, and clay content. Avocado trees grow best in soil with a depth greater than 48 cm. Soils that are angular blocky, granular, and/or powdery are suitable, while massive aggregate shapes result in no suitability. If the soil has a high base saturation, deep depth, and a crumb aggregate shape, then the soil's hydraulic conductivity and/or clay content decides its avocado suitability. In this case, low hydraulic conductivity is suitable for avocado trees, but very high hydraulic conductivity results in low suitability. In addition, if the hydraulic conductivity is high and the clay content is equal to or less than 28 percent, the soil offers low suitability. However, if the clay content is above 28 percent, then the soil is suitable. If the municipality's most common soil is highly suitable, then I give it a soil value of 3, I give the municipality's soil a 2 value if its suitable, 1 if the soil has low suitability, and 0 if the soil has no suitability for avocado trees. I denote soil S in municipality i as S_i . I base the value of soil on the most common soil in a municipality. Table A3 in the appendix provides the general characteristics and index values of dominant municipality soils in the sample.

The second portion of the index takes into account a municipality's climate. Key climate components of a municipality's avocado suitability include mean annual temperature (Celsius), the ratio of precipitation (inches) to mean annual temperature (P/T), altitude (meters), and average temperature in January. Weather averages for mean annual temperature, precipitation, and the month of January at the municipal level come from SMN's

²⁵INEGI's edaphology data is publicly available on the following website: <https://en.www.inegi.org.mx/temas/edafologia/>

²⁶Avocado trees require very distinctive conditions that are uncommon worldwide. Andosol is the only highly suitable soil based on the methods of Dubrovina and Bautista (2014). It is also the world's rarest soil. Michoacán has a large landmass of Andosol soil that helps make it arguably the most conducive climate for avocados worldwide.

1980-2010 weather station averages. A municipality's altitude range comes from INEGI's edaphology data.

Figure 4 shows what determines a municipality's avocado climate suitability value. Like the soil calculations, a municipality can have one of the following values for avocado suitability: Highly Suitable, Suitable, Low Suitability, and No Suitability. Avocados are highly sensitive to frosts, heat waves, and water volume. A mean annual temperature equal to or below 11.9 Celsius is not suitable for avocado trees. If a municipality's mean annual temperature is above 11.9 Celcius and its P/T is below 40.6, then it has low suitability. In the same case, if its P/T value is above 40.6 and its altitude is above 2,505 meters, it has low suitability.²⁷ A high mean annual temperature, high P/T value, altitude below 2,505 meters, and an average January temperature equal to or below 15.7 would lead to a suitable climate. Otherwise, if a municipality's average January temperature is above 15.7 Celcius, the climate value depends on the magnitude of the P/T ratio. A P/T value, in this case, above 53.9 would result in a highly suitable climate, while a value below or equal to 53.9 represents a suitable climate. I give a value of 3 to a municipality with a highly suitable climate, 2 to a suitable climate, 1 for low suitability, and 0 for no suitability. I denote climate C in municipality i as C_i . Equation 1 displays the conditional function of a municipality's avocado suitability index in municipality i.

²⁷Municipalities have varying altitudes. Based on Figure 4, if a municipality has an altitude range only above 2,505 meters then the I classify the municipality as having low suitability. Otherwise, I also consider January temperature and/or the P/T value.

Table A1: Results with Import Prices

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Homicide	Homicide	Homicide	Homicide	Homicide	Homicide	Homicide	Homicide
Index _{<i>i</i>} , $\ln(\text{ImportPrice})_{t-1}$	-0.376*** (0.111)	-0.397*** (0.095)	-0.840*** (0.217)	-0.883*** (0.194)	-0.455*** (0.118)	-0.487*** (0.108)	-0.966*** (0.278)	-0.989*** (0.251)
Estimation Method	ZINB	ZINB	IV-ZINB	IV-ZINB	ZINB	ZINB	IV-ZINB	IV-ZINB
FAS Converted	No	No	No	No	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Right Hand Controls	No	Yes	No	Yes	No	Yes	No	Yes
Zero Observations	3,926	3,926	3,926	3,926	3,926	3,926	3,926	3,926
F-Stat (1st Stage)	-	-	5.3e+08	1.5e+08	-	-	7.8e+05	2.2e+05
N	10,285	10,285	10,285	10,285	10,285	10,285	10,285	10,285

Note: All columns display zero-inflated negative binomial regressions. In Columns 1, 2, 5, and 6, robust standard errors clustered at the municipal level are in parenthesis. In columns 3, 4, 7, and 8, bootstrapped robust standard errors clustered at the municipal level with 1000 replications are in parenthesis. Variables not shown and included in regressions with right-hand controls include log population, percent of the population with primary education completion, logged population that is 15 years or older and economically active, and a dummy accounting for what years El Niño takes place. The F-statistic in each multistage regression refers to the Angrist-Pischke F-statistic of excluded instruments. Columns 1-4 display the results with Non-FAS converted import prices while columns 5-8 show the results with FAS converted import prices. *** is significant at the 1 percent level, ** is significant at the 5 percent level, and * is significant at the 10 percent level.

Table A2: Summary Statistics for Mechanism Sample

Variable	Observations	Mean	Std. Dev.	Min	Max
Agricultural Sector	908	2,235.338	1,804.354	84	11,891
Manufacturing Sector	908	1,896.443	2,274.262	8	15,990
Services and Tourism Sector	908	2,469.264	3,115.94	60	25,267
Index	908	1.121	0.943	0	3
Population	908	25,712.41	20,685.69	2,155	99,870
Male Population	908	12,496.690	10,050.820	1,062	49,666
Economically Active Persons	908	6,822.130	6,166.729	402	35,543
Primary Education Completion	908	3,170.077	2,650.768	218	14,609
Homes with Flooring	908	3,708.420	3,526.496	12	19,162
Homes with Running Water	908	3,684.673	3,427.314	23	20,203
Homes with Electricity	908	4,408.247	3,851.832	151	22,029
Temperature	908	19.542	4.058	10	29.5
Precipitation	908	868.904	270.250	302.8	2,267.9

Note: See data section for definitions of variables.

Table A3: Summary Statistics 2 for 2011 - 2017 Analysis

Variable	Observations	Mean	Std. Dev.	Min	Max
<i>Panel-level municipal variables</i>					
Property	2,316	26.352	36.757	0	250
Cattle Theft	2,316	2.595	4.555	0	48
Reported Threats	2,316	5.562	12.736	0	175
Rape	2,316	1.935	2.898	0	26
Highway Robbery	2,316	0.703	2.879	0	51
Kidnapping	2,316	0.300	0.853	0	14
El Niño	2,316	0.375	0.484	0	1
<i>Cross-sectional municipal variables</i>					
Index	438	1.050	0.955	0	3
Mexico 1980 - 2010 Temperature Avg. (Celcius)	438	20.248	3.953	10.9	29.5
Mexico 1980 - 2010 Precipitation Avg. (Celcius)	438	884.335	282.47	302.8	2,267.9
Population 2010 Census	438	27,324.77	21,689.73	2,082	99,576
<i>Annual-level variables</i>					
Real Mexico Producer Price (USD/Ton)	7	640.874	71.054	561.114	805.639
Lagged Avg. Temp. Deviation (Degrees)	7	-0.428	0.742	-1.2	0.73
Lagged Avg. Prec. Deviation (Inches)	7	-0.022	1.050	-1.33	2.31
Lagged Avg. Minimum Temp Deviation(Degrees)	7	2.297	1.880	-0.686	5

Note: See data section for definitions of variables.

Table A4: Summary Statistics for 11 States

Variable	Observations	Mean	Std. Dev.	Min	Max
<i>Panel-level municipal variables</i>					
Homicides	13,456	3.560	7.493	0	155
Homicide Rate Per 100,000 People	13,456	13.657	23.019	0	389.805
El Niño	13,456	0.35	0.477	0	1
Population	1,797	26,135.560	21,129.600	1,346	99,870
Economically Active Persons	1,797	8,649.358	7,570.855	242	44,098.010
Primary Education Completion	1,797	3,400.872	2,778.099	143	14,608.990
<i>Cross-sectional municipal variables</i>					
Index (Geometric Mean)	599	1.027	0.935	0	3
Index (Product Function)	599	6.659	3.412	3	17
Mexico 1980 - 2010 Temperature Avg. (Celcius)	599	19.610	3.964	2.2	29.5
Mexico 1980 - 2010 Precipitation Avg. (Celcius)	599	843.119	332.106	302.8	2,809.600
<i>Annual-level variables</i>					
Real Mexico Producer Price (USD/Ton)	23	603.501	118.294	404.940	828.262
Real FAS Converted Import Price (USD/KG)	23	1.387	0.174	1.059	1.920
Real Not FAS Converted Import Price (USD/MT)	23	1,471.828	330.751	1,100.321	2,512
Lagged Avg. Temp. Deviation (Degrees)	23	1.885	2.750	-4.830	12.255
Lagged Avg. Prec. Deviation (Inches)	23	-0.024	1.456	-3.99	6.93
Lagged Avg. Minimum Temp Deviation(Degrees)	23	2.557	3.911	-8.700	19.590

Note: See data section for definitions of variables.

Table A5: Main Results of Table 2 Expanded to 11 States

	(1)	(2)	(3)	(4)
	Homicide	Homicide	Homicide	Homicide
Index _{<i>i</i>} · Ln(<i>ProducerPrice</i>) _{<i>t</i>-1}	-0.121** (0.056)	-0.580*** (0.169)	-0.119** (0.056)	-0.135** (0.055)
Estimation Method	ZINB	IV-ZINB	ZINB	ZINB
State FE	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	Yes
Municipality FE	No	No	Yes	Yes
Right Hand Controls	Yes	Yes	No	Yes
Zero Observations	5,241	5,241	5,241	5,241
F-Stat (1st Stage)	-	1.3e+07	-	-
N	13,456	13,456	13,456	13,456

Note: All columns display zero-inflated negative binomial regressions. Columns 1,3, and 4 include robust standard errors clustered at the municipal level in parenthesis. Column 2 includes bootstrapped robust standard errors clustered at the municipal level with 1000 replications in parenthesis. Variables not shown and included in regressions with right-hand controls include log population, percent of the population with primary education completion, logged population that is 15 years or older and economically active, and a dummy accounting for what years El Niño takes place. The F-statistic in each multistage regression refers to the Angrist-Pischke F-statistic of excluded instruments. In column 2, the interaction term of the avocado suitability index and logged real producer price is instrumented with the interaction of the avocado suitability index and two-year lagged (in relation to price) weather conditions in the U.S. (average temperature, precipitation, and minimum January temperature). *** is significant at the 1 percent level, ** is significant at the 5 percent level, and * is significant at the 10 percent level.

Table A6: Mechanism for 11 State Sample

	(1)	(2)	(3)	(4)	(5)	(6)
	Agricultural Emp.	Agricultural Emp.	Manufacturing Emp.	Manufacturing Emp.	Services Emp.	Services Emp.
Treat _{<i>t</i>} * Index _{<i>i</i>}	0.056*** (0.016)	0.035*** (0.011)	0.013 (0.021)	0.015 (0.018)	0.027* (0.014)	0.008 (0.010)
Right Hand Controls	No	Yes	No	Yes	No	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
R ²	0.976	0.990	0.976	0.986	0.991	0.996
N	1,179	1,179	1,179	1,179	1,179	1,179

Note: Robust standard errors clustered at the municipal level are shown in parentheses. Variables not shown and included in regressions with right-hand controls include log population, economically active persons, primary education completion, homes with non-dirt flooring, homes with running water, and homes with electricity. Additional right-hand controls not shown include the 1980-2010 average municipal level temperature and precipitation. Columns 1 and 2 evaluate the association of the avocado suitability index with the change in agricultural employment from 1990 to 2000. The dependent variables in columns 3-4 and 5-6 are manufacturing and services employment, respectfully. All left-hand variables are logged.

Table A7: Main Results Without Michoacán

	(1)	(2)	(3)	(4)
	Homicide	Homicide	Homicide	Homicide
$\text{Index}_i \cdot \text{Ln}(\text{ProducerPrice})_{t-1}$	-0.130*	-0.258***	-0.187**	-0.197**
	(0.077)	(0.063)	(0.078)	(0.077)
Estimation Method	ZINB	IV-ZINB	ZINB	ZINB
State FE	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	Yes
Right Hand Controls	Yes	Yes	No	Yes
Zero Observations	2,923	2,923	2,923	2,923
F-Stat (1st Stage)	-	5.3e+06	-	-
N	7,839	7,839	7,839	7,839

Note: This table displays the main results when Michoacán is omitted from the sample. All columns display zero-inflated negative binomial regressions. Columns 1,3, and 4 include robust standard errors clustered at the municipal level in parenthesis. Column 2 includes bootstrapped robust standard errors clustered at the municipal level with 1000 replications in parenthesis. Variables not shown and included in regressions with right-hand controls include log population, percent of the population with primary education completion, logged population that is 15 years or older and economically active, and a dummy accounting for what years El Niño takes place. The F-statistic in each multistage regression refers to the Angrist-Pischke F-statistic of excluded instruments. In column 2, the interaction term of the avocado suitability index and logged real producer price is instrumented with the interaction of the avocado suitability index and two-year lagged (in relation to price) weather conditions in the U.S. (average temperature, precipitation, and minimum January temperature). *** is significant at the 1 percent level, ** is significant at the 5 percent level, and * is significant at the 10 percent level.

Table A8: Main Results with Import Prices and Municipality Fixed Effects

	(1)	(2)	(3)	(4)
	Homicide	Homicide	Homicide	Homicide
$\text{Index}_i \cdot \text{Ln}(\text{ImportPrice})_{t-1}$	-0.371*** (0.095)	-0.378*** (0.094)	-0.458*** (0.104)	-0.474*** (0.103)
Estimation Method	ZINB	ZINB	ZINB	ZINB
Municipality FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Right Hand Controls	No	Yes	No	Yes
Zero Observations	3,926	3,926	3,926	3,926
Price	Non FAS Conv.	Non FAS Conv.	FAS Conv.	FAS Conv.
N	10,285	10,285	10,285	10,285

Note: This table shows the results of using either Non-FAS converted import price or FAS converted import prices instead of producer price with municipality fixed effects. For columns 1-4, robust standard errors clustered at the municipal level are shown in parentheses. All columns display zero-inflated negative binomial regressions. Variables not shown and included in regressions with right-hand controls include log population, log male population, percent of the population with primary education completion, logged population that is 15 years or older and economically active, the cross-sectional 1980-2010 municipal temperature and precipitation, and a dummy accounting for what years El Niño takes place. *** is significant at the 1 percent level, ** is significant at the 5 percent level, and * is significant at the 10 percent level.

Table A9: Main Results With Product Function Index

	(1)	(2)	(3)	(4)
	Homicide	Homicide	Homicide	Homicide
$Index_i \cdot Ln(ProducerPrice)_{t-1}$	-0.054*** (0.018)	-0.138*** (0.055)	-0.050*** (0.018)	-0.053*** (0.018)
Estimation Method	ZINB	IV-ZINB	ZINB	ZINB
State FE	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	Yes
Municipality FE	No	No	Yes	Yes
Right Hand Controls	Yes	Yes	No	Yes
Zero Observations	3,926	3,926	3,926	3,926
F-Stat (1st Stage)	-	7.9e+06	-	-
N	10,285	10,285	10,285	10,285

Note: For this table, Index is calculated using the following function: $Index_i = Soil_i * Climate_i + Soil_i + Climate_i + 2$. All columns display zero-inflated negative binomial regressions. Columns 1,3, and 4 include robust standard errors clustered at the municipal level in parenthesis. Column 2 includes bootstrapped robust standard errors clustered at the municipal level with 1000 replications in parenthesis. Variables not shown and included in regressions with right-hand controls include log population, percent of the population with primary education completion, logged population that is 15 years or older and economically active, and a dummy accounting for what years El Niño takes place. The F-statistic in each multistage regression refers to the Angrist-Pischke F-statistic of excluded instruments. In column 2, the interaction term of the avocado suitability index and logged real producer price is instrumented with the interaction of the avocado suitability index and two-year lagged (in relation to price) weather conditions in the U.S. (average temperature, precipitation, and minimum January temperature). *** is significant at the 1 percent level, ** is significant at the 5 percent level, and * is significant at the 10 percent level.

Table A10: First Stage Results of Table 2

	(1)
	Index · Ln(ProducerPrice) _{t-1}
Index _i · USTemp _{t-3}	0.010*** (0.000)
Index _i · USPrec _{t-3}	-0.055*** (0.000)
Index _i · USMin _{t-3}	0.023*** (0.000)
F-Stat	1.1e+07
Year FE	Yes
State FE	Yes
Right Hand Controls	Yes
N	10,285

Note: Robust standard errors clustered at the municipal level are shown in parentheses. This table displays the first-stage results for Table 2. *** is significant at the 1 percent level, ** is significant at the 5 percent level, and * is significant at the 10 percent level.

Table A11: First Stage Results With 7 IVs

	(1)
	$\text{Index}_i \cdot \text{Ln}(\text{ProducerPrice})_{t-1}$
$\text{Index}_i \cdot \text{USTemp}_{t-3}$	0.084*** (0.000)
$\text{Index}_i \cdot \text{USPrec}_{t-3}$	-0.093*** (0.000)
$\text{Index}_i \cdot \text{USMin}_{t-3}$	0.021*** (0.000)
$\text{Index}_i \cdot \text{USTemp}_{t-3}^2$	-0.35*** (0.000)
$\text{Index}_i \cdot \text{USPrec}_{t-3}^2$	-0.043*** (0.000)
$\text{Index}_i \cdot \text{USMin}_{t-3}^2$	0.005*** (0.000)
$\text{Index}_i \cdot \text{Ln}(\text{ProducerPrice})_{t-2}$	0.525*** (0.001)
F-Stat	2.0e+08
Year FE	Yes
State FE	Yes
Right Hand Controls	Yes
N	10,285

Note: Robust standard errors clustered at the municipal level are shown in parentheses. This table displays the first-stage results for Table 5. *** is significant at the 1 percent level, ** is significant at the 5 percent level, and * is significant at the 10 percent level.

Table A12: Results with Different Weather Lags

	(1)	(2)
	Homicide	Homicide
$\text{Index}_i \cdot \text{Ln}(\text{ProducerPrice})_{t-1}$	0.123 (0.118)	-0.466*** (0.130)
Year	t-2	t-4
Year FE	Yes	Yes
State FE	Yes	Yes
Right Hand Controls	Yes	Yes
F-Stat	3.1e+07	4.1e+07
N	10,285	10,285

Note: Robust standard errors clustered at the municipal level are shown in parentheses. Variables not shown and included in regressions with right-hand controls include log population, percent of the population with primary education completion, logged population that is 15 years or older and economically active, and a dummy accounting for what years El Niño takes place. Column 1 shows the results of using 1 year weather lag instruments in relation to producer prices. Column 2 displays the results of using 3 year weather lag instruments in relation to producer prices. *** is significant at the 1 percent level, ** is significant at the 5 percent level, and * is significant at the 10 percent level.

Table A13: Results for Other Crime from 2011-2017

	(1)	(2)	(3)	(4)	(5)	(6)
	Threats	Threats	Highway Robbery	Highway Robbery	Kidnapping	Kidnapping
Index _i · Ln(ProducerPrice) _{t-1}	0.622** (0.262)	0.261 (0.374)	-0.559 (0.638)	0.107 (0.787)	0.324 (0.242)	0.866 (0.609)
Estimation Method	ZINB	IV-ZINB	NBREG	IV-NBREG	ZINB	IV-ZINB
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Right Hand Controls	Yes	Yes	Yes	Yes	Yes	Yes
F-Stat	-	2.2e+07	-	2.2e+07	-	2.2e+07
N	2,316	2,316	2,316	2,316	2,316	2,316

Note: Columns 1-2 and 5-6 show results for zero-inflated negative binomial regressions. Columns 3-4 display negative binomial regressions. Odd number columns include robust standard errors clustered at the municipal level in parenthesis. Even numbered columns include bootstrapped robust standard errors clustered at the municipal level with 1000 replications in parenthesis. The response variable for columns 1-2 is reported threats, columns 3-4 is highway robberies, and columns 5-6 is kidnappings. Variables not shown and included in regressions with right-hand controls include log population, percent of the population with primary education completion, logged population that is 15 years or older and economically active, and a dummy accounting for what years El Niño takes place. The F-statistic in each multistage regression refers to the Angrist-Pischke F-statistic of excluded instruments. For even numbered columns, the interaction term of the avocado suitability index and logged real producer price is instrumented with the interaction of the avocado suitability index and two-year lagged (in relation to price) weather conditions in the U.S. (average temperature, precipitation, and minimum January temperature). *** is significant at the 1 percent level, ** is significant at the 5 percent level, and * is significant at the 10 percent level.