"From Guac to Glock: Exploring the Consequences of Avocado Production on Organized Crime in Mexico"

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1 Introduction

In recent years, the popularity of avocados has soared to new heights. The humble fruit has gone from a relatively unknown ingredient to a ubiquitous presence in many households and restaurants around the world. Despite being a traditional ingredient in Mexican cuisine for centuries, avocados have recently gained a reputation as a "superfood," with various health benefits touted by bloggers, social media influencers, and nutritionists. From avocado toast to guacamole, the versatility of this fruit has made it a beloved ingredient among foodies and health enthusiasts alike. However, the impact of the avocado craze extends far beyond social media and brunch menus. In particular, Mexico, the largest exporter of avocados to the United States, has seen drastic effects from the increased demand on its agricultural sector and violent crime rates.

On February 11, 2022, the USDA temporarily banned avocado imports from Mexico after a sanitary inspector was "verbally threatened" in Michoacan, choking the supply of avocados before its biggest event: the Super Bowl (Creswell, 2022). While the ban lasted only 9 days, it was enough to disgruntle unhappy football fans when stores and restaurants ran out of guacamole.[1] But the ban also represented one of many issues in the long history of Mexican cartel influence on licit industries. In an attempt to expand and diversify their

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[1]Approximately 90% of U.S. avocado consumption is supplied from Mexico

portfolios, cartels have latched on to lucrative crop markets, siphoning money from farmers most commonly through extortion and homicides/homicide threats. Between 2009 and 2013, cartels expropriated $770 million from avocado farmers, approximated 13% of total revenue. In extreme cases, cartels have even induced supply shocks to jack up crop prices, allowing them to expropriate higher margins. In 2022, lime prices skyrocketed over 300% after cartels instructed lime farmers to only work 2 days a week (Simon 2022).

While cartels have carved out spheres of influence in the avocado industry, it is less clear whether their entries into the market have increased crime rates. A quick google search provides no shortage of articles claiming that avocados, also known as "green gold," have become the next big conflict commodity in Mexico. The link between avocado producers and cartels is undeniable, but can we say that the explosion in avocado production has increased crime compared to the counterfactual, a world where avocado farmers would have been farming other crops or potentially working for cartels? There are a few competing theories. The U.S. has had a long history of restricting imports from Mexico due to pest and disease concerns and only recently allowed heavily-monitored importing via law changes in 1997 and 2016. These law changes provided opportunities for farmers to switch from illicit crop markets to the avocado market, potentially decreasing the intra-regional influence of cartels[2]. In addition, historical evidence suggests that cartels have various strategies when entering new markets, ranging from territorial fortification and defense (which would lead to decreased violence) to increased aggression in an attempt to stamp out competing gangs (which would lead to increased violence).

Thus, the purpose of this paper is to determine whether the increase in demand for avocados led to an increase in cartel-related violence in Mexico. Using a difference-in-differences (DID) and fixed-effects design centered around the 2016 USDA lifting of import restrictions, we demonstrate that treated municipalities[3] experienced statistically significantly lower rates

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[2]While cartels extort licit markets, they have less relative control over their production and transportation compared to illicit crops since licit crops can be legally exported to the U.S.

[3]Municipalities that started producing avocados for export to the U.S. in 2016 because they were not allowed to previously.

of cartel-related crime and homicide than control municipalities. As the demand for avocados continues to increase year on year, our results have important policy implications for the well-being and safety of avocado producers in Mexico.

The structure of the paper is as follows. We first provide background on the history of avocado imports to the U.S. and the influence of cartels on avocado-producing regions. Then, we discuss related literature on cartel presence and impact on licit markets. Next, we explain our data and design a DID model to investigate the difference in crime rate between treated and untreated municipalities. Finally, we analyze our results and conclude with broader implications and future steps.

2 Background

2.1 Avocado production and imports

The North American Free Trade Agreement (NAFTA) in 1994 promised to lift an import ban on Mexican avocados dating back to 1914. The purpose of the ban was to protect American domestic producers from invasive pests such as weevils, scabs, and moths.[4] While the blanket ban was lifted, the USDA's Animal and Plant Health Inspection Service (APHIS) continued to demand strict regulations on all steps in the avocado production process and limited imports to Mexico's most developed avocado production state, Michoacan. In partnership with Mexico's Secretariat of Agriculture, Livestock, Rural Development, Fisheries, and Food (SAGARPA), APHIS imposed requirements for inspection and cleaning at packing centers, criteria for shipment rejection, detailed documentation and storage before transportation, and timely pest inspections at numerous supply chain choke points (SAGARPA, 2005).

As of a result of these guidelines, until 2015, only 24 municipalities in the state of Michoacan were approved to ship avocados to the U.S.[5] These were the municipalities that were

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[4]Five specific pests mentioned in USDA literature are: stem weevils (*Copturus aguacatae*); seed weevils (*Conotrachelus aguacatae*, *Conotrachelus perseae*, and *Heilipus lauri*); and seed moths (*Stenoma catenifer*).

[5]Acuitzio, Tancitaro, Uruapan, Ting¨uindin, Salvador Escalante, Nuevo Parangaricutiro, Periban de Ramos, Ario, Los Reyes, Apatzingan, Taretan, Tacambaro, Tingambato, Madero, Cotija de la Paz, Erongaricuaro, Tocumbo, Tuxpan, Irimbo, Hidalgo, Turicato, Ziracuaretiro, Paracuaro, and Tangamandapio.

both located in the Trans-Mexican Volcanic Belt[6] and possessed or were able to develop avocado collection, packing, and transportation infrastructure in accordance with APHIS guidelines. Nevertheless, the U.S. and Mexico had become each other's largest trading partner with respect to avocados. 80% of Mexican avocado exports were sent to the U.S., and this accounted for approximately 90% of U.S. avocado consumption (USAID, 2014).

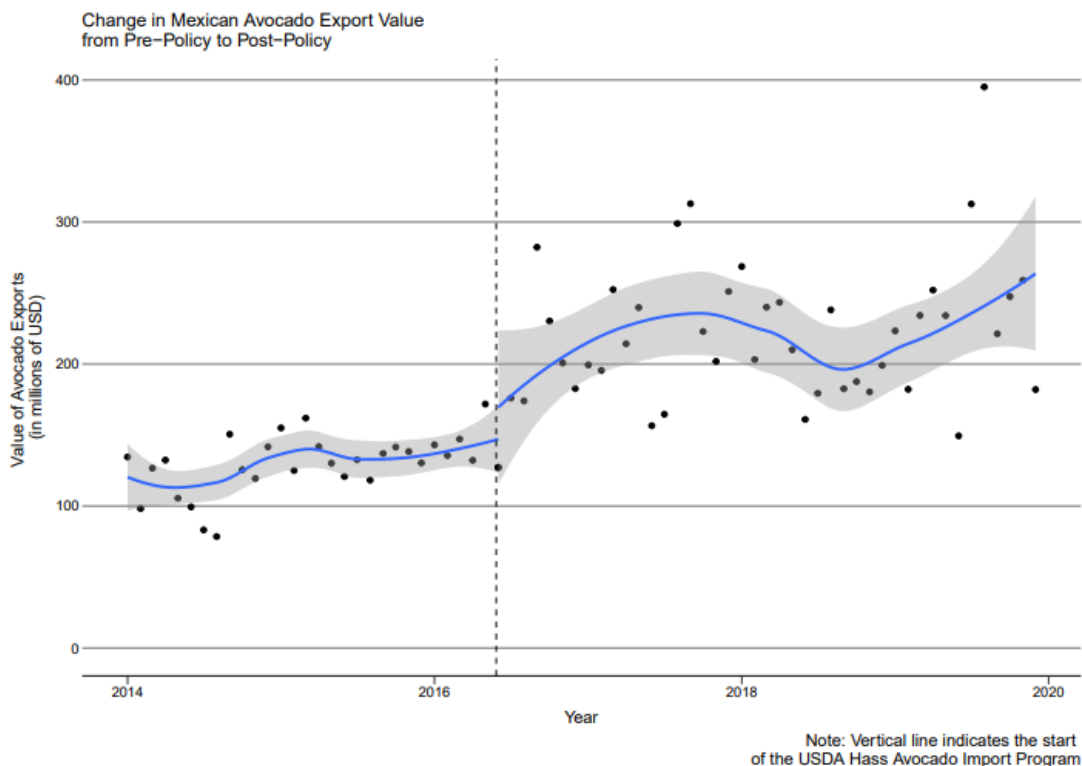The landscape of production and export changed in 2015 when APHIS announced a revision

Figure 1: Mexican avocado exports over time

in avocado policy that would allow all municipalities to export avocados to the U.S. as long as they met the requirements established post-NAFTA (USDA, 2016). The final policy was signed and enacted in June 2016, and the Volcanic Belt states of Jalisco, Mexico, Michoacan, Morelos, and Nayarit consequently saw massive increases in production of avocados, primarily aimed at export to the U.S, over the next few years. Figure 1 shows the impact of the U.S. import law change on Mexican avocado exports.[7]

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[6]Ideal soil and weather conditions for avocado farming.

[7]Created from U.S. Global Agricultural Trade System query.

2.2 Cartels in Michoacan and nearby states

Organized crime groups in Mexico, commonly referred to as cartels, function as highly efficient criminal enterprises that are involved in various illegal activities, including drug trafficking, extortion, and violence. Cartels operate as a decentralized network of independent factions that share common goals and collaborate in the drug trade. They are typically led by a few powerful individuals known as "capos," who are responsible for coordinating the group's activities and maintaining control over their territory. Cartels often rely on a complex system of alliances and rivalries with each other, which can shift over time as new factions emerge or existing ones are weakened. They frequently engage in violent conflicts with each other over control of lucrative drug trafficking routes and territory and use violence to intimidate and control local communities and government officials.

Cartels have increasingly entered licit markets as a way to diversify their revenue streams, launder money, and legitimize their businesses. This allows them to operate more openly and avoid the scrutiny of law enforcement agencies. Regarding agricultural markets and avocados in particular, cartels have infiltrated the industry through various points in the supply chain. Whether coercing farmers to join their organization or demanding "safe transportation" taxes from exporters that operate within their regions of control, cartels rely on threats of violence to ensure local cooperation with their illegal activities.

The presence of cartels in Michoacan dates back to the 1980s. A common theme of violent displacement of established cartels by new ones proceeded until 2006. Los Valencias maintained a drug empire involved in trafficking cocaine, marijuana, and methamphetamines in the 1980s and 1990s until violently expelled by Los Zetas in 1999. Los Zetas was the first cartel to expand extortion to licit markets, including avocados (Ornelas, 2018). They were ultimately uprooted by La Familia Michoacana who provided temporary protection to agricultural producers until defeating Los Zetas.[8]

La Familia Michoacana was ultimately destroyed when Felipe Calderon became presi-

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[8]Afterwards, La Familia Michoacana charged farmers for their "protective services."

dent in 2006 and started the Mexican Drug War. Pressure and bolstered by the U.S. Federal Government, Calderon sought to disrupt and dismantle the control of cartels through military force. Supplied with U.S. equipment, Calderon sent tens of thousands of federal police and militia into cartel-controlled territories with the intent of a blanket crackdown on criminal activity. Ultimately, the impact of the Mexican Drug War is controversial due to the widespread violence between cartels and government forces that spilled over to residential areas, catching civilians in crossfire and destabilizing political infrastructure.[9]

The Mexican Drug War exacerbated the influence of cartels on licit agricultural markets. Since the pathways and supply chains in drug production were destabilized, cartels sought to establish themselves in legal businesses. Avocado producers provided an attractive market because of various reasons according to Ornelas (2018):

> "1) businesses in traditional sectors of the economy with a high degree of territorial specificity; 2) a relative small size of firms; 3) a relatively low technological level; and 4) a region where the public sector is relatively large and legal institutions are weak"

Indeed, the avocado industry in Michoacan checked all four boxes, and following the fragmentation of cartels during the Drug War, various groups fought for control of the avocado market. The Knights Templar and Los Viagras emerged as the dominant cartels in Michoacan during the 2010s, and proceeded to engage in maximally predatory behaviors towards the avocado industry as well as inter-cartel violence. Moncada (2021) notes that the Knights Templar efficiently extorted almost every checkpoint in the supply chain of avocado exports, including plant nurseries, orchards, packing houses, transport checkpoints. In addition, farmers were charged for simply owning land within the Templar's territory and, in some cases, forced to sign ownership of land away to cartel members. Such demands on the supply chain and at the individual farmer level were enforced primarily through extortion, kidnapping, and murder.

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[9]By the end of Calderon's term in 2012, over 120,000 people were killed as a result of the War on Drugs (Booth 2012).

Most recently, the lifting of the restriction of the U.S. import ban has brought new actors to the avocado producing states, including Jalisco New Generation who is thought to be responsible for the threatening of the U.S. inspector in February 2022 (that led to the 9 day ban) when he rejected a truck of cartel-related avocados. The presence of multiple cartels within these regions set the stage for our analysis into how the increase in avocado exports has affected crime and violence. Figure 2 shows a visual history of cartel influence in Michoacan and neighboring states.[10]
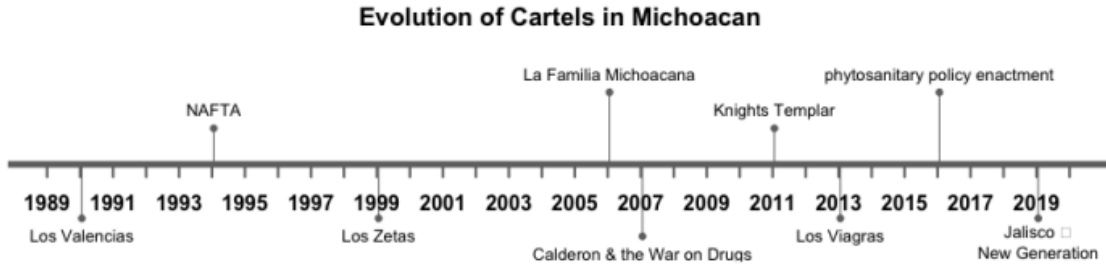

Figure 2: History of Michoacan cartels

3   Related Literature

As mentioned in Ornelas (2018), the relative weakness of Mexican agricultural institutions is conducive to the large influence of organized crime. Two main theories exist on the effect of market shocks on violence due to organized crime. The first is the rapacity hypothesis, which claims that positive market shocks increase violence because rising commodity demand/prices increases potential gain from exploitation of said market, leading to increased conflict over its control. In simpler terms, the pie is bigger, so people are more willing to fight over control of the pie. The second is the opportunity cost hypothesis, which states that positive market shocks decrease violence because higher commodity demand/prices generates more employment opportunity, raising the opportunity cost of engaging in violent appropriation. In simpler terms, because the pie is bigger, more people are satisfied with their share

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[10]Obtained from Erickson 2020.

of the pie and feel less inclined to fight over the rest of the pie.[11]

In the context of agricultural industry, more research leans towards the opportunity cost hypothesis because of the labor-intensive nature of agricultural production. Dube and Vargas (2013) supported this hypothesis by studying the difference in crime rates in Colombia during the Civil War in response to exogenous price shocks to labor-intensive commodities and capital-intensive commodities. They found that market shocks were negatively correlated to violence in labor-intensive commodities such as coffee, sugar, banana, palm, and tobacco, while market shocks were positively correlated to violence in capital-intensive commodities such as oil, coal, and gold. Blair (2021) corroborates this claim through meta-analysis of 46 natural experiments that estimate the causal effect of commodity price changes on armed civil conflict. Dal Bo (2011) further supports this hypothesis and provides an equilibrium model that determines how commodity price shocks would influence violence. These papers demonstrate that the two hypotheses may both be applicable depending on the type of market, where the opportunity cost effect trumps the rapacity effect in labor-intensive markets and vice-versa. Therefore, we would expect that the crime rates in Mexican avocado-producing regions would decrease relative to other regions after the positive exogenous shock induced by the U.S. import restriction lifting.

Mejia and Restrepo (2015) suggest other reasons for why licit market shocks are negatively correlated with violence. Specifically, they argue the state plays a larger role in reducing violence in licit markets because licit crop farmers can use state authority to enforce property contracts. In addition, the state has more incentive to regulate organized criminal activity since it can collect taxes on licit crop production. Thus, if more actors enter the licit market from an illicit market as a result of a positive shock, organized crime loses influence in the form of increased state intervention. Such a scenario could feasible play out in regions that were allowed to produce avocados starting in 2016.

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[11]Note that this analogy is not perfectly correct due to the complexity of the issues surrounding market shocks and cartels.

Regarding the Mexican avocado industry, Roett (2020) argues that positive price shocks in avocado imports to the U.S. caused an increase in violence in avocado-producing regions. However, we believe the model used can be improved since the difference-in-difference treatment indicator is staggered and proportional to the log import value of avocados per month. Roett doesn't use the 2016 USDA import restriction lifting as a treatment, rather indicating treatment as whenever a municipality started producing avocados. As Baker (2022) states, it is difficult to properly assess potential biases in staggered difference-in-differences estimates. For example, there were municipalities that started producing avocados between 2010 and 2016 for domestic Mexican consumption or export to countries other than the U.S. However, it is unlikely that these farmers experienced the same extortion as exporters to the U.S. since their avocados do not pass through the various supply chain check points (collection, transportation, border inspection, etc.) that avocados bound for the U.S. pass through. Thus, the extortion that occurs at these checkpoints by cartels such as the Knights Templar applies unevenly to the data Roett sampled.

4 Data

Data was taken from a variety of national agencies of the United States and Mexico. All cleaning, scraping, and preparation was done in python. Robust regressions are calculated using Stata. We include two primary outcome variables as proxies for cartel violence: crimes per capita (*crimes_pc* and homicides per capita (*homicides_pc*. Homicides per capita is the number of intentional homicides per 100,000 people and is recorded at the municipal-monthly level. Crime per capita is homicides per capita plus the number of extortions per 100,000 people and is recorded at the municipal-monthly level. While we would have liked to include additional types of crime related with cartel violence such as torture and kidnappings, this data was not available in the designated time frame of 2011-2019. This data was collected from Mexico's Executive Secretariat of the National Public Security System and (SESSNP)

the National Institute of Statistics and Geography (INEGI).[12]

The primary regressor is the treatment variable in the difference-in-differences model. For control municipalities, this variable is always 0 since no avocados are produced between 2011 and 2019. If a municipality starts producing avocados after the import change or starts producing significantly more after 2016 than before, we deem it a treated municipality. Significantly more is defined as the average production post-2016 being 2.2 times more than the average production pre-2016. This threshold was estimated through the USDA GATS monthly avocado import data from 2011-2019. The threshold ensures that the treated municipalities are indeed increasing avocado production because of the U.S. import law change, not just due to global increased demand (which is growing albeit at a slower pace than U.S. consumption demand). As a sanity check, we confirm that all 24 municipalities that produced avocados for export to the U.S. before 2016 are not included in the treatment group. The treatment municipalities have treatment variable equal to 1 times the log mean production value from 2016-2019. We believe this gives us a more accurate treatment effect since the increase or decrease in crime should vary more depending on the potential productivity of the municipality with respect to avocados. All data is taken from the Mexican Agricultural and Fisheries Information Service (SIAP) and the USDA Global Agricultural Trade System (GATS).[13]

With these variables, we create panel data from 2011-2019 at the municipality-month level, dropping municipalities with more than 12 missing values (1 year of data). In the end, we have 189 municipalities from the five states, Jalisco, Mexico, Michoacan, Morelos, and Nayarit, that produced large amounts of avocado after 2016, 57 treated and 132 control. All municipalities lie within the Trans-Mexican Volcanic Belt and have similar weather patterns and approximately Gaussian distributed log populations. Histograms and additional visualizations are available in the appendix. 189 municipalities over 9 years, or 108 months, creates 20412 observations.

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[12]Crime data available at https://www.gob.mx/sesnsp, population data obtained from https://www.inegi.org.mx/app/scitel/.

[13]Data available at https://www.gob.mx/siap/acciones-y-programas/produccion-agricola-33119 and https://apps.fas.usda.gov/gats/.

Table 1: Variable Descriptions and Statistics

variable name	mean	std dev.	min	max
homicides	1.706	4.04	0	56
homicides_pc	1.312	2.804	0	52.514
crimes	2.603	6.096	0	73
crimes_pc	1.793	3.225	0	57.511
treat	1.856	3.860	0	13.167
pop	137924	250760	4862	1645352
N	20412			

5 Method

We employ a difference-in-differences model to determine the effect of the U.S. import law change on cartel homicides and crimes:

$$(1) \quad crimes\_pc_{it} = \beta(treat_{it} \cdot v_i) + \delta_t + \alpha_i + \epsilon_{it}$$

$$(2) \quad homicides\_pc_{it} = \beta(treat_{it} \cdot v_i) + \delta_t + \alpha_i + \epsilon_{it}$$

where $homicides\_pc_{it}$ and $crimes\_pc_{it}$ are the number of homicides and cartel-related crimes (homicides plus extortions) per 100,000 people for municipality i and month t, respectively. $treat_{it}$ is the DID treatment indicator and β estimates the treatment effect of the lifting of the U.S. import restrictions in 2016 on homicides and cartel-related crimes. δ_t represents time fixed-effects, α_i represents municipality fixed-effects, and ϵ_{it} is the error term.

Using a difference-in-differences model allows us to control for unobservable factors that may bias our regression had we simply done fixed-effects. Because we are concerned with municipalities all from similar regions within 200 miles of each other that exhibit similar relevant characteristics such as weather patterns, presence of agricultural, cartel presence, etc., we argue that the municipalities provide balanced treatment and control groups for the

DID model.

Table 2: DID regression on crime per capita

	(1) crimes_pc	(2) homicides_pc
treat	-0.0485*	-0.0408*
	(0.0197)	(0.0172)
constant	1.052***	0.976***
	(0.185)	(0.179)
Time fixed-effects?	Yes	Yes
Location fixed-effects?	Yes	Yes
R^2	0.0293	0.0192
N	20412	20412

Robust standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The coefficients in the row treat indicate the average treatment effect of the import law change on crime and homicide rates.

6 Results

Table 2 presents the results of our DID regression model on equations (1) and (2). The DID yields the subtraction between the difference in homicide/crime rate in treated municipalities and the difference in homicide/crime rate in control municipalities before and after the import law change in 2016. This eliminates potential selection bias among municipalities and allows us to obtain a quasi-experimental estimate of the average treatment effect of the law change on cartel-related crime. On average, a 1% increase in mean avocado production value led to a decrease of 0.05 crimes per 100,000 people and 0.04 intentional homicides per 100,000 people, significant at the $\alpha = 0.05$ level. For the median municipality whose production value increased by 28%, this accounts for a decrease in 1.36 crimes per 100,000 people and 1.14 homicides per 100,000 people. This is significant relative to the average number of crimes and homicides per 100,000 people, which are 1.79 and 1.71 respectively.

Figures 3 and 4 in the appendix give us a visualization of the treatment effect of the import law change on crimes per capita and homicides per capita. 4 data points are plotted on each graph, illustrating the average crimes/homicides per capita among treated and untreated

municipalities before and after the law change in 2016. The dashed line represents the counterfactual where the law change never happened and treatment regions continued to not produce avocados. We can clearly see that the treatment effect had a significant effect on reducing crimes/homicides in treated municipalities. Had the law not been implemented, under the parallel trends assumption, these municipalities would have experienced more incidents of crime.

7   Conclusion

Through a twoway fixed-effects difference-in-differences model, we demonstrate that the increase in avocado production caused by the 2016 U.S. import law change had a statistically significant decrease on homicides and cartel-related crimes in treated municipalities. This result makes sense in the broader context of relevant literature. Since avocado production in Mexico is a labor-intensive commodity that was subject to an exogenous positive market shock in 2016, we expected homicide and crime rates to decrease as a result of the opportunity cost hypothesis. When profits are high from lucrative licit crops such as avocados, it makes sense for farmers to switch from producing illicit crops to avocados, weakening the presence of cartels and decreasing the amount of crimes. Moreover, the boom of the avocado industry only further incentivizes the Mexican government to crackdown on cartel influence within the industry. As the value of avocado imports nears $3 billion, protecting farmers and workers along the export supply chain provides more tax revenue for the government and will hopefully prevent any supply shocks such as the February 2022 inspector threat incident.

Additionally, from the perspective of cartels, we argue that the avocado boom encouraged cartels to spend resources on fortifying their existing territory, rather than fighting other cartels to expand their control. Given the long history of cartels in regions such as Michoacan and the presence of at least 3 major cartels in the region during the 2010s, we argue that the cartels were long entrenched in these municipalities before the import law change occurred in 2016. Erickson (2020) corroborates this statement. Given that municipalities were under the control of various cartels before the law change, it made more sense

for cartels to secure the avocado production within their own territories in the years following the change. While media and anecdotes from farmers suggest that avocados have become the next conflict commodity, our analysis demonstrates that, on average, the policy caused a reduction in crime.

Nonetheless, future steps may include investigation of these anecdotes. It may be the case that violence from cartels against avocado farmers has increased (matching anecdotal evidence), yet has been outweighed in our research by the decrease in inter-cartel violence. We hope that the Mexican government in the future may be able to provide more detailed breakdowns of crimes specific to agricultural industries. We also hope to explore how the COVID-19 pandemic affected the relative strengths of cartels and government institutions in avocado-producing regions, though this may be a difficult task due to the missing data reports during 2020 and 2021. Given that the import law change occurred 7 years ago, cartels may have resumed violent attacks on each other after building sufficient fortifications on their territories. In this way, the effect of the rapacity hypothesis may override the opportunity cost effect because of the vast array of exploitations the cartels employ on all aspects of the avocado export industry. Finally, we hope to explore the environmental consequences of the explosive growth in demand for avocados. As a water and nutrient intensive crop, the never-ending increase in avocado production has led to a strain on natural resources such as freshwater sources. The importance of regulating violence and crime related to cartels matters only insofar as people's basics needs are met.

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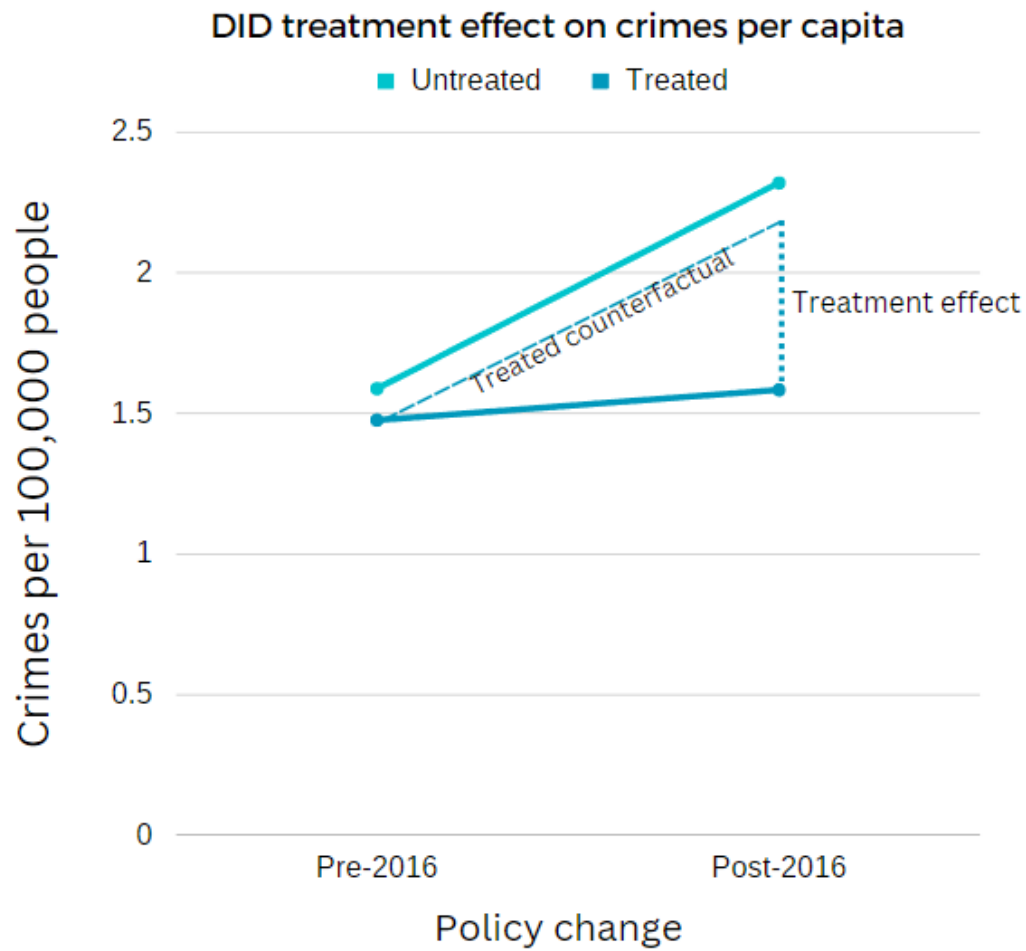
9 Appendix

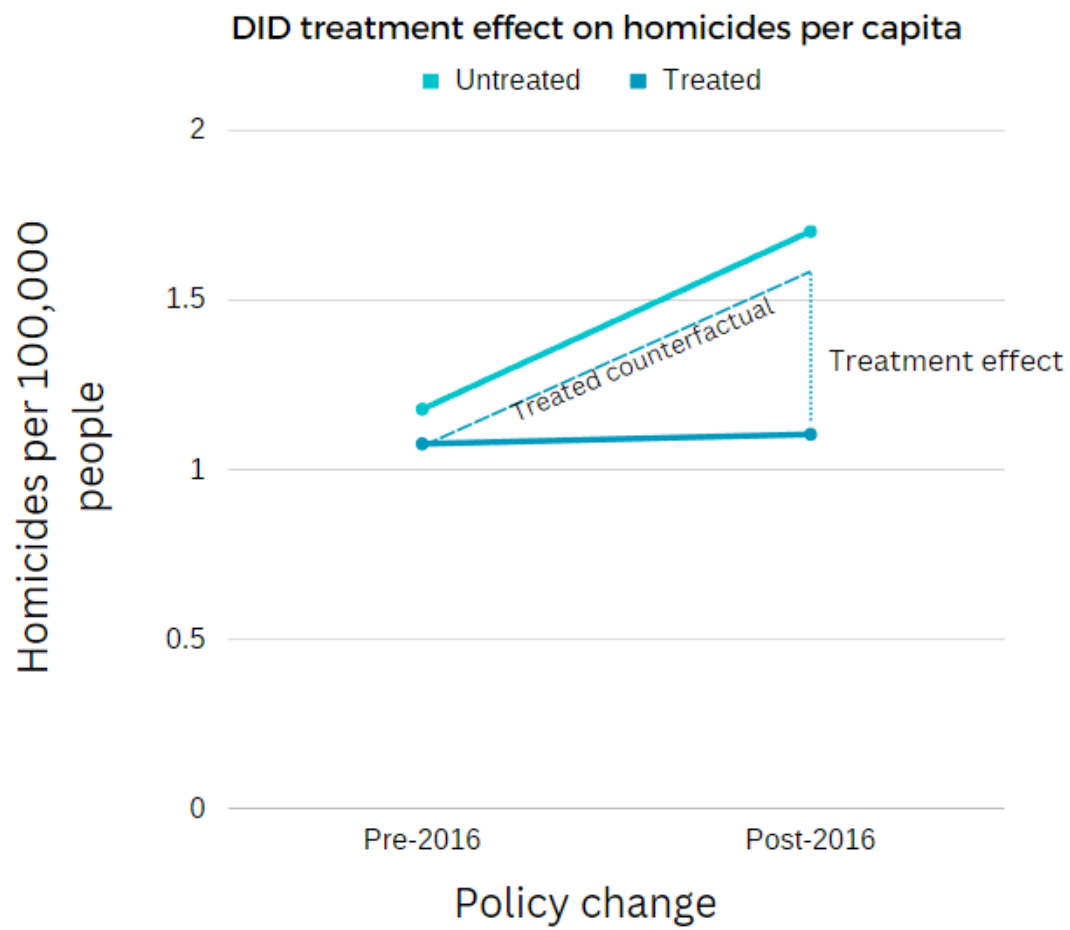Figure 3: Crimes per capita visualization
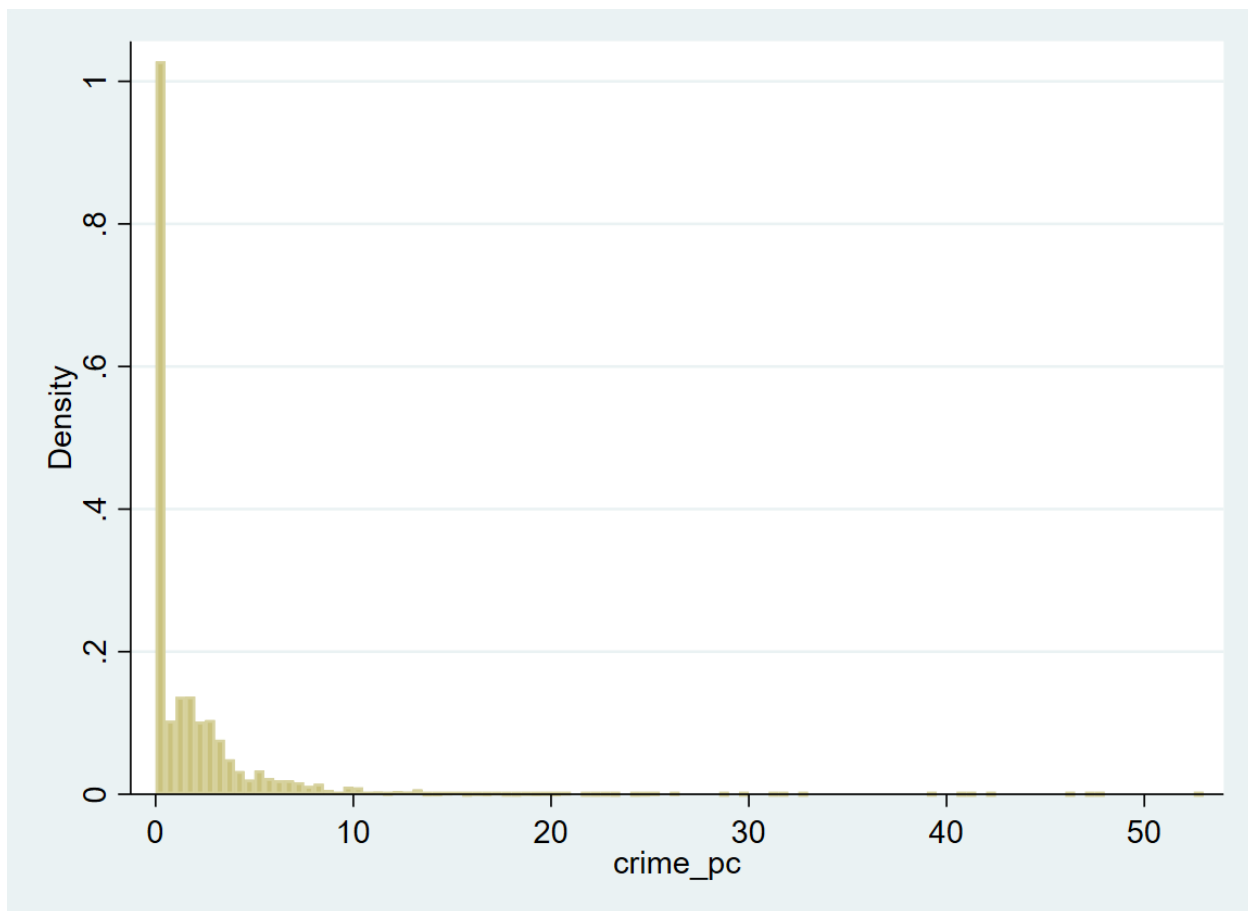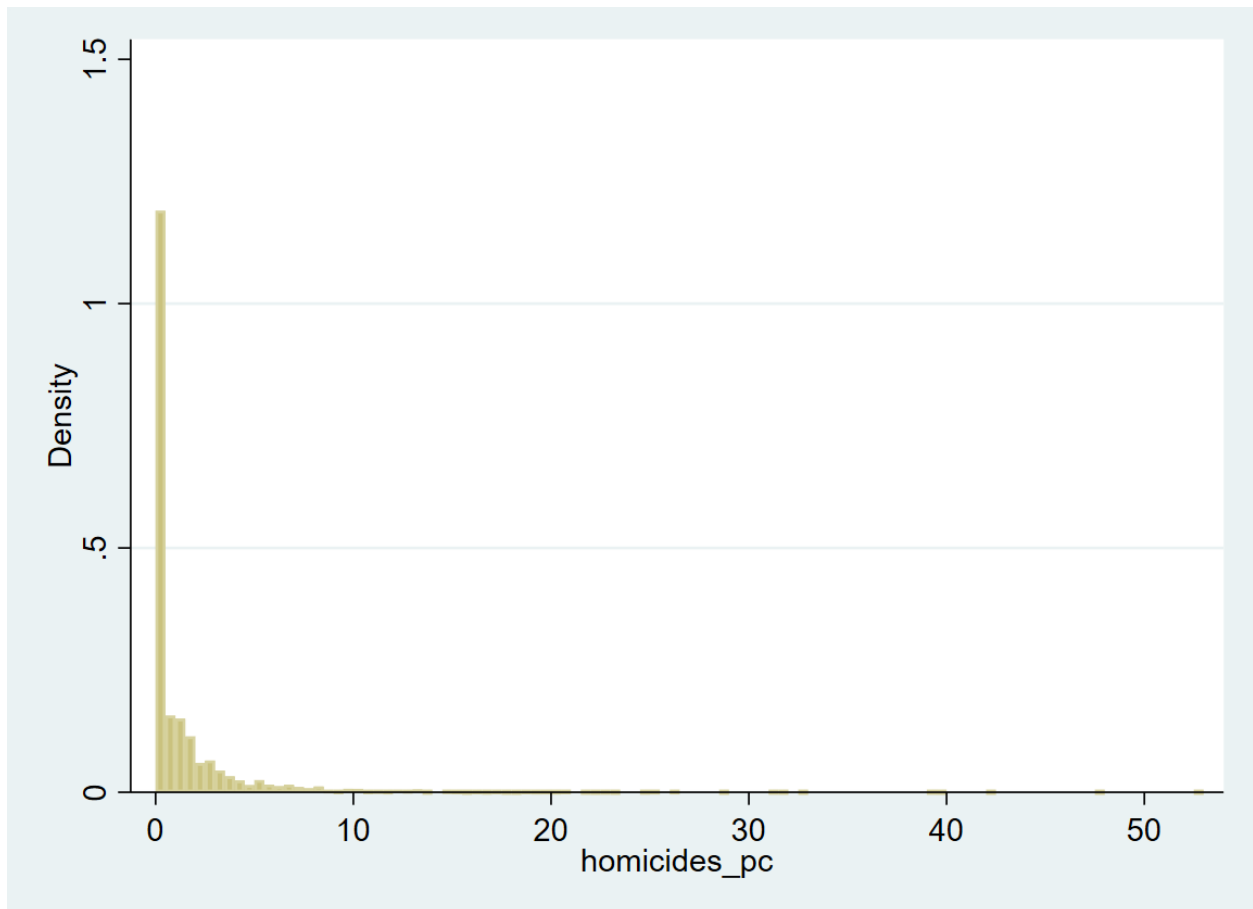
Figure 4: Homicides per capita visualization

Figure 5: Histogram of crime per capita

Figure 6: Histogram of homicides per capita