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Banco de México

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Imperfect Law Enforcement, Informality, and Organized Crime*

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Abstract: How does imperfect law enforcement affect drug trafficking, predation on firms, informality, and aggregate production? To quantify it, a general equilibrium occupational model is developed in which there is room for drug trafficking, crime against businesses, and tax evasion in the presence of imperfect institutions. Detailed micro-level data on business victimization and cartels in Mexico are used to calibrate the model. It is found that the imperfect application of the law generates considerable losses in production derived from a misallocation of occupations and resources. Finally, using counterfactual simulations, the effects of policies that seek to improve the allocation of resources are calculated. With complete law enforcement in the illegal drug market, the workers in that sector would relocate to the productive sector, and aggregate production would increase. Without crimes against businesses, which would allow a reallocation of work, capital, and occupations to the formal sector, production would increase even more. However, the largest effects come from a decrease in informality.

Keywords: Misallocation, aggregate distortions, drug cartels, crime, formal and informal sectors.

JEL Classification: O11, O17, O43, O47, K42

Resumen: ¿Cómo afecta la aplicación imperfecta de la ley al tráfico de drogas, al despojo en las empresas, a la informalidad y a la producción agregada? Para cuantificarlo, se desarrolla un modelo ocupacional de equilibrio general en el que ante instituciones imperfectas hay lugar para el tráfico de drogas, delitos contra las empresas y evasión fiscal. Para calibrar el modelo, se utilizan datos detallados a nivel micro sobre victimización empresarial y cárteles para México. Se encuentra que la aplicación imperfecta de la ley genera pérdidas considerables en la producción derivadas de una mala asignación de las ocupaciones y de los recursos. Finalmente, usando simulaciones contrafactuales se calculan los efectos de políticas que buscan mejorar la asignación de los recursos. Con la aplicación total de la ley en el mercado de drogas ilegales, los trabajadores de ese sector se reubicarían en el sector productivo, y la producción agregada aumentaría. Sin delitos contra las empresas, que permitiría una reasignación del trabajo, capital y ocupaciones al sector formal, la producción aumentaría inclusive más. Sin embargo, los mayores efectos surgen por una disminución en la informalidad.

Palabras Clave: Mala asignación de recursos, distorsiones agregadas, cárteles de drogas, sector formal e informal.

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1 Introduction

Recent studies have stressed the importance of idiosyncratic distortions on heterogeneous producers to explain income differences between countries (Restuccia and Rogerson, 2008; Hsieh and Klenow, 2009). Moreover, the literature has shed light on the nature and consequences of such distortions, such as differentiated access to financial services (Moll, 2014; Ranasinghe and Restuccia, 2018), frictions associated with accessing the labor market by gender (Cuberes and Teignier, 2016; Chiplunkar and Goldberg, 2021), differences in managerial practices (Bloom et al., 2022), size-dependent policies (López and Torres, 2020; Guner et al., 2008), or labor informality (Leal-Ordóñez, 2014), among others. In this paper, I further rationalize a component of such idiosyncratic distortions faced by producers as imperfect institutions that influence the predatory behavior of private agents. In particular, I examine a channel where partial law enforcement expands informality and markets for illegal drugs and increases crimes against businesses when governments run on fixed budgets. The result is that aggregate output declines as the size and composition of establishments become distorted. The effects are consistent with recent empirical evidence that links the presence of organized crime with adverse effects at the aggregate level (Pinotti, 2015).

I build a general equilibrium model of occupational choice with criminal markets to understand the mechanisms and the policy implications at the national level in Mexico.¹ I base my model on Lucas (1978) and Guner et al. (2008) and extend their framework to include crime against establishments, as in Ranasinghe (2017), and illegal drug markets as in Castillo et al. (2014) and Castillo and Kronick (2020). The institutional framework, or the imperfect law enforcement I have referred to, consists of parameters that determine the probability of victimization, the share of informality, and the proportion of drugs that reach the final consumer. One can rationalize the origin of imperfect law enforcement

¹Mexico is a suitable study case because of its high labor informality levels (close to 50% of all workers), organized crimes (See Figures 11 and 12), and crime-related direct costs. The direct costs comprise the spending on security and health and property value handed to criminals (INEGI, 2016b,a). For example, in 2017, property crimes cost Mexicans 2.5% of GDP (1.65% of GDP from households and 0.86% from firms). However, these numbers do not consider the indirect crime costs, like decreased production and investment or the foregone production by establishments that exit the market.

as government limitations because of running on fixed budgets.

My model generates an endogenous distribution of establishments that hire formal or informal workers, as in [Leal-Ordóñez \(2014\)](#), that enables me to more closely follow the distribution of Mexican establishments and pair my model's predictions with the results of [Dell \(2015\)](#) and [Utar \(2018\)](#), who found links between informality and organized crime in Mexican municipalities.²

Individuals differ in their managerial talent, which determines their occupation as workers or entrepreneurs in the formal or informal sector. Informal entrepreneurs employ a low level of capital to avoid detection from the government. That distortionary channel is pivotal since a significant fraction of establishments is informal. Crime is a technology that steals from each entrepreneur a fraction of her output with some probability, which depends on government and private protection.

I model a drug market as a noncooperative two-stage game with an endogenous entry of drug cartels. Drug cartels buy and transport drugs over routes they control and sell them to final consumers. The government counteracts drug trafficking through interdiction, which decreases the effectiveness of controlling routes.

My calibration relies on a micro-level dataset on business victimization, the *Encuesta Nacional de Victimización de Empresas 2018*, conducted by Mexico's National Institute of Statistics and Geography ([INEGI, 2018](#)); the dataset targets key property crime moments.

The mechanisms by which partial law enforcement and illegal behavior affect the economy are the following. When the government partially seizes illegal drugs during transit, drug cartels sell a lower number to final consumers (the non-seized drugs). As a result, the final price of drugs increases and cartels' aggregate profits. The reason is that the consumer demand for drugs is price inelastic. That is, the government action forces the drug cartels to operate in the more profitable part of the demand. As drug cartels are price takers, they would not have been able to do it voluntarily. The increase in profits pushes more cartels to enter the market and fight for control of the fixed number

²An informal worker is one whose employer neglects his or her tax obligations. An informal employer does not pay taxes.

of routes, and therefore violence increases.

With partial protection on private property, plants spend more on security, and criminals still steal a share of their output. As a result, a fraction of formal plants on the edge of profitability switches to the informal sector to decrease costs. That is, they stop paying taxes to remain profitable. In addition, plants can operate indefinitely in the informal sector since the government cannot detect them if they remain small (in capital). Also, since the more productive formal sector reduces its size, the aggregate use of inputs decreases, and wages, in turn, contract. The wage decline pushes a fraction of workers into informality, as the relative value of being a worker decreases compared to an informal entrepreneur. As a consequence, the size of the less productive informal sector size further increases.

In the final part of the paper, I study different law-enforcement policies aimed at increasing the productivity of the private sector. In the first regime, I shut down drug trafficking and keep crime against businesses and informality. Under this policy, former drug traffickers reallocate into the productive sector, and output increases by 0.5%. Next, I provide complete protection for businesses while keeping drug trafficking and informality. The result is that output increases by 2.6%. Finally, I shut down the possibility of operating in the informal sector. Under this scenario, output increases by 11.9%. The positive effects of the last two scenarios arise through a better reallocation of occupations and resources.

My work is closest to [Besley and Mueller \(2018\)](#) and [Ranasinghe \(2017\)](#). Both papers use plant-level data from the World Bank to examine the misallocation effects of crime and security spending and their effects on aggregate productivity. I expand those studies and contribute to the misallocation literature by considering two additional channels not studied together: informality and illegal drug trafficking. In addition, I use a detailed micro-level dataset of business victimization from the Mexican Institute of Statistics (INEGI), which allows me to relate the occurrence of crime to the plant size.

Recent works have studied the effects of drug-related crime in Mexico during the War on Drugs. [Robles et al. \(2013\)](#) estimate that establishments decreased their productive activities by proxying them with lower electricity consumption after the initial increase

in violence. [Montoya \(2016\)](#) finds that the industrial sector reduced operations in high-crime municipalities. [Enamorado et al. \(2014\)](#) find a negative effect of drug-related crimes on the average income growth of municipalities for the years 2005-2010. Similarly, [Balmori de la Miyar \(2016\)](#) finds that GDP per capita in states with military operations related to drug cartels is, on average, 0.5% lower. My paper expands our knowledge by providing a framework that explains the mechanisms behind those results and quantifies the general equilibrium effects that have not been thoroughly addressed. Such channels are relevant to understanding the effects of different policies aimed at improving the productivity of the private sector.

In addition to the contributions mentioned in previous paragraphs, by including two additional channels not studied together (informality and drug trafficking with crime against establishments), my paper also contributes to the theoretical literature that studies the aggregate implications of criminal markets under calibrated structural models ([Platania and Schlagenhauf, 2000](#); [İmrohoroğlu et al., 2004](#); [Ranasinghe, 2017](#); [Ranasinghe and Restuccia, 2018](#)), to the study of the economic consequences of imperfect institutions that result in predatory risk ([Hall and Jones, 1999](#); [Acemoglu et al., 2001](#); [Besley and Mueller, 2018](#)), to the literature on the aggregate economic consequences of armed conflicts ([Abadie and Gardeazabal, 2003](#); [Blattman and Miguel, 2010](#)), to the studies on the organization and the adverse effects of cartels ([Acemoglu et al., 2013](#); [Murphy et al., 2017](#)), and to the consequences and interactions of illegal markets ([Dube et al., 2016](#); [Sviatschi et al., 2017](#); [Dell et al., 2019](#); [Aldeco Leo et al., 2022](#))

2 Sample and data used

It is challenging to have a realistic picture of the state of illegality in Mexico because crime has an underreporting problem, colloquially known as the *dark figure*. Government statisticians estimate the dark figure to be around 87% for crime against businesses ([INEGI, 2018](#)). That is, of all victimized businesses in a given year, only 13% of them approach the authorities. On the other hand, the reasons business owners provide for not reporting crime are attributable to the authorities in 63% of the cases, and the

rest to other causes.³ To address this underreporting bias, INEGI has published the National Survey of Victimization of Establishments, which is a representative survey at the national level that quantifies the total number of crimes on establishments, the underreporting, the perceptions of crime, trust in institutions, and of particular importance for this study, the costs and security spending associated to crime.⁴

The results for 2017 indicate that one-third of establishments was a victim of crime (33.7%). However, the victimization differs by establishment size: 32.9% of establishments with less than ten workers were victimized, compared to 59.3% of the largest establishments. Figure 13 shows the probability of facing crime for all establishments by size. This number is, by itself, not exceptionally high relative to other regions. As an example, in the European Union, the same number was 35.4% in 2012, with a minimum range of 25.7% for Hungary and 56.6% for Belgium (Dugato et al., 2013). However, the type of crimes, the degree of violence, and their effects on businesses are different in the Mexican case.

Figure 14 displays the major crimes against businesses and victimization rates. The crime with the highest occurrence is petty theft, with 13% of establishments facing it. The second is theft or robbery of merchandise, money, inputs, or final goods with 11%. Next are extortion, fraud, and corruption acts with 5%, theft of transit goods and motor vehicle theft with 4%, vandalism, and other types of theft with 1%. Since most of these crimes involve a forced exchange of property, we will ignore vandalism to calibrate the model in subsection 3.6.

There are differences in the cost of individual occurrences of crime too. Figure 15 plots the average monetary cost of the establishment by different types of crime. The

³The causes attributable to authorities, as mentioned by business owners, are fear of being extorted by authorities, waste of time, long and complicated procedures to denounce the crime, lack of trust in authorities, or having previous bad experiences. The other causes are fear of retaliation by the offender(s), the crime was of little (monetary) value, or the owner lacked convincing evidence. Source INEGI (2018)

⁴The survey is stratified and probabilistic. It is representative at the national and state level. The units of observation are the economic units of the private sector, excluding agriculture and public sector and units without a physical location. The survey was carried in the presence of the highest hierarchy person in the establishment. In total, 32,588 units were surveyed during early 2018. See INEGI (2016a) for additional survey design.

highest loss is grand theft auto, with an average cost of MXN \$213,930. The second one is kidnapping, with \$209,901, and the theft of transit goods comes third, with \$85,256. Although extortion is a high-impact crime, its average loss is just \$8,584 per establishment, possibly indicating that the less profitable establishments are being extorted or that criminals only extort a small amount. In addition, the smaller value may denote its recurrence nature (that is, criminals extort enough money to keep the establishment profitable).

The survey estimates that the total cost of crime is 155.8 billion Mexican pesos (or 8.2 billion U.S. dollars). That number represents 0.86% of the Mexican GDP. Of that number, 55.9% are direct losses, and 44.1% are expenses in preventive measures. Figure 16 shows the distribution of security expenses. The majority of changes that businesses make to evade crime are physical. Changing locks, installing alarms and CCTVs, changing doors and windows, and installing fences represent 70%. Hiring private guards represent just 7%. The rest are buying insurance and spending on software with 5% and 3%.⁵

Entrepreneurs respond strategically to crime when the institutional framework is feeble. For example, they may respond actively when they hire private security or passively when they handle their property to the criminals (Sutter et al., 2013). However, it is not only the actual occurrence of crime that affects the behavior of entrepreneurs but the expectation of it (Oguzoglu and Ranasinghe, 2017). This expectation effect is especially true in high crime areas like Latin America. For example, in Mexico, as a consequence or in anticipation of crime, some establishments permanently close their operations, move their operations to other cities or countries, hire private security, change the logistics of their processes, or even pay the extortions without recurring to the authorities (Ramirez et al., 2015). According to the ENVE survey, in 2017 in Mexico, 13.1% of establishments canceled some form of investment due to crime, and

⁵Security expenses consist of items that are paid once, like installing alarms and fences, and changing locks and windows; and costs that are paid periodically, like insurance or wages of security guards. However, the cross-section nature of ENVE survey does not allow for tracking the security payments of the establishments through time. Therefore, an establishment may be changing locks every month or year if it is constantly victimized.

6.3% exited the market after being victims of crime.

Information about drug cartels comes from official sources, academic studies, and organizations like the United Nations. In subsection 3.6, I provide more detailed information about the size of the industry.

3 A model of occupational choice with criminal markets

I use a *span of control* model in the spirit of Lucas (1978) and Guner et al. (2008). According to their managerial skills, individuals supply their labor as workers or run establishments as entrepreneurs. I extend the framework by including an endogenous distribution of formal and informal establishments, as in Leal-Ordóñez (2014); crime against establishments, as in Ranasinghe (2017); and extend the framework of Castillo and Kronick (2017) and Castillo and Kronick (2020) to include general equilibrium effects into their illegal drug markets model.⁶

Criminals operate a costly technology that targets each entrepreneur with some probability and steals a personalized output level. Entrepreneurs may decrease that probability by purchasing private security.

Cartels buy illegal drugs from a representative producer and sell them to final consumers. To do that, they transport those drugs through routes they control by hiring workers. More routes allow cartels to sell more drugs to final consumers.

There are three types of institutions in this economy. Their goal is to provide public security, track and punish entrepreneurs in informality, and inhibit the number of drugs that reach final consumers. These institutions are time-invariant and known by all agents. I assume that the institutions are imperfect because the government (not

⁶The framework of Leal is appropriate because of its static nature. Although in the models that study the misallocation of talent and resources in the tradition of Guner et al. (2008) the setup is dynamic, the comparisons between steady states render a static interpretation of the results. In addition, my model abstracts from modeling some mechanisms (e. g., search and matching) that may result in unemployment spells or wage dispersion, which can affect criminal decisions (Burdett et al., 2003). Therefore, a natural extension of my work that incorporates dynamics at business cycle frequency should consider the works of Fernández and Meza (2015) and Leyva and Urrutia (2020).

explicitly modeled) operates on a fixed budget.

3.1 Endowments and occupations

Individuals are heterogeneous in their talent (or managerial skill) $s \in S = [\underline{s}, \bar{s}]$ and form a continuum set of measure one. Talent s is inalienable, invariant, and distributed according to the pdf $\mu(s)$. From now on, s denotes both talent and index.

Every period, each household member has one unit of time which she supplies inelastically to her occupation: entrepreneur in the formal sector, entrepreneur in the informal sector, or worker.

3.1.1 Entrepreneurs

Entrepreneurs produce y units of the consumption good by renting k units of capital at price r and hiring n workers at the wage rate w . Production takes the form of $f_s(k, n) = sk^{\alpha_k}n^{\alpha_n}$ with $\alpha_k + \alpha_n < 1$. Entrepreneurs pay a fixed fraction τ_y of output as taxes, and each s gets a fraction τ_c of output stolen with probability F that depends on the rule of law, $\lambda_R \in [0, 1]$, and spending on protection, $z \geq 0$. The rule of law is the probability with which the state prevents crime against businesses. Higher values represent a stronger rule of law, and lower values increase the victimization probability. Security spending complements the rule of law, but it is costly. The cost is given by bz^ψ/ψ , in which $b > 0$ is a scale parameter and ψ is an elasticity parameter. The victimization probability has the following form:

$$F = 1 - \lambda_R (1 + z^{\lambda_z}). \quad (1)$$

Equation (1) is a reduced-form construct for a mix of factors that may affect the victimization probability, like the number of criminals, the unemployment levels, the socioeconomic status of the workers of the establishments, the city size, or urban growth, among others (Gaviria and Pagés, 2002).

Entrepreneurs may avoid paying taxes by switching to the informal sector, where they have to remain small (in their capital levels) to operate undetected by the government.

The government detects informal entrepreneurs with probability $\rho(k)$, and takes away their revenues as punishment. Punishments last only one period and entrepreneurs who are caught have a fresh start after that. The probability of detecting an informal entrepreneur s is:

$$\rho(k_s) = \begin{cases} 0, & k_s \leq k_{caught} \\ 1, & k_s > k_{caught}, \end{cases} \quad (2)$$

with $k_{caught} > 0$. The government policy allows entrepreneurs to produce using a capital level below k_{caught} and enjoy tax avoidance benefits. However, notice that an informal entrepreneur that produces more than k_{caught} only exists in an off-equilibrium path.⁷ In equilibrium, all informal establishments rent capital less than or equal to k_{caught} irrespective of their talent.

Since there are no time interdependences, entrepreneurs solve a static problem in every period. A formal entrepreneur solves the following maximization problem:

$$\pi_s^F(\mathbb{P}, \tau_c) = \max_{n, k, z \geq 0} (1 - F\tau_c)(1 - \tau_y)y - wn - rk - \frac{bz^\psi}{\psi}, \quad (3)$$

in which $\mathbb{P} = (w, r)$. Notice that the price of the consumption good is the numeraire. An informal entrepreneur that rents some level of capital below k_{caught} solves:

$$\pi_s(\mathbb{P}, \tau_c) = \max_{n \geq 0, 0 \leq k < k_{caught}, z \geq 0} (1 - F\tau_c)y - wn - rk - \frac{bz^\psi}{\psi}. \quad (4)$$

Similarly, an informal entrepreneur constrained on capital solves the following problem:

$$\pi_s(\mathbb{P}, \tau_c) = \max_{n, z \geq 0} (1 - F\tau_c)y - wn - rk_{caught} - \frac{bz^\psi}{\psi}. \quad (5)$$

⁷The intuition is the following. Imagine an establishment that rents a capital level higher than k_{caught} . Every period the government detects it with probability 1. With non-negative prices of inputs, production is costly. As a result, the government seizure of revenues results in negative profits, which leads the entrepreneur to change occupation.

3.1.2 Workers

Workers inelastically supply their time to entrepreneurs and drug cartels (defined below). Moreover, workers randomly provide their working hours to entrepreneurs and drug cartels. That is, workers put their hours in a bag, and anyone in need grabs those hours and pays the competitive wage to the worker.⁸ Workers' earnings are, therefore, equal to the competitive wage rate w .

3.1.3 Criminal group

A criminal group operates a costly technology that targets all entrepreneurs and steals a fraction τ_c of their output with probability F , defined in (1).

For each entrepreneur (both formal and informal) the criminal group solves every period the following static problem:

$$\pi_c(s; z, P) = \max_{0 \leq \tau_c \leq 1} \left[1 - \lambda_R (1 + z^{\lambda z}) \right] \tau_c y_s - \frac{a \tau_c^\rho}{\rho}, \quad (6)$$

where $a, \rho > 0$ are scale and elasticity parameters. Formal and informal entrepreneurs differ in their production levels and the security units they purchase; therefore, the fraction of stolen output will differ between entrepreneurs.

3.2 The illegal drugs sector

The cartel economy is a non-cooperative two-stage game with endogenous entry. In it, players' payoffs depend on their actions and all players'. In the first stage, potential drug cartels may enter the market if it is profitable. In the second stage, if a drug cartel enters, it buys x drugs from a drug producer, transports them through R routes it controls, and sells q of them to final consumers. Drug cartels differ in their fixed costs of operation. Controlling more routes allows cartels to move more drugs to final consumers. The level of interdiction e reduces the movement of drugs. The interaction

⁸I am not modeling individual decisions to join crime since the final goal of this paper is to quantify the aggregate misallocation. However, adding that layer of complexity is a venue for future research if one wants to understand different distortionary channels through the household side.

between route saturation and interdiction implies that the amount of produced drugs is lower than the drugs final consumers buy: $x \leq q$.

3.2.1 Drug producer

A representative drug producer sells X_s drugs at price p_x . He hires n_x workers to produce using the following technology:

$$X_s = A_x n_x^{\alpha_x}, \quad (7)$$

where $A_x > 0$ and $0 \leq \alpha_x \leq 1$. The drug producer pays the competitive wage w , and his profits are given by:

$$\pi_x = p_x A_x n_x^{\alpha_x} - w n_x. \quad (8)$$

3.2.2 Drug cartels

A discrete number J of potential cartels differ in their time-invariant fixed costs of operation that they draw in period 0 from a discrete uniform distribution $\mathcal{U} \{c_f^{\min}, c_f^{\max}\}$.

There is a continuum of routes with measure one. A cartel i hires h_i workers to control routes and pays them the competitive wage rate w . Routes are distributed according to the following Tullock contest function:

$$R_i = \frac{h_i^{\alpha_h}}{\sum_i^E h_i^{\alpha_h}}, \quad (9)$$

where α_h is a decreasing returns parameter common to all cartels, $E \leq J$ is the number of cartels that enter the market. Cartel i sells q_i drugs to final consumers with the following functional form:

$$q_i = (R_i^{-1} e + x_i^{-1})^{-1}, \quad (10)$$

where e is the level of interdiction.

Profits are given by:

$$\pi_i = p_q q_i - w h_i - p_x x_i - c_{f,i}. \quad (11)$$

Cartels in every period choose the number of drugs they buy and the workers they hire to control routes. Notice in equation (10) that without interdiction (that is, when $e = 0$), cartels sell to consumers the same amount of drugs they buy: $q_i = x_i$. Also, the profit function for cartel i in (11) implies that profits depend indirectly on other cartels' actions through p_x , and directly through the contest function. This interaction implies that each cartel has a best response function for the actions of other cartels.

Cartels enter the market if they make non-negative profits. Therefore, the distribution of fixed costs determines the number E of cartels that operate in the drugs market.

3.2.3 External demand for drugs

The demand for drugs is fixed and given by:

$$Q = A p_q^{-B}, \quad (12)$$

where $A > 0$ is the level, p_q is the price consumers pay for drugs, and $B > 0$ is the price elasticity.

Notice from equation (13) that local consumers do not benefit from consuming illegal drugs. Therefore, one should consider equation (12) as a demand for drugs outside the country (think of Mexico providing drugs to satisfy the demand of the U. S.). Since, to reiterate, the ultimate goal is to measure the distortions in the local private sector, the assumption of the existence of only an external demand for drugs does not invalidate the results. However, one should micro-found the demand for drugs for future iterations of works that aim to provide optimal supply or demand policies against drug trafficking.

3.3 Representative household

All individuals comprise a representative household that lives forever, values consumption, accumulates capital, and chooses occupations for each member at each period.

Preferences are given by

$$\sum_{t=0}^{\infty} \beta^t u(C_t), \quad (13)$$

in which C_t denotes aggregate consumption in time t , $\beta \in (0, 1)$ is the discount factor, and $u(\cdot)$ is the per-period utility function. The household accumulates capital by increasing investments I_t that follows the motion

$$K_{t+1} = I_t + (1 - \delta) K_t, \quad (14)$$

in which δ denotes the depreciation rate of capital.

The household maximizes the utility function in (13). Following [Ranasinghe \(2017\)](#), the profits from the criminal group and drug cartels are wasteful or deadweight losses. With that, the budget constraint of the representative household is given by:

$$C_t + I_t \leq w_t N_t^s + r_t K_t + \int_{s \in S} I_t^F \pi_t^F \mu(s) + \int_{s \in S} I_t^I \pi_t^I \mu(s), \quad (15)$$

in which N_t^s is the measure of workers, I_t^F is an indicator variable that denotes if individual s is a formal entrepreneur, π_t^F represents the profits of the formal entrepreneurs, I_t^I is an indicator variable that denotes if individual s is an informal entrepreneur and π_t^I represents the profits of the formal entrepreneurs.

3.4 Timing of events

The interaction between criminals in both markets (goods and illegal drugs market) implies some strategic behavior between agents. For this paper, I use the concept of Nash Equilibrium.

At time zero, the household has some initial capital, the government sets the institutions, and each household member draws his or her talent. At every time t , criminals observe the talent of each member and set a personalized theft for any labor, capital, security, and occupational choice they make. Theft only triggers if the household member becomes an entrepreneur.

In anticipation of crime, household members have their best-response function. First, they make occupation choices by comparing the after-theft profits with the wage income. After that, entrepreneurs make their production and security decisions, and workers supply their labor. Next, production takes place, and criminals steal from entrepreneurs. At the same time, drug cartels observe prices, buy drugs from producers, hire workers to contest the routes, and sell drugs to final consumers.

At the end of the period, entrepreneurs, workers, criminals, and drug cartels bring their income to the household to make consumption and capital decisions.

3.5 Steady-state competitive equilibrium

A steady-state equilibrium is a distribution of talent $G(s_{\min}, s_{\max})$, a distribution of occupations (workers, informal and formal entrepreneurs), production decisions $\{n_s, k_s, z_s\}$ for formals and informals, a distribution of fixed costs for the drug cartels $\mathcal{U}\{c_f^{\min}, c_f^{\max}\}$, E number of cartels that enter the market, cartel decisions $\{n_i, x_i\}$, X drugs produced and Q drugs bought, K units of capital and C units of consumption, and prices $\mathbb{P} = \{w, r, p_x, p_q\}$, such that:

- Household maximizes utility given in (13).
- Each s chooses occupations that maximize their income.
- Formal entrepreneurs maximize profits given by (3):
- Informal entrepreneurs maximize profits given by (5):
- Criminals maximize profits given by (6):
- Each cartel maximizes (11).
- The representative drug producer maximizes profits given by (8):
- E cartels enter the market.
- Aggregate quantities are consistent.

3.6 Calibration

There are three groups of parameters to calibrate. The first group targets the moments of the distribution of establishments in Mexico. The second group targets victimization levels, costs of property crimes on establishments, and security spending. The last group targets the size of the market for illegal drugs.

Moments related to the distribution of establishments Following [Leal-Ordóñez \(2014\)](#), the distribution of talent follows a Pareto Distribution of the form:

$$G(s) = \frac{1 - \left(\frac{s^{\min}}{s}\right)^{\text{shape}}}{1 - \left(\frac{s^{\min}}{s^{\max}}\right)^{\text{shape}}}; \quad (16)$$

therefore, there are nine parameters to calibrate related to the distribution of establishments: $\alpha_k, \alpha_n, \delta, \tau_y, s_{\min}, s_{\max}, \beta, k_{\text{caught}}$ and shape. I set those parameter values following [Leal-Ordóñez \(2014\)](#). His model abstracts from crime on establishments, however. Later in this subsection, I show that including crime in the author’s framework still allows me to match critical moments closely.

Moments related to crime against establishments

There are six parameters related to crime against businesses: $b, a, \psi, \rho, \lambda_z$ and λ_R . [Ranasinghe and Restuccia \(2018\)](#) estimated for Colombia a probability function similar to equation 1. I take two of the parameters the authors calculated and set $b = 7.422$ and $a = 19.35$, representing scale parameters of the security cost establishments pay and the extortion cost the criminal group pays. My implicit assumption is that the returns to crime in Mexico are different from Colombia’s, but not their level. This assumption allows me to restrict the estimation to a parameter space in which the aggregate effects are *well behaved*; that is, there are no sudden discontinuities with slight changes in the parameters.

The reason for fixing a and b to the Colombian estimations is twofold. First, the Colombian economy is similar to the Mexican; for example, their GDP and HDI are

similar, and they face similar problems concerning organized crime, illegality, and drug trafficking. Therefore, one would expect both countries to have similar criminal technologies. Furthermore, the second reason concerns the stability of the parameters. By fixing the parameters, I restrict the parameter space to a stable region regarding the aggregate effects. To prove it, in the last point of this subsection, I perform a sensitivity analysis in which I change the values of a and b and calculate the effects on output.

To calibrate the other four parameters related to crime, I use the business victimization survey ENVE from [INEGI \(2018\)](#). The target moments are the following:

- The sum of all property handed to criminals as a share of GDP is 0.481%
- The total spending on security by all establishments as a share of GDP is 0.379%
- The total cost of crime (property lost + security spending) of establishments with less than 100 workers as a fraction of GDP is 0.725%.
- The prevalence of crime in all establishments is 33.7%.

Moments related to drug trafficking

There are eight parameters related to drug trafficking: $B, e, \alpha_h, A, A_x, \alpha_x, c_f^{\min}$ and c_f^{\max} . The minimum value of the distribution of fixed costs can be set to any number, since c_f^{\max} determines the total number of cartels that enter. I set it to $c_f^{\min} = 0$. I set the price elasticity of drugs to 0.61. That number comes from the World Drug Report 2016 from [Bussink et al. \(2016\)](#).

I use diverse sources to calculate the moments related to the markets for illegal drugs. The Department of Homeland Security estimates that Mexican drug cartels generate profits of around 19 to 29 billion dollars. I use the average of the two, which represents 2.1% of Mexican GDP in 2017. The number of workers associated with the whole drug industry comes from [Rios and Sabet \(2008\)](#). The authors estimate that around 300,000 people work producing drugs (0.56% of the labor force) and 168,000 work in other chains of drug trafficking as hitmen, drivers or security providers. That number represents 0.31% of the labor force.

I did not find estimations about the revenues of Mexican drug producers, but I use the number for Colombia, which is 0.40% of GDP. In 2018, the Mexican government estimated that 37 drug cartels operated throughout the country (Monroy, 2019). I use that number as a target moment. Finally, to pin down the effectiveness of interdiction, I use estimations from the United Nations Office on Drugs and Crime. They determined that around 43% to 68% of illegal drugs do not reach their final destination. I use the average of both ciphers. Table 1 summarizes all mentioned targets.

Table 1: Empirical targets: Model and data

Category	Description	Moments	
		Model	Data
Non-target moments	Informality share	0.444	0.447
	Average size (workers)	5.865	5.460
	Share. 100+ workers	0.292	0.298
	Capital output ratio	2.016	2.000
	Average size. 100+ workers	380.033	359.970
Target moments	Crime loss / output (%)	0.451	0.481
	Security / output (%)	0.497	0.379
	(crime + sec.) / output (%). 100- workers	0.675	0.725
	Prevalence of crime (%)	0.234	0.337
	Profits of drug cartels (% of GDP)	2.076	2.100
	Labor in drug trafficking (% labor force)	0.310	0.310
	Labor producing drugs (% labor force)	0.560	0.560
	Revenues (% of GDP) of drug producers	0.501	0.400
	Percentage of seized drugs	75.900	55.000
	Number of drug cartels	37.000	37.000

Notes. The target moments related to the distribution of establishments are from Leal-Ordóñez (2014). I calculate the moments related to property crimes using the business victimization survey *Encuesta Nacional de Victimización de Empresas 2018* from INEGI (2018). The drug trafficking moments are taken from Rios and Sabet (2008), Coscia and Rios (2012), and different official sources. The model moments are obtained by solving the model for all equilibrium values and finding parameters that minimize the squared difference between the target and the model moments.

Jointly calibrated parameters and model validation

The rest of the parameters have direct or weak effects on distinct variables; therefore, I calibrate them jointly. Table 2 shows the parameter values and their data source. In

general, the model replicates relatively well the target moments. Table 1 compares the model moments with their data counterparts. Notice that I am not directly targeting the moments of the distribution of establishments in Mexico, and still, the model approximates those moments with a certain degree of accuracy. Including crime in the framework of [Leal-Ordóñez \(2014\)](#) still allows me to match Mexican establishments' distribution reasonably.

Besides, the model predicts well the cost of crime and the security spending of establishments by size. Figure 17 plots the model predictions with the observed values from ENVE. I did not target those moments directly but still follow the observed ones.

Sensitivity analysis

One alternative is to estimate all parameters jointly since the framework of [Leal-Ordóñez \(2014\)](#) lacks the crime mechanism, and the framework of [Ranasinghe \(2017\)](#) does not include the informal sector. However, that approach would need to additionally estimate 12 parameters, which would probably mask the parameters that drive the outcomes or result in a lower numerical accuracy because of the nonlinearities present in the model. To show the last point, I perform a sensitivity analysis on the parameters a and b , which I fix to the values estimated for Colombia by [Ranasinghe and Restuccia \(2018\)](#).

In the exercise, I create a grid of 100 parameter values that range from $0.5a$ to $1.5a$ and $0.5b$ to $1.5b$. I solve the model for each grid value by fixing the other parameters to the values in Table 2, and then I calculate the effects on output. Figure 18 plots the outcomes for parameters a and b . Both figures show that the calibrated parameters fall inside a less jagged region. Therefore, the parameter space is restricted for a joint estimation, and so one would expect that the potential bias that may arise by fixing the values is not of consideration.

4 Results of the calibrated model

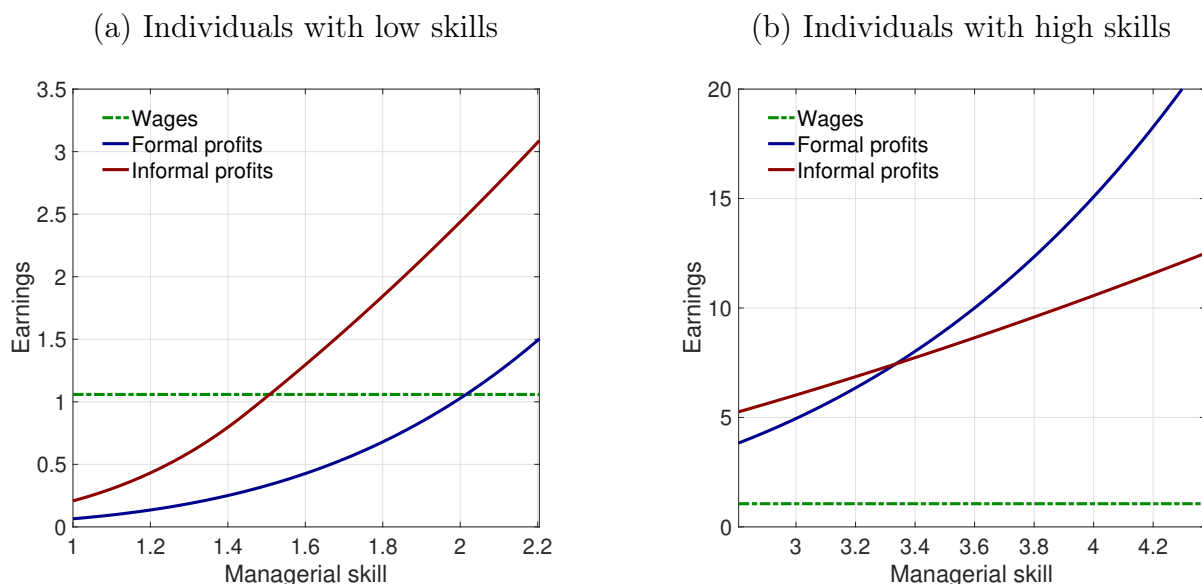
The key parameters that determine the institutional framework are: k_{caught} , λ_R , B and e . The calibrated values are $k_{caught} = 10.5$, that is, informal entrepreneurs who rent capital

Table 2: Calibrated parameters

Category	Description	Parameter	Value	Source
Establishments	Income share of capital	α_k	0.330	Leal-Ordóñez (2014)
	Capital depreciation rate	δ	0.050	
	Income tax rate	τ_y	0.250	
	Min value of talent distribution	s_{\min}	1.000	
	Discount rate	β	0.943	
	Income share of labor	α_n	0.446	
	Maximum capital of informals	k_{caught}	10.500	
	Maximum value of talent	s_{\max}	13.500	
	Shape of distribution	shape	4.250	
Property crimes	Scale of security cost	b	7.422	Ranasinghe and Restuccia (2018)
	Scale of extortion cost	a	19.350	
	Elasticity term of security cost	ψ	0.817	Joint calibration
	Elasticity term of extortion cost	ρ	2.485	
	Returns to spending on protection	λ_z	0.043	
Rule of law	λ_R	0.499		
Drug markets	Elasticity of drugs	B	0.610	Bussink et al. (2016)
	Interdiction	e	5.171	Joint calibration
	Elasticity of labor to routes	α_h	0.074	
	Level demand for drugs	A	0.075	
	Level for producing drugs	A_x	5.465	
	Returns to scale for prod. drugs	α_x	0.407	
Determines dist of fixed costs	c_f^{\max}	0.001		

Notes. This table displays the calibrated parameters. I take the first nine moments from Leal-Ordóñez (2014). The parameters related to the scale of the crime technology are from Ranasinghe and Restuccia (2018), which the authors calibrated for Colombia. I assume that the level of crime technology between Colombia and Mexico is the same, but the returns in Mexico are different. For the elasticity of drugs, I use estimations from the Bussink et al. (2016). Finally, I jointly estimate the rest of the parameters by minimizing the distance between the sample and data moments.

Figure 1: Earnings by managerial skill



Notes. Individuals with low managerial skills select as workers. Some individuals with low managerial skills become informal entrepreneurs; they operate a technology but choose not to pay taxes. They operate in the informal sector by renting a low capital level to avoid government detection. Individuals with higher talent obtain more substantial profits by producing and renting high levels of capital. That is, they choose to pay their taxes since it is profitable to do that.

below 10.5 will go undetected. $\lambda_R = 0.499$, that is, the government provides half of the maximum level of property rights. $B = 0.61$, which results in a price-inelastic demand for illegal drugs. $e = 5.171$, which is related to interdiction efforts. Interdiction efforts comprise different factors, including spending on interdiction, a better-trained police, or others. However, it does not have a concrete interpretation related to a particular factor.

The occupational choice is plotted in Figure 1. Low-skilled individuals become workers (those with skill levels below 1.5) since the value is the highest. Individuals with managerial skills between 1.5 and 2 become informal entrepreneurs, and those with skills above 2 become formal entrepreneurs.

4.1 Effects of illegality at the individual level

Criminals observe each entrepreneur and tailor the intended level of output they will steal (that is, the best response function τ_c). Figure 2 (a) plots the intended fraction they will steal from informal establishments and (b) formal ones. Criminals intend to steal more from higher-skilled informal establishments since they produce more than lower-skilled ones. However, they cannot afford enough security to counteract the offensive, as formals can [see Figure 2 (c)]. Low-productive informal establishments produce less, so the criminal group sets them a lower τ_c . In addition, low-productive formal establishments are more targeted than their higher-productive counterparts. Although higher productive formal entrepreneurs produce more—and hence, they are a more valuable *prey* for criminals—they can afford more security to counteract crime [Figure 2 (d)].

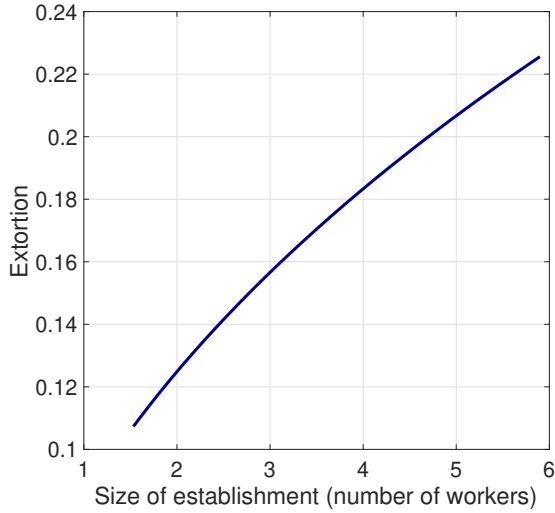
Figure 3 displays the realized share of output that criminals steal from each establishment. Again, the patterns are the same as those in the paragraph above: higher-skilled informal establishments and lower-skilled formal ones bear the highest cost of crime.

In addition to the previous direct costs, crime indirectly distorts the occupational choices and use of inputs. Figure 4 plots the ratios of inputs and output in the calibrated economy (crime economy) over their counterparts in a counterfactual economy without crime. With crime, low-skilled informal establishments hire more labor, and high-skilled informal establishments hire less. The net result is that the low-skilled informal establishments produce more, and the high-skilled informal establishments produce less. Thus, the misallocation channel in the informal sector becomes evident: resources move from high productive informal establishments to low productive ones.

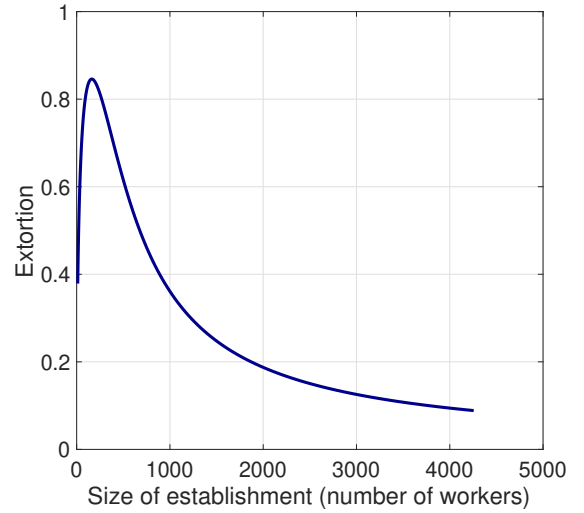
The middle productive formal establishments in the crime economy employ less capital and workers (Figure 4 b). On the other side, formal establishments that are relatively more productive rent more inputs and produce more. Thus, crime induces middle-sized formal producers to use fewer resources and high productive ones to use more. Finally, and in conjunction with the previous effects, crime induces occupations to misallocate.

Figure 2: Best response of the criminal group and establishments

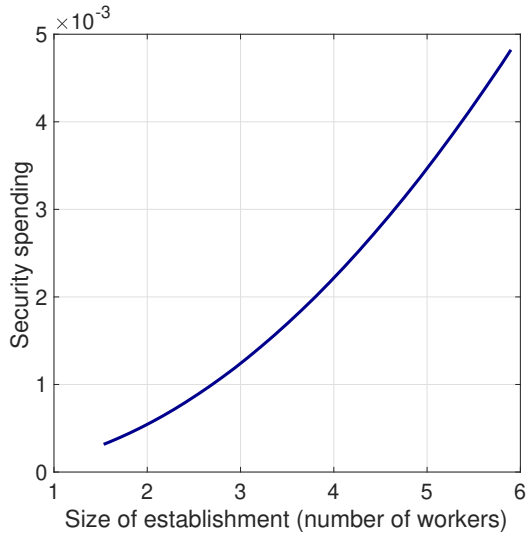
(a) Intended output stolen from informals



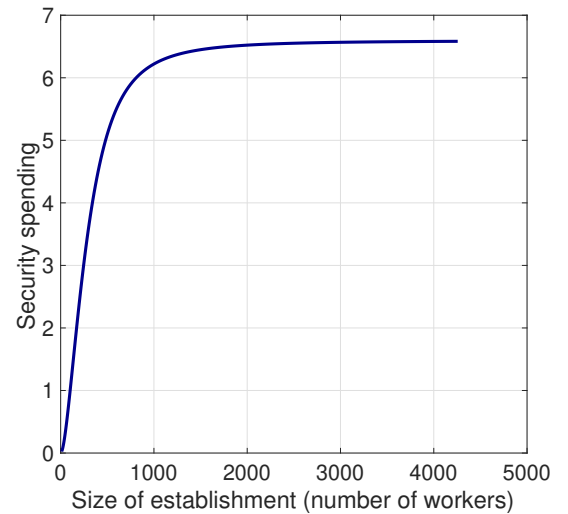
(b) Intended output stolen from formals



(c) Security spending from informals

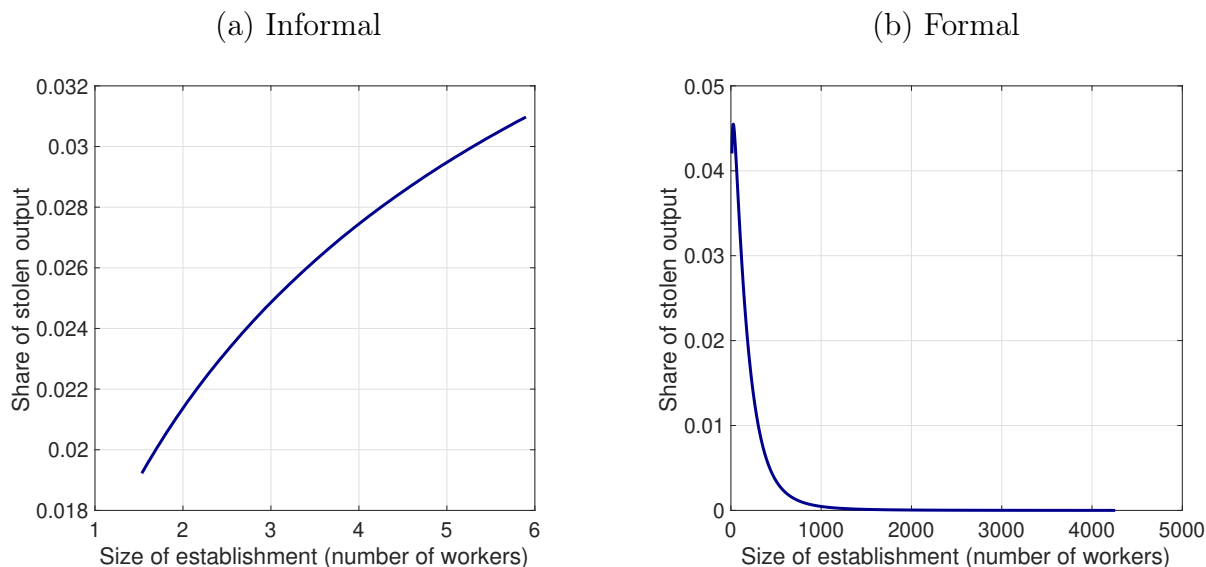


(d) Security spending from formals



Notes. Plots (a) and (b) show the best response of the criminal group, that is, the level of output that it intends to steal from informal establishments (top left), and formal establishments (top right). Small-sized informal establishments and large formal establishments are less targeted. Small informal establishments produce limited resources to steal, and large formal establishments buy more security to protect themselves. Larger informal establishments and middle-sized formal establishments bear the highest costs of crime. In the lower half of the plot, I show the best response of the informal and formal establishments, that is, their security spending. Larger establishments, both formal and informal, buy a more substantial level of security.

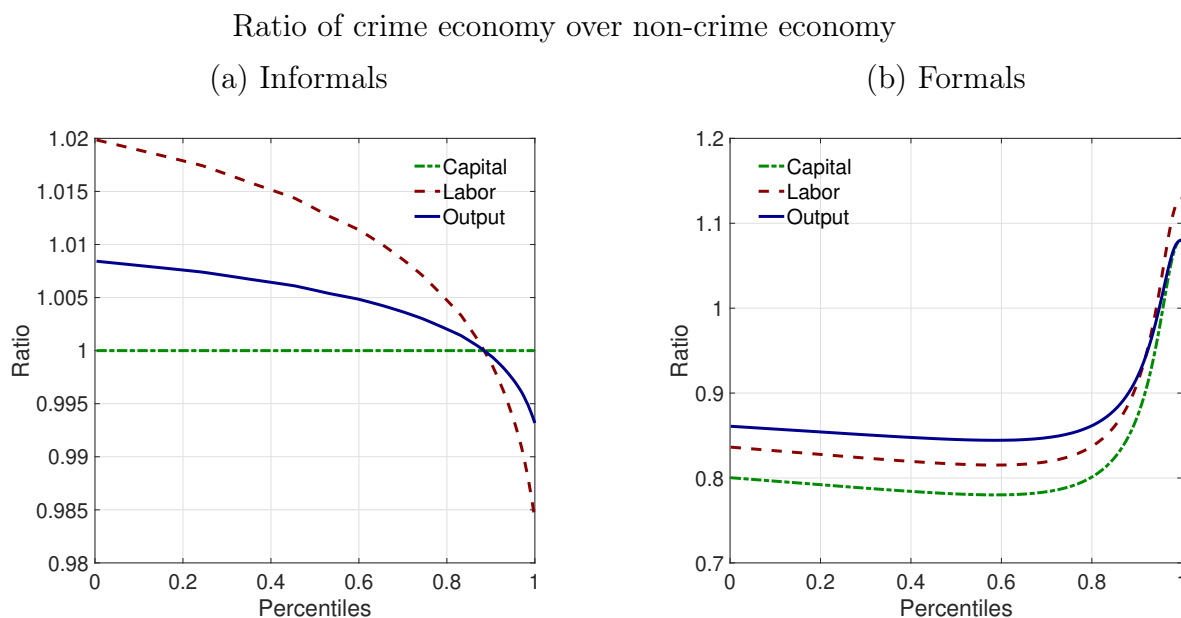
Figure 3: Share of stolen output by condition of the establishment.



Notes. The figure shows the percentage of output that criminals steal. It is expensive for criminals to steal from each establishment; therefore, low productive informal establishments are less affected since the potential reward is low (that is, they produce a low output level). Similarly, high productive formal establishments are less victimized. The reason is that, although these establishments produce a large amount of output, they can afford private security to counteract the effect of criminals. On the other hand, high-skilled informal and low-skilled formal establishments are more affected since they produce a more significant output level. However, still, they cannot afford the necessary security to shield themselves against crime.

Since, *caeteris paribus*, crime reduces profits of both formal and informal establishments for all levels of productivity; some formal establishments that face higher costs because of crime and operate on the edge of profitability switch to the less-productive informal sector to remain profitable; that is, they stop paying taxes to decrease costs. In addition to the channels mentioned above, increases in security spending reduce the aggregate use of inputs and wages, in turn, contract. The decrease in wages further pushes a fraction of workers into informality since the value of becoming an informal manager is higher than the value of being a worker. The net effect is that the share of the informal sector expands, and informal establishments rent an even more significant level of inputs.

Figure 4: Inputs and output by condition of the establishments.



Notes. The figure shows the ratio of input usage of informal establishments (left) and formal establishments (b). Crime on businesses has distortionary effects on the economy. First, victimization causes some formal establishments on the edge of profitability to switch to the informal sector to decrease costs. Besides, larger establishments spend on security to counteract the aggressions instead of using those resources to produce. As a result, the aggregate use of inputs decreases, and wages, in turn, decrease. The decrease in wages further pushes a fraction of workers into informality since the value of being an informal manager is now higher than the value of becoming a worker. The net effect is that the share of the informal sector expands, and establishments rent more inputs than an economy with no crime (graph on the left). Second, middle-sized formal establishments bear the highest cost of crime. As a result, their input usage decreases. Third, since wages decrease, large formal establishments rent more inputs (graph on the right).

4.2 Policy analysis. Full law enforcement

I compare steady states under different complete law enforcement scenarios in this section. First, I increase the size of the respective parameter that governs the degree of illegality until the illegal behavior disappears. Then I conduct two exercises. In the first one, I shut down the illegal channels while keeping the tax rate fixed. In the second one, I shut down the same illegal channels but iteratively find the tax rate that leaves the tax revenue unchanged. Notice that the comparison between steady states is an extreme exercise as is standard in the misallocation literature (see [Hsieh and Klenow, 2009](#) and [Restuccia and Rogerson, 2008](#)); that is, the whole distortionary effects are

lifted to compare the maximum values the aggregate variables attain.

I set an arbitrarily large value for parameter e , related to spending on interdiction. The thought experiment is to picture a world where the government finds a way to eradicate drug trafficking by seizing all transit drugs. The second column of Table 3 shows the percentage change from the calibrated economy for different aggregate variables. The effects on the aggregate variables are close to zero relative to the baseline calibration: aggregate capital increases by 0.54%, labor decreases by 0.14%, and output increases by 0.51%.⁹ The mechanisms that generate those changes arise from an increase in entrepreneurship, as some individuals who worked for cartels become low-skill managers.¹⁰ Total security spending and stolen output increase by almost 2% as the share of businesses increases.

In the third column of Table 3, I eliminate crime against businesses by providing complete government protection; that is, I set $\lambda_R = 1$. Shutting down crime reduces the informal sector by 6.4%. Since businesses no longer get their output stolen, a fraction of medium-skilled entrepreneurs can now afford to pay taxes and operate in the more productive formal sector. The expansion of the formal sector increases the use of inputs, which, in turn, increases the wage rate. With a higher wage rate, the value of becoming a worker increases, and therefore some previous informal entrepreneurs become workers. The combined effects increase output by 2.58%. Also, the increase in the wage rate reduces drug-related profits by 0.74% since drug cartels now pay higher wages to their hitmen.

In the fourth column, I set $k_{caught} = 0$; that is, the government catches and punishes any entrepreneur who chooses not to pay taxes and eliminates any possibility to operate

⁹The aggregate effects on output arise entirely from the private sector's production. Therefore, the production of drugs does not count towards the calculation of aggregate output. That is, shutting down drug trafficking does not mechanically decrease output.

¹⁰The model assumes costless transitions between occupations. Some empirical evidence in Mexico suggests that peasants that harvest illegal crops switch to legal ones, like beans, if the price of the latter increases (see [Wainwright \(2016\)](#)). However, as [Lopez Cruz and Torrens \(2021\)](#) show, drug cartel members may also switch to other illegal activities (instead of legal ones) when their revenues from drug trafficking are affected. A future extension of my model is to include costs in transitions from illegal to legal activities, or barriers to entry. In equilibrium, such a mechanism would result in a lower share of criminals becoming workers or entrepreneurs and lower aggregate effects from eradicating the illegal channels because wages or profits would need to be higher to compensate for such costs.

Table 3: Percentage change w.r.t. calibrated economy (keeping tax rate constant)

Variable	Drug trafficking	Crime	Informality	All illegality
Capital	0.54	5.70	20.29	28.21
Labor	-0.14	0.79	12.92	13.15
Output	0.51	2.58	11.94	14.84
Entrepreneurship	0.68	-3.65	-56.55	-58.21
Informality	0.93	-6.40	-100.00	-100.00
Wage rate	-0.21	4.50	-12.69	-7.92
Security spending	1.93	-100.00	42.67	-100.0
Output stolen	1.94	-100.00	142.86	-100.0
Drug profits	-100.00	-0.74	-10.30	-100.0

Notes. This table displays the percentage change of some aggregate variables to the calibrated economy by shutting down drug trafficking (second column), crime against businesses (third column), informality (fourth column), and all illegality (last column). The comparison is between steady states. Shutting down drug trafficking involves setting the parameter of interdiction to a considerable value. Shutting down crime against businesses results from setting complete protection of property rights. Shutting down informality results from setting the probability that the government catches and punishes informal entrepreneurs to one. Finally, shutting down informality results from including all the previously mentioned mechanisms.

The estimations of this table result from keeping the tax rate fixed at 0.25.

in the informal sector. The changes in the aggregate quantities are the largest under this policy. The entrepreneurship rate decreases by almost 57% as a large number of informal entrepreneurs become workers. With the disappearance of the unproductive informal sector, capital expands 20.3%, labor 12.9% and output 11.9%. Surprisingly, the wage rate decreases by 12.7% since the government now taxes a larger share of output. With cheaper labor, drug cartels hire more workers, but their profits decrease. The reason is that with more workers, cartels fight more intensively for the drug routes. The aggregate cost of crime (security spending and stolen output) increases by almost 200% since the economy increases its size.

The aggregate effects that result from eradicating informality should be seen as an upper bound, as the model abstracts from additional mechanisms that may play a role in determining the choice of operating in the formal or informal sector; for example, as recent evidence points out, increases in the minimum wage influence wages and employment in the formal and informal sectors ([Pérez-Pérez, 2020](#)). Therefore, setting

a minimum wage above the equilibrium wage would further misallocate resources and talent because some low-productive entrepreneurs would become workers to earn a higher income. In addition, some establishments would see an increase in their wage bill. However, as [Braun \(2019\)](#) shows, minimum wages can also improve welfare by dissuading individuals from joining crime. As mentioned above, my framework does not map the number of criminals into a crime function; therefore, I cannot answer if setting a minimum wage results in more or fewer distortions in the productive sector.

In the last column of [Table 3](#), I shut down all the illegal channels. Under this policy, capital increases by 28.2%, labor by 13.2%, and output by 14.8%. The changes result from a combination of all the channels mentioned in previous paragraphs.

To counteract the additional distortionary effects of the government taxing a more significant level of output when the illegal channel disappears, I replicate the previous exercises while keeping the tax revenue constant. The results are similar, but the magnitudes differ ([Table 4](#)). Shutting down all illegality increases capital by 63.5%, labor by 13.8%, and output by 24.7%. The positive effects amplify since the tax rate decreases by more than half. The substantial increase in aggregate capital more than offsets the increase in labor and, therefore, wages expand.

Table 4: Percentage change w.r.t. calibrated economy (keeping tax revenue constant)

Variable	Drug trafficking	Crime	Informality	All illegality
Capital	1.87	30.83	53.14	63.47
Labor	0.15	5.74	13.24	13.75
Output	1.16	13.05	21.43	24.74
Entrepreneurship	-0.68	-23.65	-56.91	-57.97
Informality	-1.53	-41.40	-100.00	-100.00
Wage rate	0.24	13.04	10.68	16.81
Security spending	0.74	-100.00	57.67	-100.00
Output stolen	0.99	-100.00	124.21	-100.00
Drug profits	-100.00	-9.77	-16.04	-100.00
Tax rate	-1.60	-30.88	-51.02	-52.17

Notes. This table displays the percentage change of some aggregate variables to the calibrated economy by shutting down drug trafficking (second column), crime against businesses (third column), informality (fourth column), and all illegality (last column). The comparison is between steady states. Shutting down drug trafficking involves setting the parameter of interdiction to a considerable value. Shutting down crime against businesses results from setting complete protection of property rights. Shutting down informality results from setting the probability that the government catches and punishes informal entrepreneurs to one. Finally, shutting down informality results from including all the previously mentioned mechanisms.

The estimations of this table result from keeping the tax revenue constant.

Finally, in Table 5, I shut down each illegal channel and adjust the tax rate to keep output constant between steady states. This exercise exemplifies that governments may adjust their tax rates to increase revenues while simultaneously strengthening their institutions without further distorting their economies. Although the exercise is extreme, it provides an upper bound on the possible effects. By shutting down drug trafficking, the government increases the tax rate by 2.6% (from a base rate of 0.25) to keep output constant. The higher tax rate increases the informality rate since some previous formal establishments can no longer afford to pay taxes. In consequence, both aggregate productivity and the wage rate decrease. The decrease in the wage rate increases the informality rate by 5.2%, and establishments substitute capital for labor.

In the third column of Table 5, I shut down crime against establishments. Again, the results are similar to those that arise by shutting down drug trafficking, as the government increases the tax rate (8.6%). In the second case, however, the wage rate

Table 5: Percentage change w.r.t. calibrated economy (keeping output constant)

Variable	Drug trafficking	Crime	Informality	All illegality
Capital	-0.58	-0.34	-14.30	-16.25
Labor	0.30	-0.50	12.87	13.69
Output	0.00	0.00	0.00	0.00
Entrepreneurship	3.12	2.06	-55.81	-57.97
Informality	5.16	4.02	-100.00	-100.00
Wage rate	-0.80	2.60	-37.57	-40.11
Security spending	-1.14	-100.00	-10.45	-100.00
Output stolen	0.34	-100.00	26.29	-100.00
Drug profits	-100.00	0.06	-1.03	-100.00
Tax rate	2.58	8.56	59.64	74.96

Notes. This table displays the percentage change of some aggregate variables with respect to the calibrated economy by shutting down drug trafficking (second column), crime against businesses (third column), informality (fourth column), and all illegality (last column). The comparison is between steady states. Shutting down drug trafficking involves setting the parameter of interdiction to a considerable value. Shutting down crime against businesses results from setting complete protection of property rights. Shutting down informality results from setting to 1 the probability that the government catches and punishes informal entrepreneurs. Finally, shutting down informality results from including all the previously mentioned mechanisms. The estimations of this table result from adjusting the tax rate so that output does not vary with respect to its steady-state value from the calibrated economy.

increases because the positive effects of eradicating crime against businesses more than compensate for the adverse effects of increasing the tax rate. In the fourth column, I shut down informality. In this scenario, the government increases the tax rate by 56.9% to keep output constant. The large increase in the tax rate and the eradication of informality induce many entrepreneurs to become workers, which contracts the wage rate by 37.6% (because of large increase in labor supply). Finally, the last column provides the combined effects of eradicating all illegality.

The results are consistent with what other authors have quantified in studies that evaluate the same illegal channels but in a separate way. For example, [Leal-Ordóñez \(2014\)](#), focusing only on the distortionary effects of the informal sector in Mexico, finds that aggregate output would increase by 19.3% without the distortions associated with the informal sector. In a model of crime against establishments that abstracts from the informal sector and drug trafficking (like in this study), [Ranasinghe \(2017\)](#) finds that

aggregate output would increase by 1% in Poland without crime in establishments. In the same model but calibrated to Mexican data for 2019, [Banco de México \(2021\)](#) finds the increase in output at 1.6% for Mexico. In an extension with financial constraints, [Ranasinghe and Restuccia \(2018\)](#) find that the aggregate output of Colombia would increase by 3.1% without crime in establishments. Finally, using microdata of the World Bank enterprise surveys, [Besley and Mueller \(2018\)](#) find that output would increase in Mexico by 3.5%, with business victimization levels similar to China.

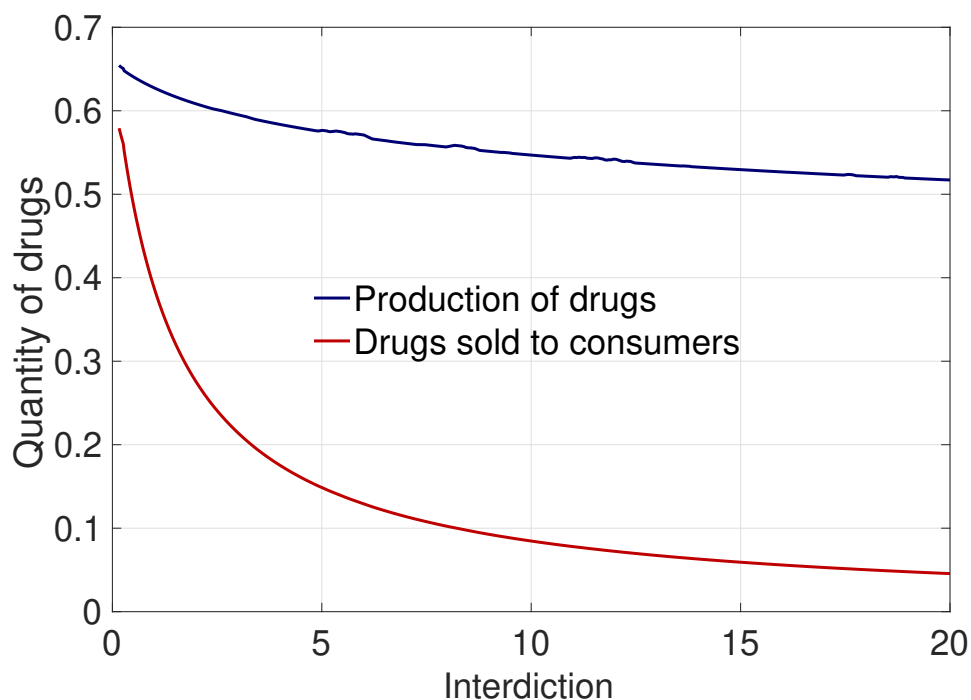
The previous policy exercises show that governments running on fixed budgets should not prioritize their police efforts on fighting drug cartels but redirect them to protect businesses and tackle informality. For example, suppose governments with fixed resources aim to decrease the consumption of illegal drugs for reasons unrelated to economic efficiency, such as health or moral reasons. In that case, they should target the demand for drugs or drug cartels' profits, which are the channels that sustain the drug trafficking market.

4.3 The Mexican War on Drugs through the prism of the model

Under my interpretation and in harmony with previous research and the results shown in this work, I rationalize the Mexican War on Drugs as a permanent increase in interdiction, e , and a permanent decrease in property rights, λ_R . The intuition behind that reasoning is that the government operated under fixed resources. Accordingly, when it mobilized the finite police units against drug trafficking, it provided less protection for producers. Consistent with this reasoning, an alternative explanation is that when security forces increased their offensive to tackle drug trafficking, drug cartels reallocated to other valuable locations to exploit other illegal activities, like oil siphoning ([Lopez Cruz and Torrens, 2021](#)).

Since I am not explicitly modeling a function that maps law enforcement resources into institutions, I will use a comparative statics approach to analyze the war on drugs. In it, I will find distinct steady-state equilibria for various levels of interdiction and government protection and connect the model's predictions with a narrative of the

Figure 5: Production and consumption of drugs by interdiction



Notes. The figure plots the number of drugs produced (blue line) and the number that reaches consumers (red line). The difference between both lines corresponds to the number of drugs that the government seizes through interdiction. Thus, as interdiction increases, the production of drugs barely changes, and the consumption of drugs decreases asymptotically.

events related to the Mexican War on Drugs.

First, I start with the effects on drug trafficking of a permanent increase of interdiction. Figure 5 plots the production and consumption of drugs as interdiction varies. When the level of interdiction increases, the consumption of drugs decreases. Before the war on drugs, Mexico had a low level of e , and after the policy, the economy transitioned to some steady-state with higher e . Since the demand for drugs is price-inelastic (refer to Table 2), the lower number of drugs that reach consumers causes an increase in the price of drugs. The increase in the price of drugs expands the aggregate revenues and profits of drug cartels. Figure 6 shows the equilibrium price and profits of drug cartels for different levels of interdiction.

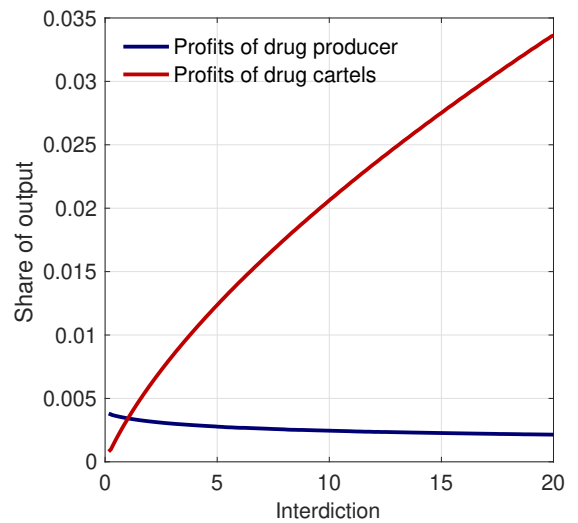
Higher illegal profits create incentives for new cartels to enter the market and contest those profits. Figure 7 (a) plots the number of drug cartels for different interdiction values.

Figure 6: Price of drugs and aggregate profits of drug cartels

(a) Prices of drugs

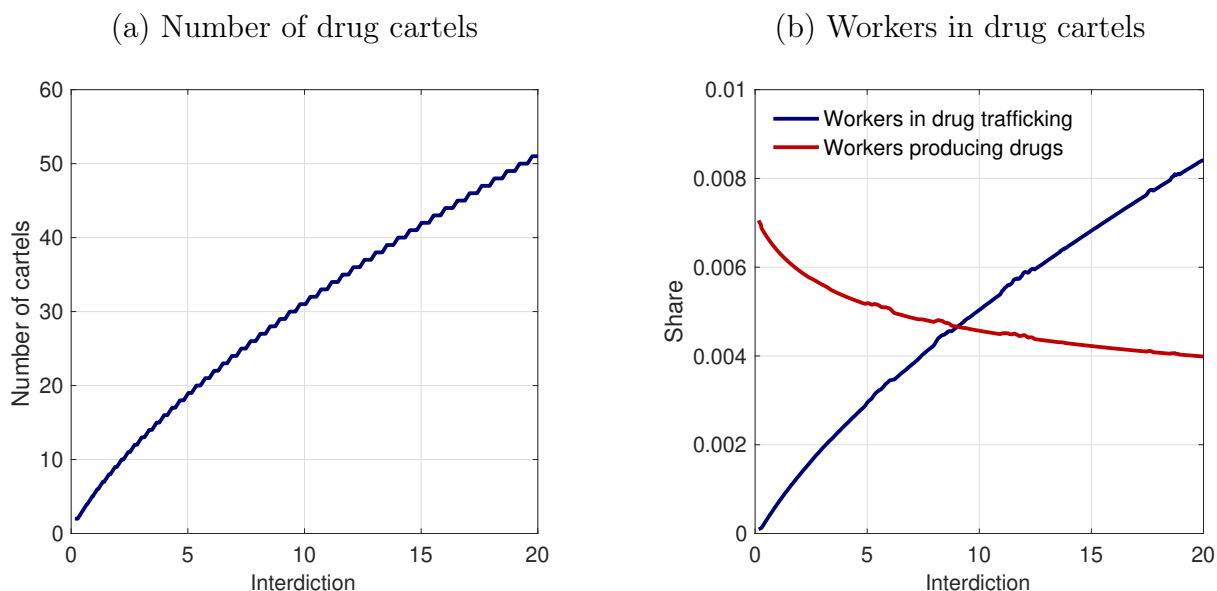


(b) Aggregate profits of drug cartels



Notes. Quadrant (a) plots the price of drugs (blue line) and the consumption price of drugs (red line) as interdiction varies. Quadrant (b) plots the profits of the drug producer (blue line) and the profits of all drug cartels (red line). With more interdiction efforts, the price and profits of the drug producer remain stable. However, the price that final consumers pay for drugs and the cartels' profits increase considerably. Both increases are a consequence of the price inelasticity of the demand for drugs.

Figure 7: Number of cartels and workers as interdiction varies.



Notes. In quadrant (a), I plot the number of drug cartels as interdiction increases, and in quadrant (b), the workers (as a share of the labor force) involved in drug trafficking and production. Starting from a low number of drug cartels, when interdiction increases, the number of drugs that reach final consumers decreases. However, since the demand for drugs is price inelastic, the price of drugs and the aggregate profits of cartels increase. This increase in profits pushes new cartels to enter the market to contest the fixed amount of routes. To contest those routes, drug cartels hire more workers.

The model predicts that the number of cartels increases for low levels of interdiction. Besides, drug cartels hire additional workers to contest those more significant profits. Figure 7 (b) plots the number of workers trafficking drugs as interdiction varies. The number of workers in drug trafficking, which one can think about as a proxy for violence, increases with interdiction, just like during the War on Drugs. Conversely, the number of workers producing drugs decreases with interdiction because cartels buy fewer drugs as consumption decreases. My results are consistent with the theoretic framework of [Becker et al. \(2006\)](#). The prohibition of illegal goods increases total spending because of the price inelasticity of the demand. In addition to that mechanism, in my framework, aggregate profits increase with interdiction, which induces new cartels to enter and contest them, and hence, violence increases.

Second, I analyze the aggregate economic effects that result from a permanent reduction in government protection. In Figure 8 (a), I plot the aggregate inputs and

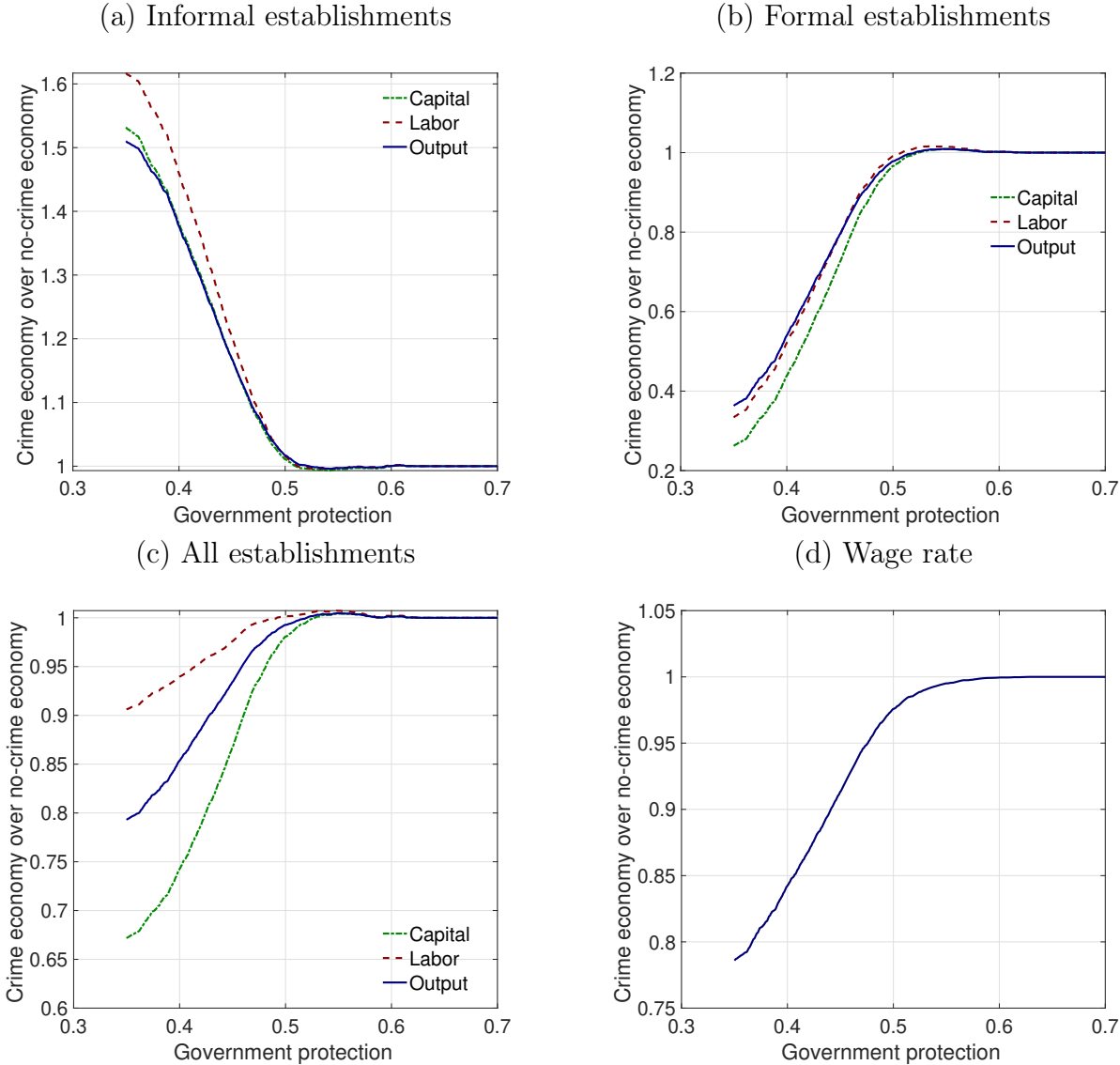
output of informal establishments as a ratio between an economy without crime and an economy with various degrees of government protection, and hence, positive levels of crime. In quadrant (b), I plot the same variables for formal establishments. With lower government protection, the input use of informal establishments increases, and the use of formals decreases. Informal entrepreneurs are less efficient than formal ones. With lower property rights, labor and capital are misallocated from formal to informal establishments, causing the total input use and output to decrease, as in quadrant (c).

What are the channels behind the results in the previous paragraphs? First, as property rights decrease, the victimization of firms increases, which induces establishments to react in two ways. The first one is that they decrease their scale of operation, and the second one is that they spend on extra security to protect themselves against crime. Both effects reduce the rental of inputs and output contracts. In addition, the occupational choices distort as well.

Formal entrepreneurs on the margin of profitability switch to the informal sector to remain profitable, and the economy experiences an influx of formals to the informal sector. A second influx to informality arises because of general equilibrium effects. Quadrant (d) of Figure 8 shows that wages decrease with lower government protection. Some workers endowed with a relatively higher entrepreneurial talent switch to informality to increase their income since the value of being a worker decreased. The whole misallocating mechanism is plotted in Figure 9, in which the occupational choices are plotted. The share of entrepreneurs and, in particular, of informal entrepreneurs increases with lower government protection.

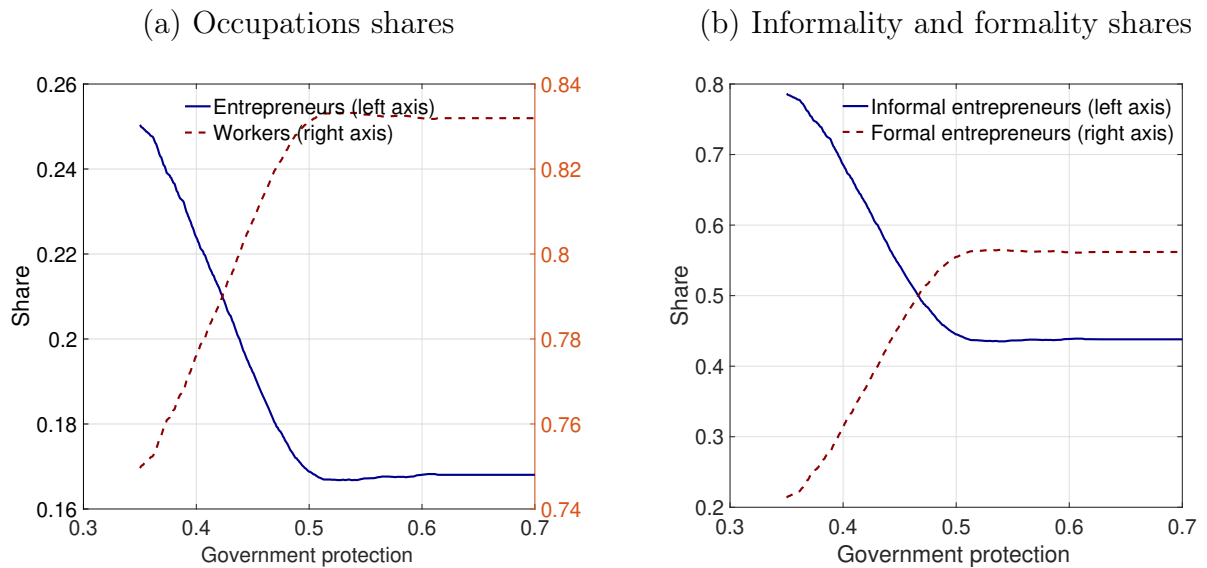
The previously mentioned effects have multiplying effects on aggregate output. Figure 10 plots the fraction of output that gets stolen and the change in output relative to an economy without crime. With lower government protection, the cost of crime increases, and the economy contracts.

Figure 8: Aggregate inputs and output, and wage rate as government protection increases.



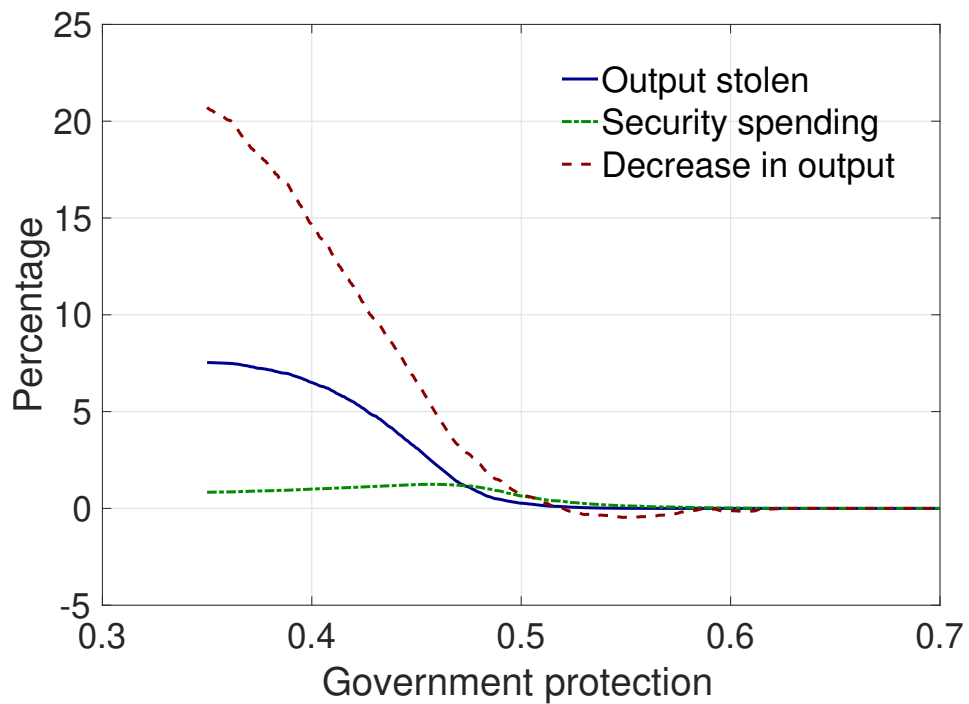
Notes. In this figure, I vary the parameter λ_R , which controls government protection on establishments. With lower government protection, crime in establishments increase. The increase in crime *i*) lowers the aggregate input use, which results in a contraction of wages [quadrant (d)], and *ii*) distorts the occupation choice, as the additional crime-related costs push a fraction of formal entrepreneurs into informality. Also, the decrease in wages forces some workers to join the informal sector. The overall effect is that resources misallocate as the more inefficient informal sector employs more inputs [quadrant (a)], the more efficient formal sector employs fewer inputs [quadrant (b)], which results that the aggregate use of inputs and production decrease [quadrant (c)].

Figure 9: Occupational choice with different levels of government protection
Shares



Notes. In Panel (a), I plot the worker and entrepreneur shares as government protection increases. When the government provides more protection, entrepreneurs bear lower costs, which allows them to employ more inputs. In the aggregate, the rent of more inputs increases the wage rate, pushing some individuals in the informal sector to work for wages. In Panel (b), I plot the distribution of formal and informal entrepreneurs for different values of government protection. When the government provides more protection, some informal entrepreneurs switch to the more productive formal sector. In addition, since the costs of crime decrease, some entrepreneurs can now afford to pay taxes and produce without the restriction on capital.

Figure 10: Cost in output by government protection



Notes. In this figure, I plot the cost of crime for different values of government protection and the decrease in steady-state output relative to an economy without crime. With low protection, criminals steal more output from entrepreneurs. Notice that crime has a substantial multiplicative effect on output. When the government is low ($\lambda_R = 0.4$, for example), criminals steal close to 6% of output, but the economy decreases by 15%.

5 Conclusions and future work

In a calibrated exercise for the Mexican economy, I show how imperfect law enforcement allows crime against businesses, labor informality, and drug trafficking that distort businesses' occupational choices and production decisions, resulting in adverse effects on steady-state output. In addition, I find that policies that target labor informality and crime against businesses would reap larger increases in aggregate efficiency. Furthermore, according to the model presented here, if the demand for illegal drugs is price inelastic, interdiction policies risk creating violence and distorting the economy. As such, the results provide an economic rationale for authorities also to consider alternative policies, like consumer-side policies or seizing the illegal profits of drug cartels.

This paper has three main limitations. To keep the model and estimation tractable, I abstract from including crime against households. New empirical studies have examined the links between organized crime and labor markets. For example, [BenYishay and Pearlman \(2013\)](#) find that in violence-stricken Mexican states, the increase in homicides leads to a reduction in the number of hours worked. [Velásquez \(2015\)](#) finds that in municipalities with high levels of violence, increases in homicides negatively affect women's labor force participation and working hours. [Arias and Esquivel \(2012\)](#) estimate that for every 10 per 100,000 drug-related homicides at the national level, unemployment increases by 0.5%, and the fraction of self-employed decreases by 0.4%. Including the mechanisms by which crime affects households' decisions is an avenue for future work.

The second limitation is that I do not model the individual decisions to engage in criminal behavior. Since the ultimate goal of this paper is to study the aggregate effects, ignoring this aspect is not of great concern. However, if the interest lies in policies that target groups prone to crime, future iterations should explicitly model crime decisions.

Moreover, the final limitation is that my framework does not inform about optimal law enforcement policies that maximize welfare. In this paper, the institutional framework is given and recovered during the calibration. In reality, governments face tradeoffs between increasing the tax burden to provide better quality institutions—and potentially distorting the economy with higher taxes; or providing institutions of lower quality

by reducing the tax burden— and potentially distorting the economy with low-quality institutions. In this paper, I can only inform about the potential benefits of different policies on steady-state output.

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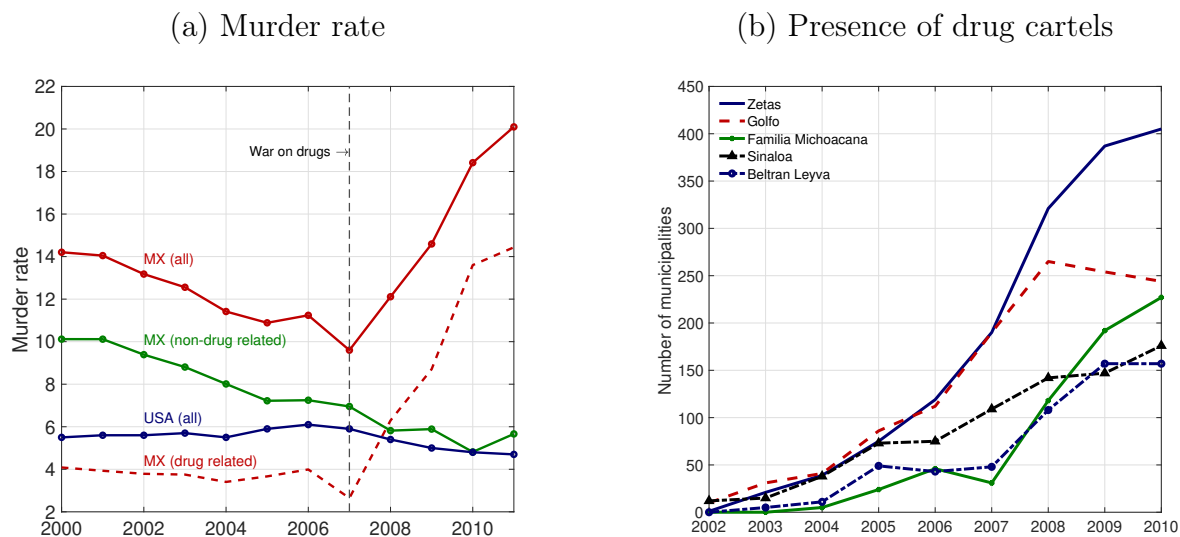
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Appendix. Figures

Figure 11: Drug-related crimes and cartels before and after the War on Drugs



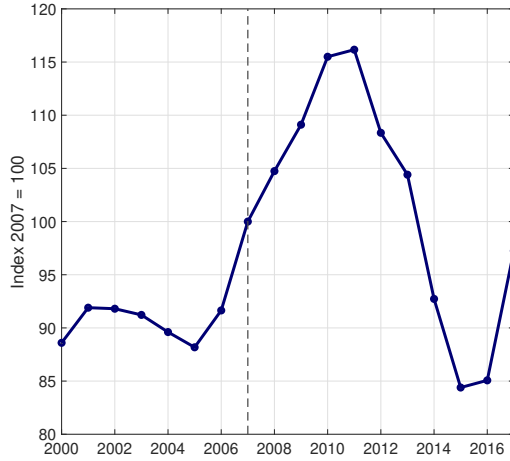
Note. Figure (a) shows Mexico’s murder rate (number of murders per 100,000 inhabitants) compared with rates in the U.S. Before the War on Drugs in late 2007, Mexico’s murder rate was in a convergence process to the U.S. rate. After the war, Mexico’s murder rate increased considerably. The increase in homicides is explained by drug-related murders, as the non-drug related murder rate continued its downward trend and reached levels similar to the U.S.

Figure (b) plots the presence of drug cartels in Mexican municipalities. The database was compiled by [Coscia and Rios \(2012\)](#) using blogs and news outlets. After the policy went into effect, cartels’ presence increased in Mexican municipalities.

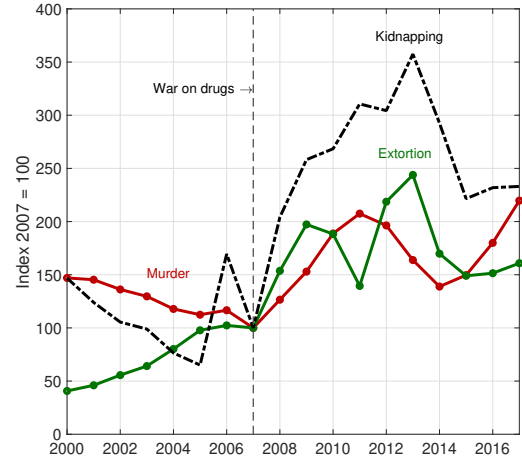
Source: For Mexico, the Ministry of the Interior, [Molzahn et al. \(2012\)](#) and [Enamorado et al. \(2016\)](#). For the U.S., the Federal Bureau of Investigation.

Figure 12: Recent crime rates of Mexico.

(a) Property crime



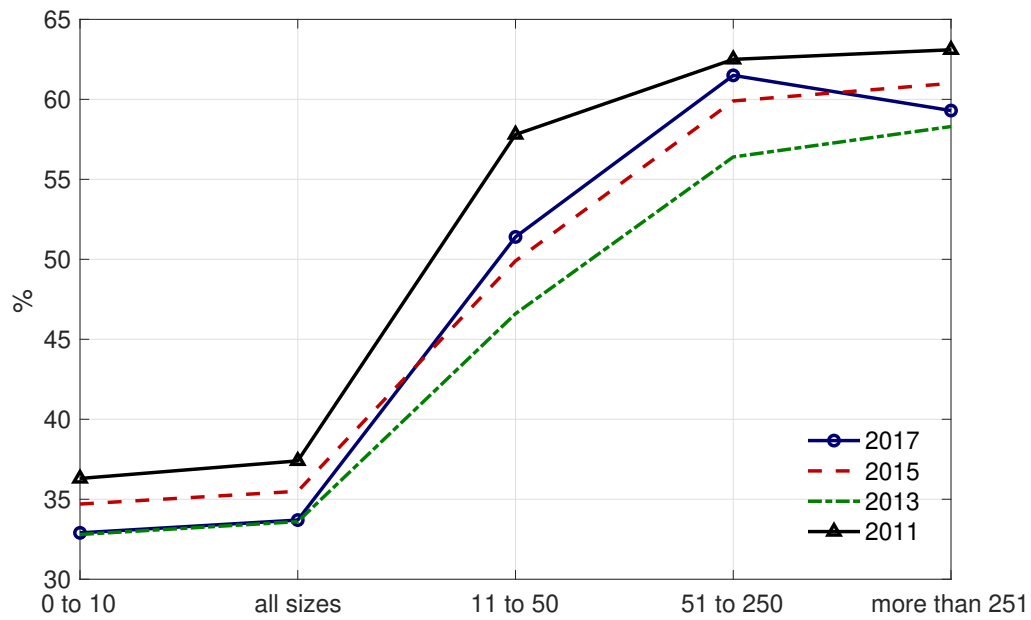
(b) Crimes related to organized crime



Note. The figure shows the official crime rates (occurrences per 100,000 inhabitants) of property crime (left) and murder, theft, extortion, and kidnapping (right). After the onset of the War on Drugs, all crimes reached all-time highs. These plots, however, should be interpreted with caution, since official statistics present biases that arise from underreporting and false statistics. However, if we assume that the bias is constant through space and time, these graphs are still informative because they demonstrate the direction and magnitudes of the changes in crimes.

Source: Mexican Ministry of Interior and INEGI.

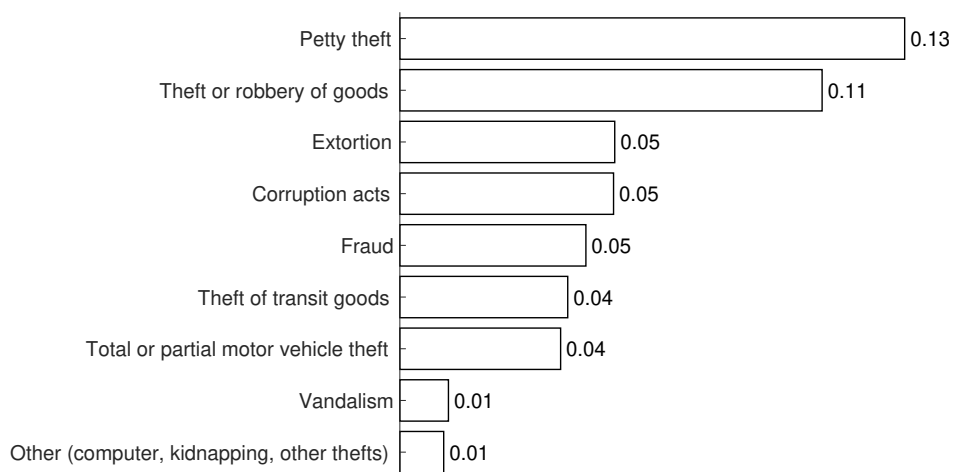
Figure 13: Victimization rate by establishment size



Notes. The figure displays victimization rates of establishments by their size (number of workers) from 2011 to 2017. The victimization rates have remained stable over time. Smaller establishments face a lower probability of crime, and larger establishments face a higher probability.

Source: Encuesta de Victimización de Empresas (ENVE) for years 2012, 2014, 2016 and 2018.

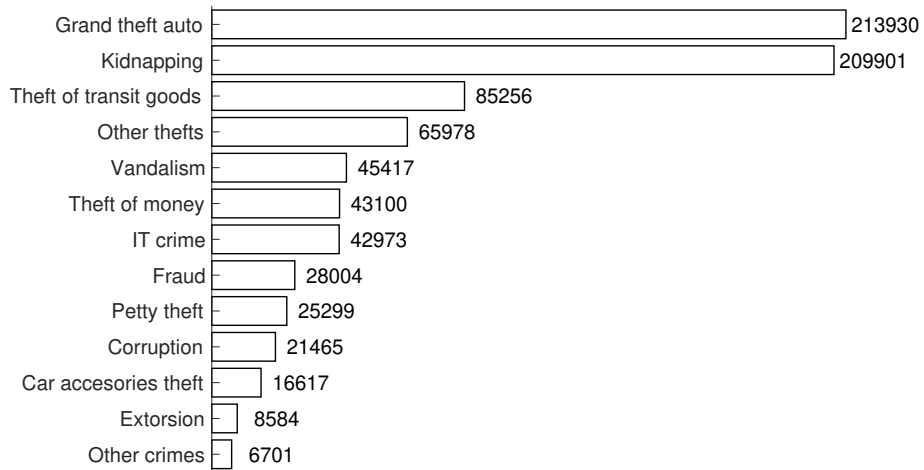
Figure 14: Business victimization rate by type of crime



Notes. The majority of crimes against establishments involved a forced exchange of property (property crimes). Vandalism, which does not involve property transfer, had a victimization rate of just 1%.

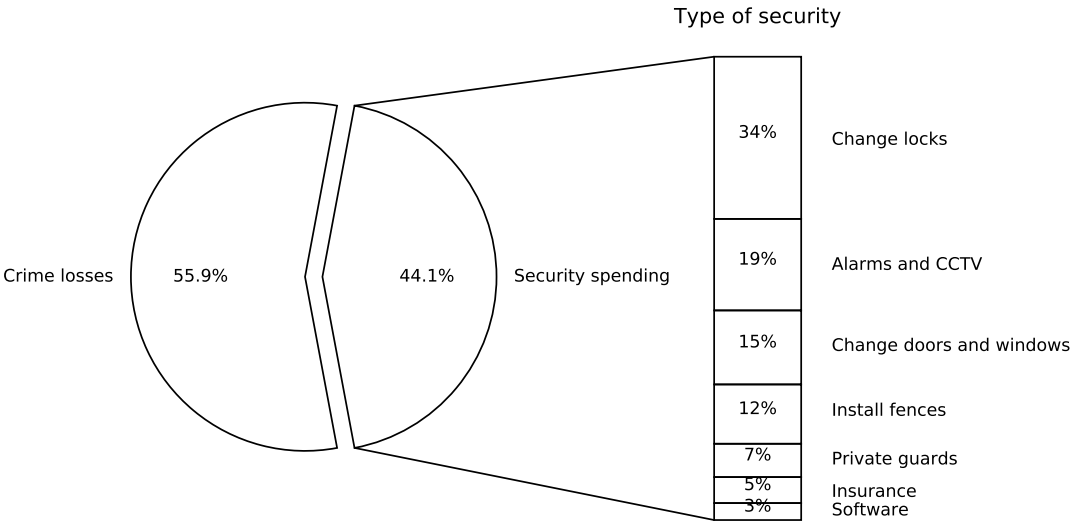
Source: Encuesta de Victimización de Empresas (ENVE) for 2018.

Figure 15: Average monetary losses (in MXN \$ of 2017) by type of crime



Source: Encuesta de Victimizaci3n de Empresas (ENVE) for 2018.

Figure 16: Distribution of costs by crime and distribution of security spending by type

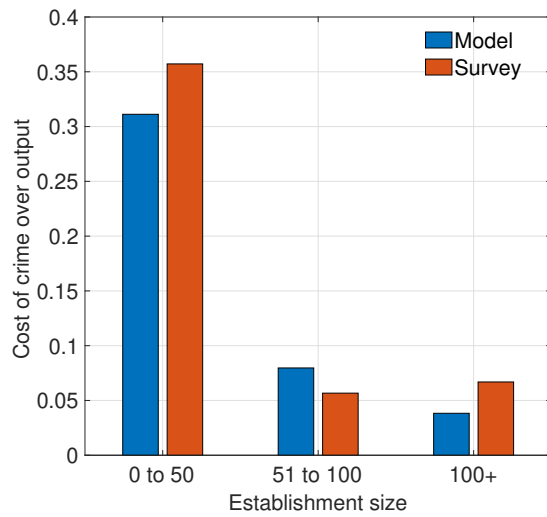


Notes. In 2017 crime against establishments cost 0.86 percent of Mexican GDP. Of that number, 55.9% were direct losses (value of property lost), and the rest consisted of additional spending on security. The main components of security spending are: changing locks, installing alarms and CCTV, changing doors and windows, and installing fences.

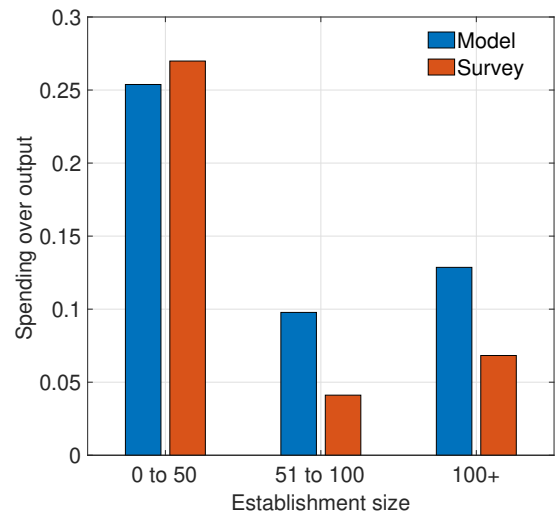
Source: Encuesta de Victimización de Empresas (ENVE) for 2018.

Figure 17: Model moments vs survey moments

(a) Cost of crime



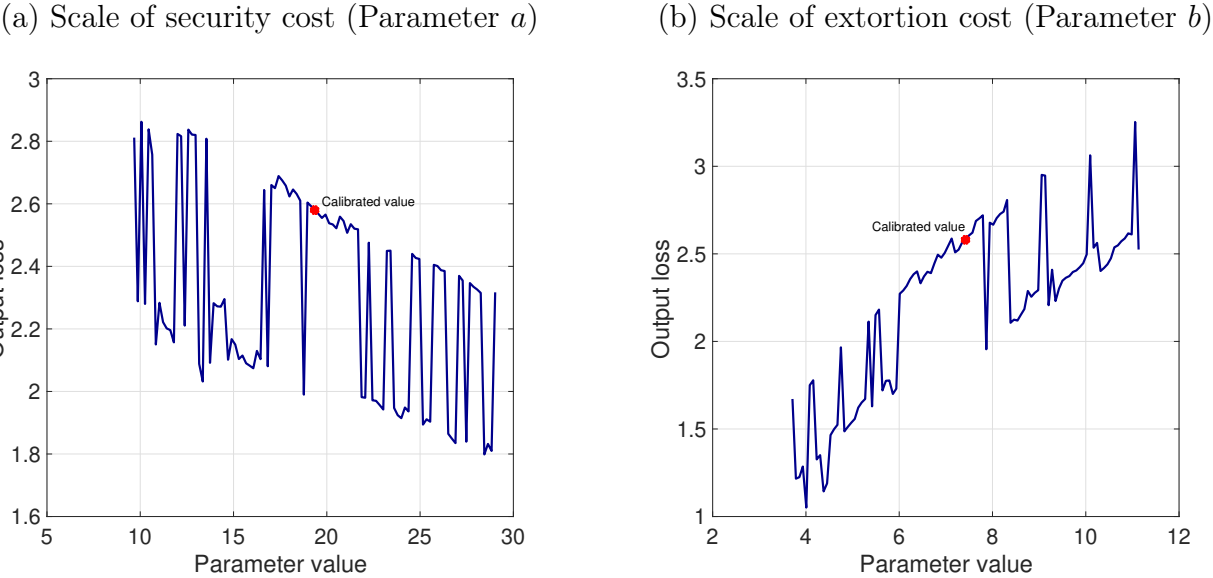
(b) Security spending



Notes. Figure (a) plots the total value of property lost as output share by establishment size, and figure (b) plots total security spending as output share. The blue bars correspond to the results from the model, and the red bars are the observed moments from the ENVE survey. The results from the estimated parameterization follow the survey counterparts closely.

Source: Model predictions using data from [INEGI \(2018\)](#)

Figure 18: Effects of crime on output by varying the scale of security and extortion costs



Notes. Figure (a) plots the output loss associated with crime in establishments by varying the parameter that controls the extortion cost scale. Figure (b) plots the counterpart exercise for parameter b , which controls the scale of extortion costs. The red dots denote the fixed values taken from the estimation for Colombia by [Ranasinghe and Restuccia \(2018\)](#). In both cases, the calibrated values fall inside a region that does not result in sharp spikes in the aggregate effects on output.