Public Law Enforcement: More Is not Always Better*

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Abstract

To date, the economic literature on theft is primarily limited to the microeconomic arena. In this paper we incorporate theft in a macroeconomic setting with the goal of understanding the effects of public law enforcement (PLE) on the incarceration rate, aggregate output and average welfare. Our primary finding is that there exists a non-monotonic relation between the level of PLE and all three of these aggregate variables. In particular, for countries with relatively small amounts of PLE, there is an inverse relationship between PLE and both aggregate production and welfare primarily due to an increase in the incarceration rate. However, for countries with higher levels of PLE, the level is positively related to production and welfare and inversely related with the incarceration rate. We also find that private security is used as a substitute for PLE and causes a negative externality in economies with low levels of PLE.

JEL Classification: D23, K11, K42

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1 Introduction

Property rights, the ability of firms and consumers to own capital and other resources, are essential to almost every economic model. However, for the most part these rights are taken as given. A walk through the streets in an urban area of virtually any developing country reveals that, in practice, this is not the case. Private security guards, metal bars and large locks are commonplace to counteract theft. Economists have remained largely silent on the discussion of theft and how to counteract it even though it is important for policymakers. In this paper we incorporate theft, private security and public law enforcement (PLE) in a general equilibrium framework with the goal of understanding the effects of PLE on the incarceration rate, aggregate output and average welfare. Our primary finding is that there exists a non-monotonic relation between the level of PLE and all three of these aggregate variables. In particular, for countries with relatively small levels of PLE, there is an inverse relationship between PLE and both aggregate production and welfare primarily due to an increase in the incarceration rate. However, for countries with higher levels of PLE, the level is positively related to production and welfare and inversely related with the incarceration rate. We also find that private security exhibits a negative externality and is used as a substitute for PLE which results in an overuse of private security, particularly in economies with a low level of PLE.

The primary mechanism which is responsible for this result is relatively straightforward. For countries with low levels of PLE, very few criminals are actually caught. As this level increases, so does the incarceration rate, which removes agents from the labor force. Additionally, there is a general equilibrium effect which lowers the relative income of the non-incarcerated agents through the increased burden of supporting those who are incarcerated. This essentially decreases the deterrence of imprisonment and incents additional agents to become thieves. As the level of PLE increases the probability of getting caught rises, this deters agents from stealing. At some point the increase in the percent of thieves being caught is outweighed by the deterrence effect on the quantity of individuals choosing to steal. At this point, the incarceration rate begins to decrease in the level of PLE. This non monotonicity in the incarceration rate is the primary driver behind the additional non monotonicities in aggregate output and welfare. To quantity these effects using our benchmark model, if the level of PLE in Guatemala increased to the level in Mexico, we would predict a *decrease* in aggregate production of 0.33%. Again using our benchmark model, if the level of PLE in Mexico improved to the level of that in the United States, we would predict an *increase* in aggregate production of 2.58%.

For countries with a low level of PLE, we observe a high level of substitution between PLE and expenditures on private security which dampens the effect PLE has on the overall level of theft. Further, not only do these firms substitute private security for PLE, we find that economies with low levels of PLE tend to hire more private security than is socially efficient. If we restrict firms such that they are only permitted to hire a fraction of the private security that they would otherwise find individually optimal, aggregate production is higher than if firms were unrestricted in their private security decisions. The reason for this is that by restricting how much firms can spend on private security, firms end up hiring more workers which produce the final good even though a larger portion of what is produced is stolen.[1]

For high enough levels of PLE, we find that marginal increases in the level of PLE provide significant gains to aggregate production and increase the labor force. As the probability of getting caught rises, agents are deterred from stealing and at some point the drop in theft becomes larger than the increase in those thieves who are caught. The reduction in incarceration rates augments the total labor force which increases total production. Additionally, reduction in theft from firms lowers the distortionary wedge between the marginal product of labor and the wage rate which rises both the efficiency and average size of firms. Finally, the increase in the wage rate and the reduction in the burden of the incarcerated on the non-incarcerated increases the actual cost of getting caught and puts further downward

[1] In our model theft has a contemporaneous distortion on firms' optimal decision. For an analysis on possible inter-period distortions that crime has on production see Arias et al. (2014).

pressure on the theft rate.

The level of PLE is drastically different across countries, with police force and incarceration rates varying by a factor of 100.[2] Our results provide a possible explanation of why this is the case. Since the marginal effects of changes in PLE are very different depending on the current level of PLE, if the transition in the level is not instantaneous, countries with low current levels of PLE may initially experience a reduction in welfare and production before seeing improvements in response to increases in PLE. This implies that countries which are sufficiently impatient would prefer to remain in a state of low PLE rather than face the transition path to a high level of PLE.[3]

Data which exists for private security consistently reveals that the correlation between private security expenditures and theft is positive. We match this fact. In our model this relation is caused by PLE which both deters theft and serves as a substitute for private security. In this sense, we make the same empirical observation as North (1968) in that economies where firms have lower private security expenditures are also economies with less theft and often higher production.

In order to direct and validate the way we model the decision of thieves in when and how much to steal, and the way we model private security, we adopt two strategies. First we incorporate existing findings on theft in the psychology and sociology literature. Second we allow agents to vary across two dimensions: in aversion to theft and in level of ability as in the Lucas (1978) span of control model. Granting variation across these dimensions gives insight into micro decisions of agents and across firms. We validate our modeling of theft and private security by matching these patterns to the data.

Heterogenous modeling of agents also gives further insights. Specifically, agents with lower ability earn less which decreases their cost of being caught and increases the likelihood they engage in theft. Second, the distortion from theft across firms is not uniform. Firms

[2]Source: http://www.prisonstudies.org/info/worldbrief/

[3]Buonanno et al. (2014) document a non-monotonic relation between property crime and income within the US states.

managed by entrepreneurs with higher ability afford larger amounts of private security which reduces the wedge between the marginal productivity of labor and the wage rate. This mechanism causes the dispersion across firm size to be increasing in the rate of theft.

As far as we are aware, we present the first general equilibrium model incorporating theft, private security and PLE. However, our work contributes and builds upon a vast theoretical and empirical literature.

Our paper continues in the spirit of the seminal work by Becker (1968). In our model consumers analyze the costs and benefits of committing a crime and make a rational decision of whether to engage in criminal activity. Perhaps the model most similar to ours is the one in Fender (1999) which includes many of the same elements and some of the same results. In that model, corruptible agents choose between work and theft and there is consideration of the level of enforcement which is very similar to our notion of PLE. In line with this paper, we observe similar relationships between the level of enforcement, the number of criminals and the number punished. In contrast to Fender (1999) and Burdett et al. (2003), our model allows thieves to both work and steal, we include a notion of firms, agents are heterogenous in ability and we incorporate general equilibrium effects. This allows us to match micro data in order to validate our macro results.

Our findings are consistent with the findings in the empirical paper by Buonanno et al. (2011) and Ibáñez et al. (2013). Their work suggests that increases in the incarceration rate deters crime. In our model we support that this effect holds, but the general equilibrium effects can cause pressure on crime (specifically theft) in both directions. Due to the current absence of dynamics in our model, we are unable to address the (largely empirical) literature on the deterrents of the effects of prison on recidivism.[4]

Our paper is also related to the existing literature relating trust, extortion, distortion and firm size. We observe a similar pattern in distribution of firm size due to increases in theft as Ranasinghe (2012) observes from increases in extortion in the sense that higher

[4]See Drago et al. (2009) for an example.

levels increase dispersion of firm size. Our effects differ slightly in that all firms are smaller than they would be in the absence of theft but the distortion is greatest for the smallest firms. Finally, consistent with Grobovšek (2014), we find that increased levels of theft among workers constrains firm size.

The rest of the paper is organized as follows. Section 2 presents an empirical motivation for our model and the main mechanism in it. Section 3 outlines the model. Section 4 presents the primary results. Section 5 concludes.

2 Data and Empirical Motivation

In order to validate the mechanisms used and the implied predictions of our model, we employ data from the World Bank *Enterprise Surveys* and *Worldwide Governance Indicators*. The surveys are conducted at the firm level using a representative sample of an economy's private sector. The World Bank selected firms for the *Enterprise Surveys* using stratified random sampling. All members of the population have the same probability of being sampled and no weighting of the observations is necessary. However, only firms with 5 or more employees are targeted for an interview and organizations with 100% government ownership are ineligible to participate.[5] Surveys occur face-to-face with business owners and top managers.

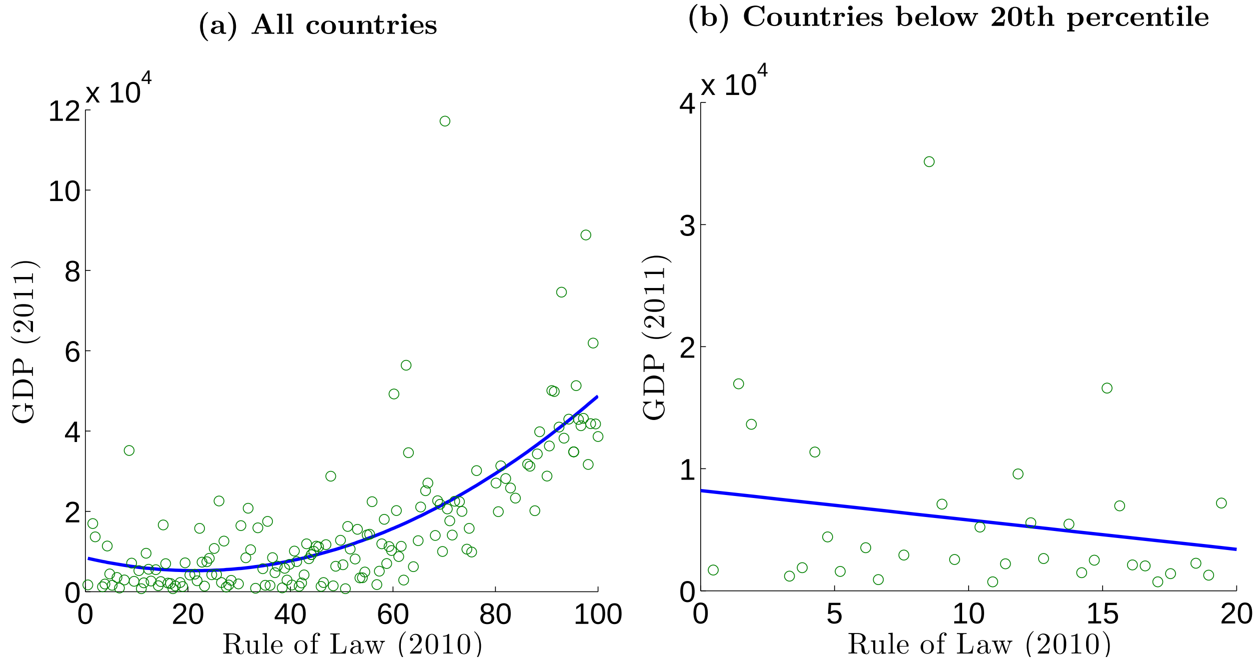
Our first result is that the data displays a non-monotonic relationship between the Rule of Law[6] and lagged GDP across countries. Figure 1 displays this relationship. Of particular interest is that there is a negative correlation between GDP and the Rule of Law index for countries below the 20th percentile in their Rule of Law rating.[7]

[5]The sample *targets* firms they believe to have 5 or more employees, however some firms are observed to have less than 5 upon conducting the interview.

[6]The World Bank establishes six governance indicators, one of which is a Rule of Law Index which orders countries according to the overall rule of law. See Kaufmann et al. (2010) for a description of the methodology used to calculate these indicators. According to the World Bank definition, "The Rule of Law index captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence". We use the percentile of this index as a proxy for the level of public law enforcement in a given country.

[7]This result is robust to either including or excluding Equitorial Guinea which is the outlier displayed in Figure 1b.

Figure 1: Rule of Law vs GDP



GDP refers to GDP per capita, PPP (current international dollars) Source: World Bank. Authors' calculations.

The primary mechanism in our model which provides insight as to why this occurs is a non-monotonic relationship in the incarceration rate as the level of Public Law enforcement increases (for which we use the Rule of Law index of 2010 as a proxy). In the data we observe a hump-shaped relationship between rule of law and incarceration rates. For low levels of public law enforcement, we observe that increases in this level are accompanied by an increase in the incarceration rate. However, once the level of public law enforcement reaches a certain point, further increases are actually related to lower incarceration rates. Table 1 shows both a linear and quadratic fit when regressing the incarceration rate on the Rule of Law. We observe that incarceration rates appear to be increasing in the Rule of Law, although after including country controls, this relationship largely disappears. When we add a quadratic Rule of Law term, the coefficient on the first term becomes much larger and increases in significance. Additionally the goodness of fit is significantly improved. Both of these support the use of a quadratic term and that the hump shape in incarceration rates matches is a better fit for the data.

Table 1: Incarceration as a function of Rule of Law

	Dependant variable is Incarceration Rate			
	(1)	(2)	(3)	(4)
Constant	106.9***	956.3***	−133.2**	657***
	(24.77)	(173.9)	(62.02)	(205.1)
Rule of Law	1.294***	−0.435	11.71***	6.950**
	(0.454)	(0.773)	(2.523)	(2.909)
Rule of Law^2			−0.097***	−0.074***
			(0.023)	(0.028)
Controls	No	Yes	No	Yes
Observations	209	157	209	157
R-squared	0.038	0.241	0.113	0.274

For incarceration rate we use the most recent information available on www.prisonstudies.org
Rule of Law refers to the Rule of Law index of 2010.
Controls include GDP, mortality rates of children under 5, and life expectancy at birth all 2011
OLS estimation. Standard errors are in parenthesis.
: Significant at 5%, *: Significant at 1%.
Source: World Bank and International Center for Prison Studies. Authors' calculations.

Since this regression result involves cross sectional data across countries it is difficult to rule out the possibility of a confounding variable. For this reason we also look for evidence of our mechanism within countries across time. The country with the largest change in its Rule of Law rating between 2002 and 2010 is Georgia which experiences an improvement in its percentile rank of over 36%. In 2002 Georgia has a relatively low Rule of Law rating and comes in at the 12.44 percentile, in 2010 Georgia is at the 48.82 percentile. Over this same period of time[8] the prison population rate per 100,000 citizens increases over three times from 174 to 530. This same pattern appears in the country with the second highest change in its Rule of Law percentile rank (Rwanda). Over the period 2002 to 2010 Rwanda increases its percentile from 20.57% to 45.97% and over the same period experienced a doubling of its prison population rate from 102 to 221.[9]

Next we want to verify that the non-monotonic relation between Rule of Law and the

[8]The data on prison population rates is collected approximately every three years, we use data in 2001 and 2010 which are the closest available to the corresponding Rule of Law data.

[9]Again, we use the closest available data on incarceration rates which in this case was 2002 and 2008.

incarceration rate holds which requires us to look at countries with initially high Rule of Law ratings. The two countries with the largest change in their Rule of Law percentile which also end up at a percentile of 80% or greater are Qatar and Estonia. Between 1996 and 2012 Qatar's rule of law percentile increases 26.97% from 55.02% to 81.99%. Unfortunately we only have data for the incarceration rates of Qatar between 1998 and 2008. Over this time period Qatar's incarceration rate falls from 95 to 38 per 100,000.[10] Estonia experiences a similar pattern. Between 1996 and 2012 Estonia experiences an improvement in its Rule of Law percentile from 62.20% to 84.36%. Over this same period it's incarceration rate falls from 342 to 266.[11]

In addition to our macro data, we turn to the World Bank *Enterprise Surveys* to provide us with micro evidence to support our modeling of theft and private security. These surveys have been conducted every year from 2006 to 2011. Nonetheless, in any single country there have been a maximum of two surveys and the vast majority of countries have been surveyed a single time. The final dataset used in this paper includes 130 country-years and averages 373 firms interviewed per country-year combination for a total of 48,436 observations. There are 111 unique countries where surveys have been conducted. Questions are both qualitative and quantitative in nature. Qualitative questions ask perception of certain business obstacles (e.g. "Do you perceive crime, theft and disorder as a major constraint?"). Quantitative questions of particular relevance request the number of employees, the annual revenue, the amount of annual losses due to theft as well as annual private security expenditures.

Summary statistics are included in Table 2. Theft is identified as a "major" constraint by over a quarter of all firms interviewed. Additionally, even though only roughly a quarter of firms directly experienced theft in the year of interview, almost two thirds of firms have positive expenditures on private security. The average security expenditures for firms purchasing private security was 2.6% of total revenues. Firms which experienced theft had an

[10] Over this period of time Qatar's Rule of Law index improves roughly 14% from 60.77% to 74.04%.

[11] Again we use incarceration data which most closely matches with the dates on the change in the rule of law index, in this case we have incarceration data in 1998 and 2010.

average loss equivalent to 3.8% of their total revenues.[12]

Table 2: Summary Statistics

Share of firms that perceive theft as a major constraint	27.8%
Share of firms that had positive expenditures on private security	63.9%
Average private security expenditures*	$59,931
Average private security expenditures over revenue**	2.6%
Firms that experienced theft	24.7%
Average level of theft*	$18,786
Average theft over revenue***	3.8%

*: Levels were converted to 2000 US dollars.

**: Conditional on having positive private security expenditures.

***: Conditional on having experienced theft.

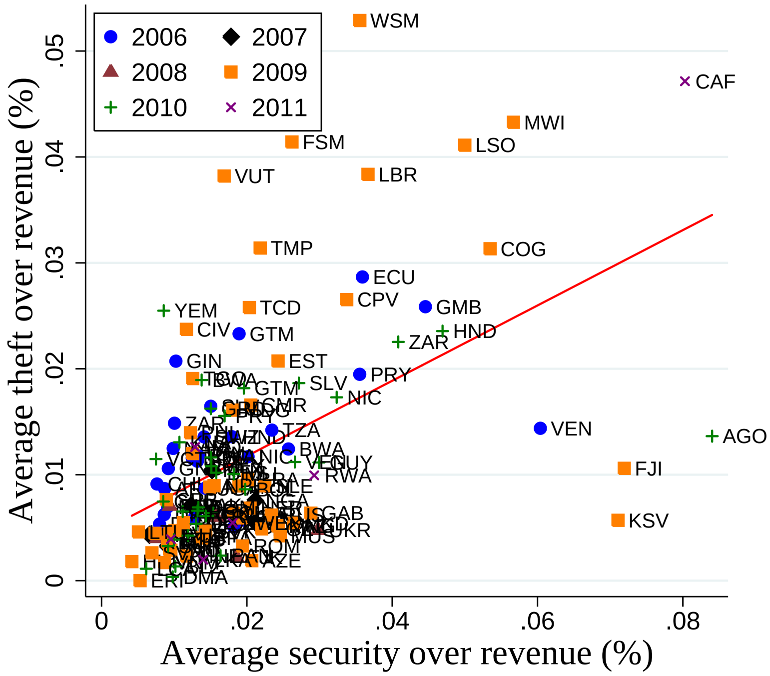
Source: The World Bank (2012). Authors' calculations.

We now make a number of motivating observations where we highlight how the level of public law enforcement is important in determining theft and private security choices in equilibrium. Figure 2 shows average experienced theft to average private security expenditures at the country level. We observe that average theft is positively correlated with average private security expenditures and the relationship is significant at the 1% level. We assume that all else constant, theft should decrease in security expenditures. However, both theft and security decisions are endogenous to the environment. Therefore the observed positive correlation is not causal but is indicative of some tertiary effect. We posit that one of the key drivers of this relationship is public law enforcement. First, as seen in Figure 3a, security is decreasing in the country's Rule of Law index which we use as a proxy for public law enforcement. Second, theft is also decreasing in public law enforcement as seen in Figure 3b. This additional information seems to support private security being an imperfect substitute for public law enforcement and that a firm's equilibrium private security decision does not fully compensate for the lack of a strong public law enforcement presence.

Our final motivating observation is that we observe average firm size to be inversely correlated with average theft, and this relation is also significant at the 1% level. Figure 4

[12] While theft accounts for 2.6% of total revenues, this translates to a larger portion of total profits and therefore a larger portion of GDP

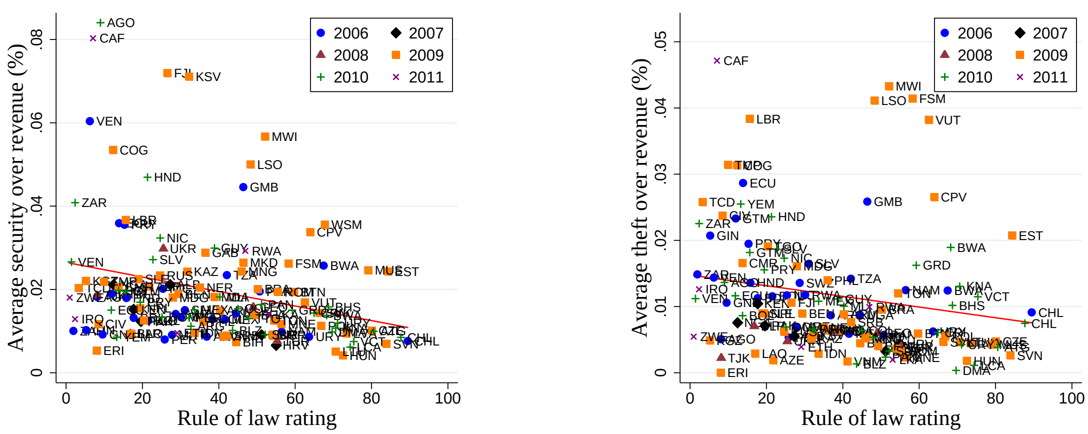
Figure 2: Theft over Revenue vs Security Expenditures over Revenue



Source: The World Bank (2012). Authors' calculations.

Figure 3: Security Expenditures over Revenue (Sec to Rev) and Theft over Revenue (Theft to Rev) vs Rule of Law

(a) Sec to Rev vs Rule of Law **(b) Theft to Rev vs Rule of Law**

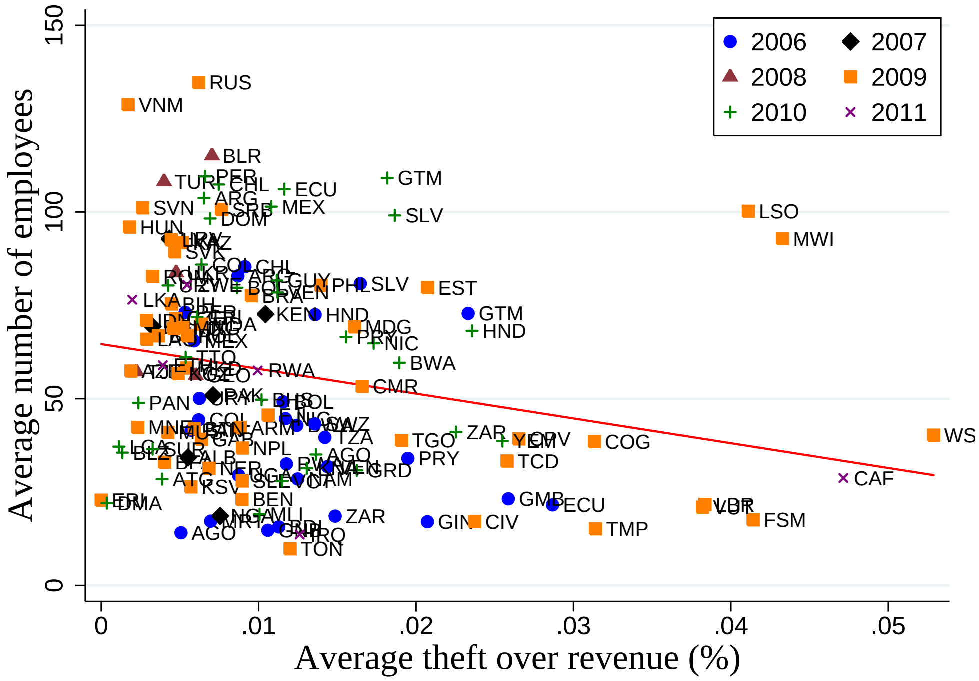


Source: The World Bank (2012). Authors' calculations.

shows this relation. A similar observation was made by Grobovšek (2014).

To conclude, we find that Rule of Law and GDP or non-monotonically related. In particular, for low levels of Rule of Law, GDP appears to be decreasing in the level. Second, incar-

Figure 4: Average Size of Firm vs Average Theft over Revenue



Source: The World Bank (2012). Authors' calculations.

ceration is also non-monotonic in the Rule of Law, in particular it is upside-down U-shaped. At the micro-level we find suggestive evidence that the level of public law enforcement is important in the determination of equilibrium theft and private security choices.

3 Environment

Our model is constructed in the spirit of Lucas (1978). Each consumer makes two choices: whether to become a thief or not, and whether to become an entrepreneur or a worker. Consider a particular consumer. If she chooses to become a thief, she optimally chooses how much to steal from firms, taking as given how much security is hired by each firm. However, she faces an exogenous probability of getting caught and losing what she stole as well as the ability to work or manage a firm. If the consumer decides to become an entrepreneur, she takes into account how much theft she faces and chooses how much security to hire, in addition to choosing the optimal size of her firm. If she becomes a worker, then she works in firms in exchange for a wage.

3.1 Consumers

In this economy there is a unit mass continuum of risk neutral consumers, each endowed with a skill level and an aversion to stealing. Consider a consumer with skill level z and aversion to stealing parameter θ. She maximizes her utility, given by (1).

$$u(z,\theta) = \max\left\{u_T(z,\theta), u_{NT}(z)\right\}, \tag{1}$$

where

$$\begin{aligned} u_T(z,\theta) &= (1-\lambda)\left[\max\left\{w,\pi(z)\right\} + \Pi_T - \Upsilon\right] + \lambda \underline{c} - \theta \\ u_{NT}(z) &= \max\left\{w,\pi(z)\right\} - \Upsilon. \end{aligned}$$

That is, she decides whether to become a thief and get utility $u_T(z,\theta)$ or not become a thief and get $u_{NT}(z)$. In the former case, the consumer steals from firms to get an extra income of Π_T. She gets away with stealing with an exogenous probability $1-\lambda$. With probability λ the consumer gets caught and loses all sources of income. Instead she receives consumption $\underline{c}$. We interpret $\lambda \in [0,1]$ as the level of public law enforcement and we interpret a thief being caught as implying that she goes to jail. In this way, if a consumer is caught, she neither works nor becomes an entrepreneur. Finally, Υ is a lump sum tax applied to consumers that do not go to jail which finances $\underline{c}$ for those in jail. That is,

$$\Upsilon = \frac{\underline{c}\lambda M_T}{1-\lambda M_T},. \tag{2}$$

where M_T denotes the mass of consumers who become thieves.

Regardless of the decision to become a thief, the consumer also decides whether to work for a wage w or become an entrepreneur and receive the profits $\pi(z)$ from the firm she manages. If she becomes an entrepreneur her income will depend on her skill z. If the consumer decides not to become a thief, she receives the income either from working or from being an entrepreneur, minus the lump sum tax.

We assume that θ and z are drawn from independent distributions. We will denote by $F(\cdot)$ and $G(\cdot)$ the cumulative distribution functions of θ and z, respectively. A consumer's decision is characterized by z and θ, so we will denote each agent by the realizations of these random variables.

3.2 Firms, theft and private security

Consider an entrepreneur with skill level z. She maximizes the profits from the firm she manages, which we will denote as firm z, by hiring workers l_y. The firms produce using a decreasing returns to scale function, zl_y^α, where $\alpha \in (0, 1)$. From what firm z produces, $(1 - \lambda)M_T\tau$ gets stolen, where M_T denotes the measure of consumers that become thieves and τ is how much each thief decides to steal from firm z.[13] Finally, firm z hires l_s security guards to diminish theft. All firms produce the same final good and we normalize the price of this good to 1. To summarize, firm z solves problem (3).

$$\pi(z) \equiv \max_{l_y \geq 0, l_s \geq 0} zl_y^\alpha - wl_y - wl_s - (1 - \lambda)M_T\tau(z). \tag{3}$$

In order to determine how many security guards are hired, we assume firm z understands the thieves' problem. Agents that choose to steal attempt to steal some amount from all firms and choose an optimal theft intensity from each firm. Consider the problem of a consumer that becomes a thief and decides to steal from firm z. The income derived in stealing from firm z is given by

$$\pi_T(z) \equiv \max_{\tau \geq 0} \tau - C_\tau(z), \tag{4}$$

[13] Since agents are risk neutral, we are able to abstract from which firms are stolen from and only care about the expected level of theft.

where $C_\tau(z)$ denotes the cost born by those who steal from firm z. We make three assumptions regarding this cost. First, $C_\tau(z)$ is increasing and convex in the amount stolen. The more that is stolen, the greater the transportation costs, storage costs, etc. Additionally, without convexity, thieves would always attempt to steal everything possible or steal nothing at all which does not hold true empirically. Moreover, the thieves' problem does not solely consider the financial costs but also the utility costs of time and anguish involved in planning and carrying out an operation. It is reasonable that the cost of theft in terms of planning, stress, and time grows exponentially from stealing a pack of gum to stealing everything in a store.

Our second assumption is that security affects the choice of theft by making it more costly to steal. The presence of a security guard in the firm causes more planning and time in order to be able to steal. This is consistent with what is found by Kraut (1976) where the risk associated with stealing is perceived as a deterrent.

Finally, we assume that the cost of stealing is decreasing in the amount produced by the firm. This accounts for the fact that if a firm is bigger, then there are more things to steal, and so stealing the same amount as from a smaller firm is easier. This is consistent with the results reported by Smigel (1956), who finds that people are more likely to steal from big firms than from small firms.

We assume that $C_\tau(z) \equiv \frac{\phi(l_s(z))}{l_y(z)} \frac{\tau^2}{2}$, where $\phi\left(l_s\right) \equiv \left(\frac{\alpha}{1-\alpha} l_s\right)^{\frac{1-\alpha}{\alpha}}$ denotes the amount of provided by hiring l_s guards for a given level of M_T and is strictly increasing and concave in l_s. The solution to (4) is

$$\tau(z) = \frac{l_y(z)}{\phi\left(l_s(z)\right)}. \tag{5}$$

Then $\pi_T(z) = \frac{1}{2}\tau(z)$ and the aggregate income received from stealing Π_T is given by

$$\Pi_T \equiv \int_{(z,\theta)\in E} \pi_T(z) dF(\theta) dG(z) - \lambda \int_{(z,\theta)\in E \bigcap T} \pi_T(z) dF(\theta) dG(z), \tag{6}$$

where E and T denote the set of consumers that become entrepreneurs and the set of consumers that become thieves, respectively. That is,

$$E \equiv \{(z,\theta) : \pi(z) \geq w\} \tag{7}$$

$$T \equiv \{(z,\theta) : u_T(z,\theta) > u_{NT}(z)\}\,. \tag{8}$$

We abuse notation and also refer to E as the set of z for which consumers become entrepreneurs. The specific use of E will be clear from context.

The second term in (6) is due to the fact that thieves do not get income when stealing from the firms managed by entrepreneurs that are thieves and get caught. Recall that a fraction λ of the total entrepreneurs that become thieves go to jail and are unable to manage firms.

3.3 Micro Support for Modeling Theft and Private Security

We use the existing literature as well as qualitative patterns in micro-data to motivate our modeling methods. Specifically we make four observations using data from the *Enterprise Surveys* (See Table 3). First, both the absolute level of theft and private security expenditures are increasing across firm size. This is consistent with Smigel (1956).

Table 3: Results in Theft and Security Across Firms

Dependent Variable:	Theft	$\frac{\text{Theft}}{\text{Revenue}}$	Security	$\frac{\text{Security}}{\text{Revenue}}$	$\frac{\text{Security}}{\text{Revenue}}$	$\frac{\text{Security}>0}{\text{Revenue}}$
Independent Variable	(1)	(2)	(3)	(4)	(5)	(6)
Size (Labor)	224.14***		613.99***			
	(12.45)		(42.86)			
Size (log Labor)		−0.002***		0.001***	0.004***	−0.003***
		(0.000)		(0.000)	(0.001)	(0.000)
Size (log Labor^2)					−0.000**	
					(0.000)	
Observations	48,299	48,299	48,299	48,299	48,299	30,838
Country-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

OLS estimation. Standard errors are in parenthesis.
***: Significant at 1%. **: Significant at 5%. *: Significant at 10%.

Next we analyze these same variables as a share of revenue. While theft is increasing in the size of firm, theft as a percentage of revenue is decreasing in the size of firm. The relation with private security expenditures is slightly more complicated. When we regress private security expenditures as a share of revenues we find that the share is increasing slowly in the size of firm. However, when we add a quadratic term on size to the regression we find a hump shape, with private security share increasing for small firms and decreasing for larger firms. Another level of analysis reveals the cause for this hump. The probability that a firm purchases private security is increasing in size. However, given a firm purchases private security (column 6 of Table 3), the share of revenue spent on private security is decreasing in the size of firm.

These micro patterns were used to guide our modeling of private security and theft. To the extent possible, given the level of heterogeneity used in our model, we match these patterns for a large range of λ. Figure 5 matches qualitatively the results we report in Table 3. In particular, Figure 5d matches the data in column 6 of Table 3. Due to the level of heterogeneity it is not within the scope of our model to exactly match the hump shape found in the data.

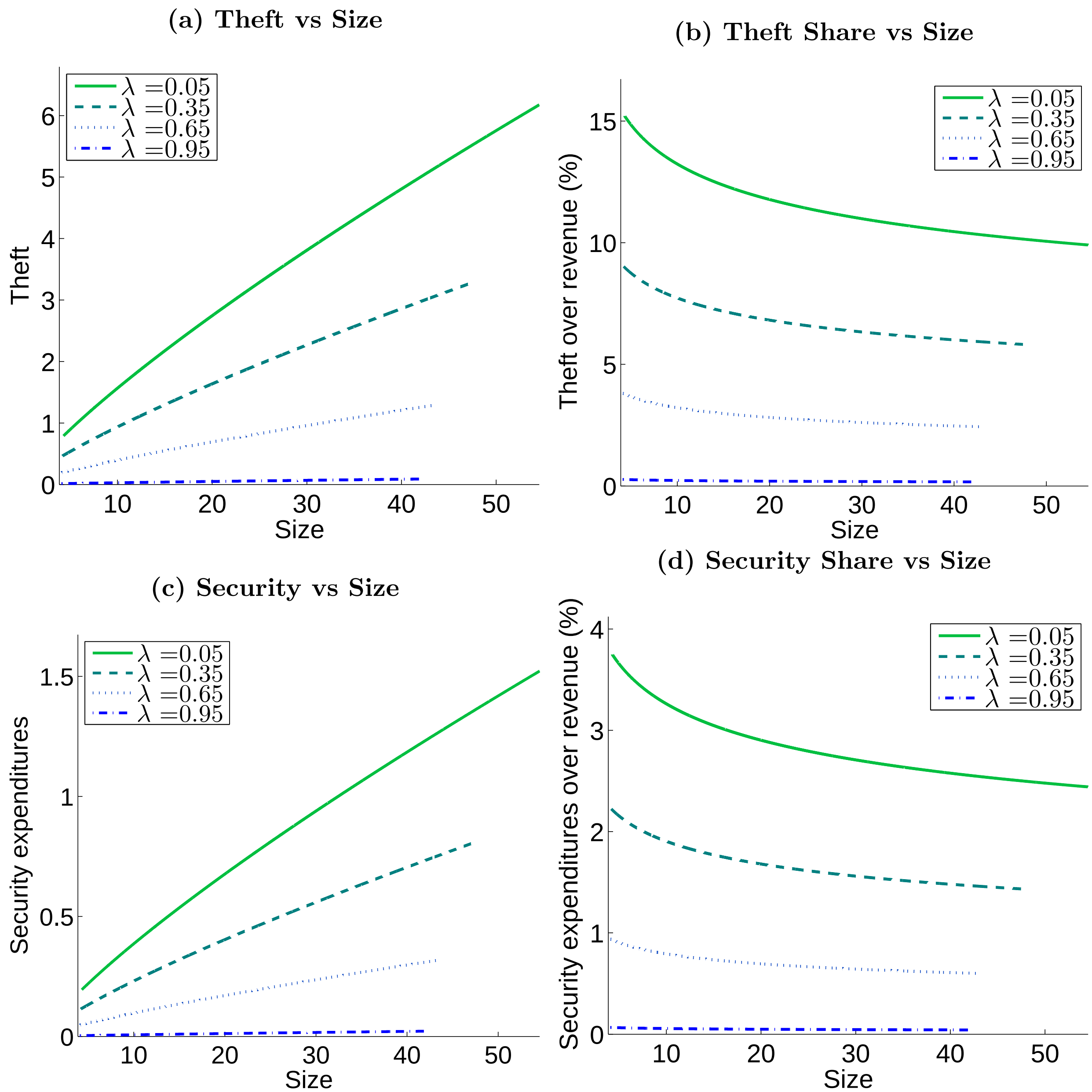
3.4 Equilibrium

An equilibrium in this economy is allocations $\{\tau(z), l_y(z), l_s(z)\}_{z \in E}$, wages w, and sets E and T such that

1. $\tau(z)$ satisfies (5) for all $z \in E$; and $l_y(z)$ and $l_s(z)$ solve (9);

2. E and T satisfy (7) and (8);

Figure 5: Matching Micro Patterns



3. the labor market clears:

$$\int_{(z,\theta)\in E} (l_y(z) + l_s(z))\, dF(\theta)dG(z) - \lambda \int_{(z,\theta)\in E\bigcap T} (l_y(z) + l_s(z))\, dF(\theta)dG(z)$$
$$= \int_{(z,\theta)\in E^c} dF(\theta)dG(z) - \lambda \int_{(z,\theta)\in E^c\bigcap T} dF(\theta)dG(z);$$

4. and the good market clears:

$$
\begin{aligned}
Y &\equiv \int_{(z,\theta)\in E} z l_y(z)^\alpha dF(\theta)dG(z) - \lambda \int_{(z,\theta)\in E\bigcap T} z l_y(z)^\alpha dF(\theta)dG(z) \\
&= \int_{(z,\theta)\in E} \left[w\left(l_y(z)+l_s(z)\right)+\pi(z)+(1-\lambda)\tau(z)M_T\right] dF(\theta)dG(z) \\
&-\lambda \int_{(z,\theta)\in E\bigcap T} \left[w\left(l_y(z)+l_s(z)\right)+\pi(z)+(1-\lambda)\tau(z)M_T\right] dF(\theta)dG(z),
\end{aligned}
$$

where

$$M_T \equiv \int_{(z,\theta)\in T} dF(\theta)dG(z).$$

3.5 Characterization of the equilibrium

Lemma 1 characterizes E and T in terms of equilibrium prices and consumer choices.

Lemma 1.

$$
\begin{aligned}
&E = \left\{(z,\theta) : z \geq z^E\right\} \\
&T = \left\{(z,\theta) : z < z^E \textit{ and } \theta < \theta^W\right\} \bigcup \left\{(z,\theta) : z \geq z^E \textit{ and } \theta < \theta^E(z)\right\},
\end{aligned}
$$

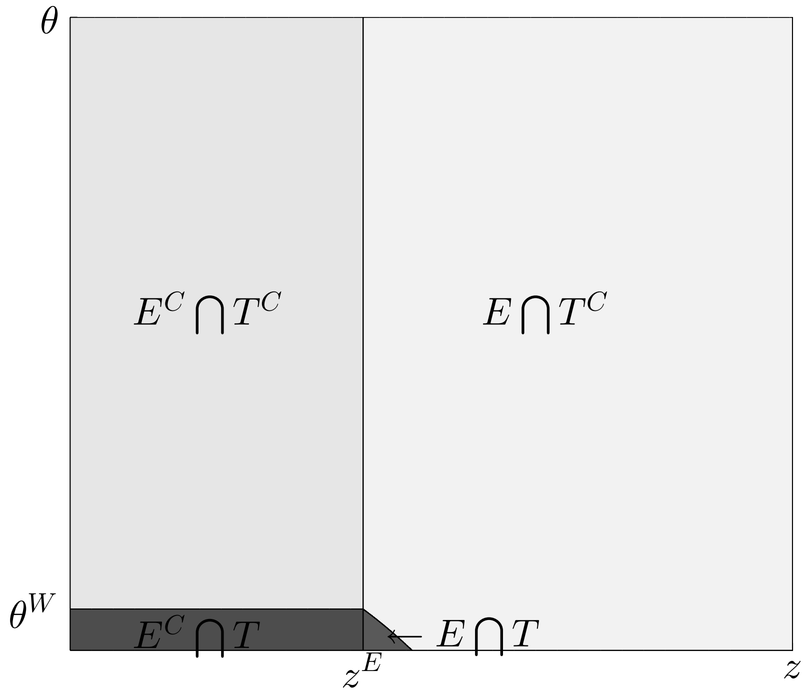
where z^E is the unique value of z such that $\pi(z^E) = w$ and

$$
\begin{aligned}
\theta^W &\equiv \frac{\lambda \underline{c}}{1-\lambda M_T} + (1-\lambda)\Pi_T - \lambda w \\
\theta^E(z) &\equiv \frac{\lambda \underline{c}}{1-\lambda M_T} + (1-\lambda)\Pi_T - \lambda \pi(z).
\end{aligned}
$$

Proof. See Appendix A.1. □

From Lemma 1 we see that thieves are those agents who have the lowest levels of skill and the lowest aversion to stealing. Since income is increasing in skill, we also observe that those with the smallest incomes are the most likely to become thieves. We note that these

Figure 6: E and T across Skill and Aversion to Stealing



results are consistent with both the theoretical and empirical existing literature.[14] Figure 6 shows E and T across skill (x-axis) and aversion to stealing (y-axis).

As mentioned, firm z knows (5). Therefore the firm's problem can be written as stated in (9).

$$\pi(z) = \max_{l_y \geq 0, l_s \geq 0} z l_y^\alpha - \left(\frac{(1-\lambda) M_T}{\phi\left(l_s\right)} + w \right) l_y - w l_s. \tag{9}$$

Lemma 2 characterizes the demand for labor and security given wages w, as well as firm's profits and how much is stolen from each firm.

Lemma 2. *Assume $\alpha > 0.5$. Then*

$$l_y(z) = \left(\frac{\alpha z}{w} - \left(\frac{(1-\lambda) M_T}{w} \right)^\alpha \right)^{\frac{1}{1-\alpha}}$$

[14]For example see Freeman (1999).

$$l_s(z) = \frac{1-\alpha}{\alpha}\left(\frac{(1-\lambda)M_T}{w}\right)^{\alpha}\left(\frac{\alpha z}{w} - \left(\frac{(1-\lambda)M_T}{w}\right)^{\alpha}\right)^{\frac{\alpha}{1-\alpha}}$$

$$\pi(z) = \frac{1-\alpha}{\alpha} w \left(\frac{\alpha z}{w} - \left(\frac{(1-\lambda)M_T}{w}\right)^{\alpha}\right)^{\frac{1}{1-\alpha}}$$

$$\tau(z) = \left(\frac{w}{(1-\lambda)M_T}\right)^{1-\alpha}\left(\frac{\alpha z}{w} - \left(\frac{(1-\lambda)M_T}{w}\right)^{\alpha}\right)^{\frac{\alpha}{1-\alpha}}.$$

Proof. See Appendix A.2. □

Now, notice from (9) that the production function satisfies Inada conditions, so $l_y(z) > 0$ for every firm. We assume that $\alpha > 0.5$ so that $\phi(\cdot)$ is strictly concave and first order conditions with respect to l_s are also sufficient. Using the fact that the solution is always interior, taking first order conditions of (9) with respect to l_y yields

$$w + \frac{(1-\lambda)M_T}{\phi\left(l_s(z)\right)} = \alpha z l_y^{\alpha-1}. \tag{10}$$

In the absence of theft (i.e. $M_T = 0$) (10) reduces to $w = \alpha z l_y^{\alpha-1}$, or $l_y = \left(\frac{\alpha z}{w}\right)^{\frac{1}{1-\alpha}}$. We observe that theft creates a wedge which causes the marginal productivity of labor to be greater than w by a factor of $\frac{(1-\lambda)M_T}{\phi(l_s(z))}$. Observe that the wedge is increasing in the measure of thieves and decreasing in both a higher level of public law enforcement and private security. As a consequence of theft, firms are smaller in equilibrium than in the absence of theft:

$$\left(\frac{\alpha z}{w} - \left(\frac{(1-\lambda)M_T}{w}\right)^{\alpha}\right)^{\frac{1}{1-\alpha}} < \left(\frac{\alpha z}{w}\right)^{\frac{1}{1-\alpha}}.$$

Corollary 1 shows that the ratio of theft experienced by a firm to private security expenditures is constant and greater than 1.

Corollary 1. *The ratio of theft experienced by a firm, $(1-\lambda)M_T\tau(z)$, and private security expenditures, $wl_s(z)$, is constant and equal to $\frac{\alpha}{1-\alpha}$.*

Proposition 1 shows that in equilibrium every firm finds it optimal to hire security.

Proposition 1. *Assume $\alpha > 0.5$. Then $l_s(z) > 0$ for all $z \geq z^E$.*

Proof. By definition z^E is such that $\pi(z^E) = w$. From the expression for $\pi(z)$ in Lemma (2),

$$z^E = \frac{w^{1-\alpha}}{\alpha}\left((1-\lambda)M_T\right)^{\alpha} + \left(\frac{1}{1-\alpha}\right)^{1-\alpha}\left(\frac{1}{\alpha}\right)^{\alpha} w$$

and $l_s(z) > 0$ if and only if $z > \frac{w^{1-\alpha}}{\alpha}\left((1-\lambda)M_T\right)^{\alpha}$. Since $z^E > \frac{w^{1-\alpha}}{\alpha}\left((1-\lambda)M_T\right)^{\alpha}$, the result follows. □

4 Results

4.1 Parameterization

Our current parametrization is chosen such that reasonable parameter values are able to give results which qualitatively match the micro and macro patterns we observe in the data. Table 4 shows the values of the parameters that we use and the moments we target.

We calibrate preference and technology parameters to match key aspects of the US economy. Our model economy consists of eight parameters. In accordance with Buera et al. (2011), we assume that entrepreneurial ability follows a Pareto distribution with shape parameter ν and scale parameter $\underline{z}$. Since Buera et al. (2011) also fit their model to the US economy, we adopt $\nu = 4.84$ from their paper. We set the nominal Pareto scale parameter $\underline{z}$ at 1 for simplicity. The distribution for preference on theft is assumed to be uniformly distributed and is characterized by $\underline{\theta}$ and $\overline{\theta}$. We calibrate these parameters to fall within a reasonable range given annual reported property crimes and the percentage of US citizens with a criminal record.[15]

We calibrate $\underline{c}$, public expenditure on the incarcerated, by matching the costs per prisoner relative to average income.[16] Parameter α is the returns to scale of the production function.

[15]The National Employment Law Project estimates that 27.8% of US adults have a criminal record. On the other hand the FBIs UCR Program reports a property crime rate of 3.1% in 2009.

[16]According to the Bureau of Justice Statistics, as cited in the report "Public Safety, Public Spending"

We choose α to target an effective return to scale α of 0.85, which is commonly used in the literature.[17]

Finally, we choose λ, the level of public law enforcement, and the extra degree of freedom we have from the distribution function on θ to match inventory shrinkage and loss prevention expenditures as a percentage of revenue from retail firms, as reported by the 2011 National Retail Security Survey.

Table 4: Calibration - Parametrization

Moment	Data	Model	Parameter
Consumption Expenditure per Criminal	0.37	0.37	$\underline{c} = 0.36$
Loss Prevention Expenditures	0.35%	0.35%	$\lambda = 0.82$
Criminal Record	3.1%-27.8%	5.00%	$\overline{\theta} = 4.00$
Inventory Shrinkage	1.42%	1.42%	$\underline{\theta} = -0.69$
Returns to Scale	0.85	0.80	$\alpha = 0.80$
Pareto Shape Parameter	4.84	4.84	$\nu = 4.84$

4.2 Macro Results

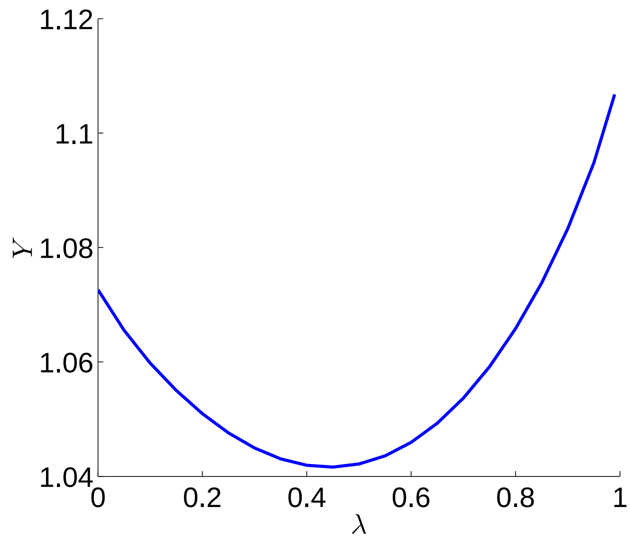
The primary result of our paper is that changes to the level of public law enforcement have different effects depending on the current *level* of public law enforcement. In Figure 7 we observe that for low levels of public law enforcement, increases to this level can actually *decrease* the amount of total production. When we compare the model to the data (as seen in Figure 1a) the pattern is quite similar; however, we only account for a relatively small portion of the differences in GDP across countries due to differences in public law enforcement. Small increases in the level of public law enforcement cause a decrease in GDP for those countries with low levels of public law enforcement. Countries with higher levels of public law enforcement demonstrate a positive correlation between per capita GDP and the level of public law enforcement. Finally, we note that the effect of public law enforcement

prepared by the Public Safety Performance Project, the marginal cost per prisoner was $13,797 in 2005. On the other hand the Social Security Administration reports an Average Wage Index in 2005 of $36,953. We choose $\underline{c}$ so that $\frac{c}{w} = \frac{\$13,797}{\$36,953} = .37$.

[17] See Khan and Thomas (2013) or Ranasinghe (2012) for other papers using a similar number.

on aggregate production can be as large as 6.02%.

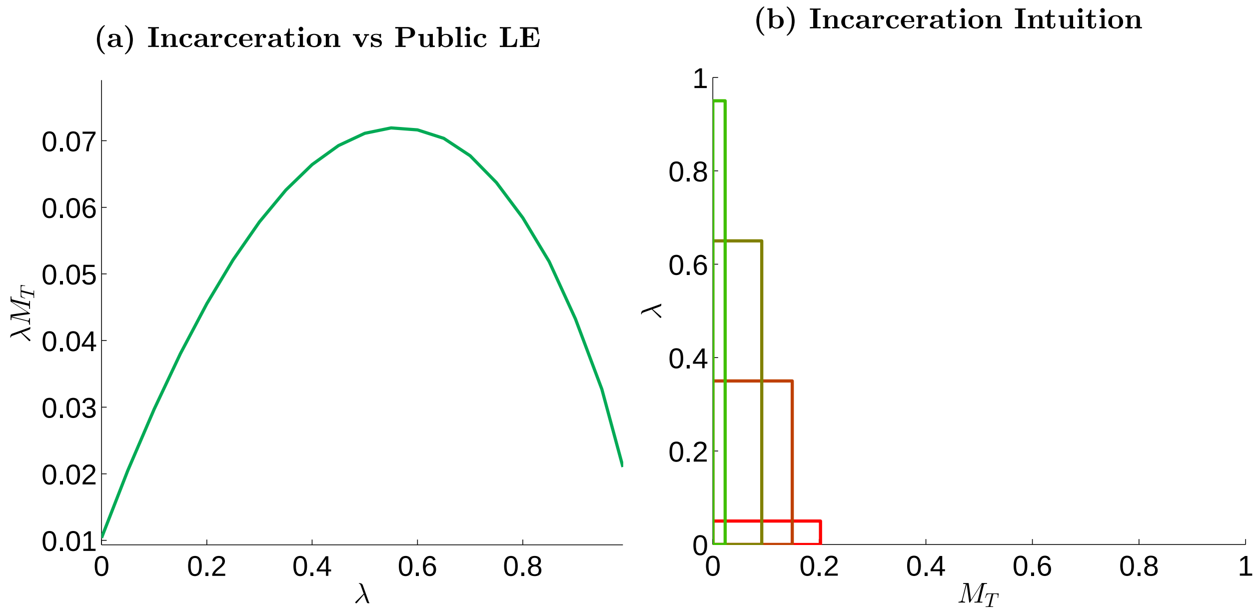
Figure 7: Total Production vs Public LE



We explain the primary mechanism for this result with Figure 8a. Recall from Table 1 the non-monotonicity in the incarceration rate. Our model produces the same pattern as we vary the level of public law enforcement holding all other parameters from the benchmark model fixed. These result can be explained rather intuitively. If we think of the incarceration rate as a rectangle with the vertical axis representing the level of public law enforcement λ, which in our model also represents the percentage of thieves who are caught, and the horizontal axis as the measure of people who steal M_T, then the incarceration rate is simply the area of this rectangle. In the benchmark model we observe that $\frac{\partial M_T}{\partial \lambda} < 0$. At some point the decrease in the measure of thieves outweighs the increase in the percentage of thieves who are caught. This concept is visually represented in Figure 8b.[18]

[18] While the levels shown in this figure are quite large relative to incarceration rates observed in the United States, the idea is that increasing public law enforcement causes workers to be removed (or possibly misallocated) from the labor force. Multiple studies have been conducted to review the measure of people in the United States who have a criminal record. This number consistently comes out between one-quarter and one-third of the population. A recent survey from the Society of Human Resources Management shows that 92% of their members perform criminal background checks on some or all job candidates (The Society of Human Resources Management is the largest association of human resources personnel. The survey can be found in *Background Checking: Conducting Criminal Background Checks* (Jan. 22, 2010)). A number of articles, including *65 Million "Need Not Apply"*, put out by the National Employment Law Project, argue that having a criminal background can severely limit job opportunity. While our model is binary in whether an agent is able to work or not, we believe that the actual effect of public law enforcement observed in our

Figure 8



In Figure 9a we calculate the equilibrium average theft and average private security expenditures across economies that only differ in their level of public law enforcement (λ). We observe a positive correlation between these two measures.[19] Figure 9b splits production into four categories, two of which are security and theft. The security line represents the total cost in final good paid to private security workers. The theft line represents the total value of goods stolen. When we look at these two variables across the level of public law enforcement we see that they match Figures 3a and 3b. While private security expenditures directly reduce theft, in equilibrium firms hire more private security *and* more agents choose to engage in theft when there is less public law enforcement. In this sense, public law enforcement directly reduces theft, but it also crowds out private security expenditures, which indirectly puts an upward pressure on theft. If policymakers fail to consider this indirect effect, they are likely to overestimate the benefits from public law enforcement.

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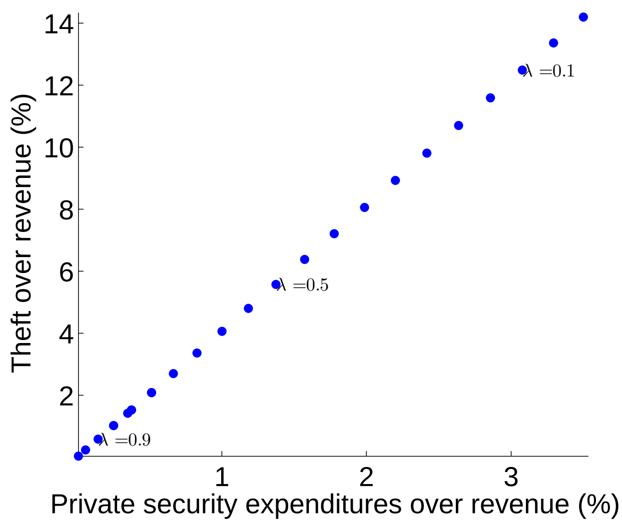
model is consistent with what is observed in data.

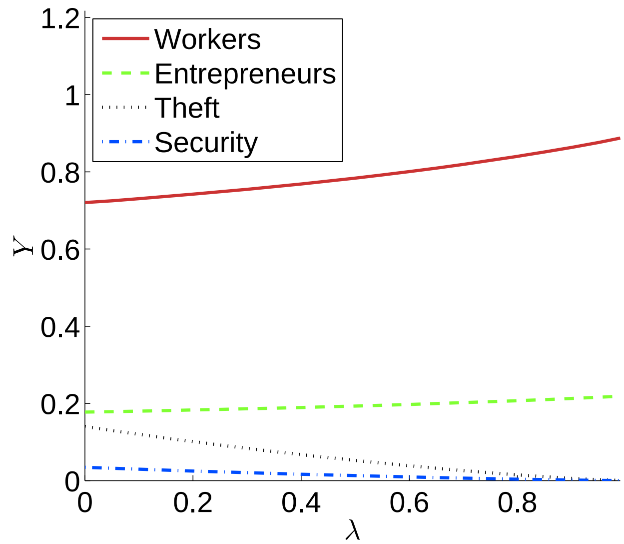
[19]In our model both measures are perfectly correlated, as proven in the Corollary to Lemma 2.

Figure 9

(a) Theft vs Private Security Expenditures



(b) Uses of Production vs Public LE



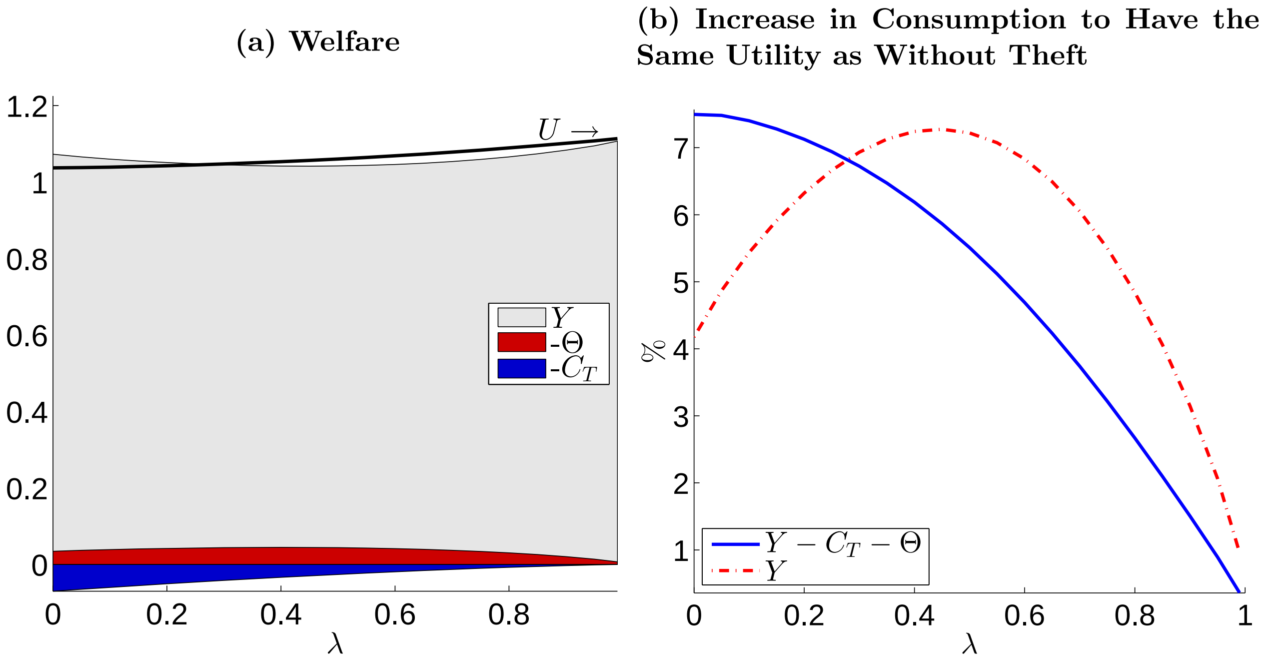
4.3 Implications on Welfare

Turning to welfare, we observe a similar pattern to that of production relative to the level of public law enforcement. For smaller levels of public law enforcement, increases in the level actually reduce total welfare as seen in Figure 10a. Nonetheless, the range of values for which welfare is decreasing is smaller than for production.

Explaining in detail this result requires analyzing the expression for welfare. Equation (11) shows that welfare is given by the production of the economy minus the cost incurred by thieves when stealing, C_T, and the aversion to steal, Θ. These two extra terms explain why welfare and production are not the same.

$$U \equiv \int_{(z,\theta)} u(z,\theta) dF(\theta) dG(z) = Y - C_T - \Theta, \tag{11}$$

Figure 10



where

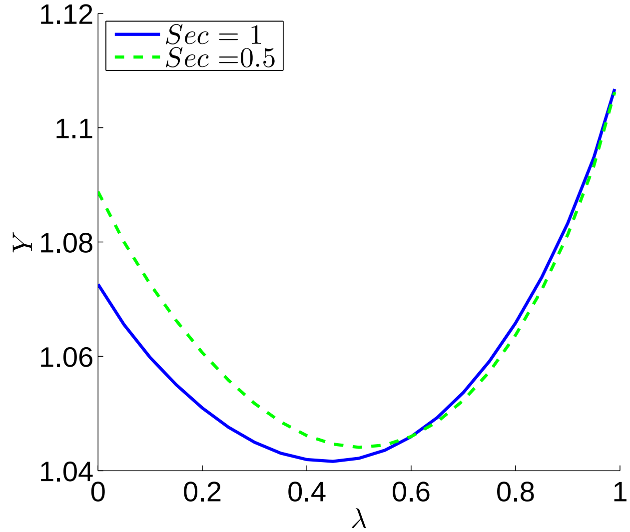
$$C_T \equiv (1-\lambda)M_T \int_{z \geq z^E} (1 - \lambda F(\theta^E(z))) \frac{a\phi\,(l_s(z)\,|M_T\,)}{z l_y(z)^{\alpha_T}} \frac{\tau(z)^2}{2} dG(z)$$

$$\Theta \equiv \left(\int_{z<z^E} \int_{\underline{\theta}}^{\theta^W} + \int_{z \geq z^E} \int_{\underline{\theta}}^{\theta^E(z)} \right) \theta dF(\theta) dG(z).$$

Next, we analyze the effect of theft on welfare by calculating the extra consumption that consumers in our model require in order to be indifferent to an economy without theft. The economy without theft that we consider is characterized in (B5) of Appendix B.

Since welfare includes non-pecuniary costs in utility due to theft and aversion to steal, we analyze how much production needs to increase both including and excluding C_T and Θ. That is, let Y^{NT} denote an economy where there is no theft. The solid line in Figure 10b shows $\frac{Y^{NT}+C_T+\Theta}{Y} - 1$ and the dotted line shows $\frac{Y^{NT}}{Y} - 1$. From this figure we can conclude that the effect of theft on welfare is considerable. For some values of λ consumption has to increase by over 7% in order to have the same utility as in an economy without theft. Notice that considering both the costs of theft and the aversion to stealing lowers the amount by

Figure 11: Production as a function of λ



which consumption has to be increased for most values of λ since the parametrization shown in Section 4.1 implies that it is mostly consumers with negative values of θ who become thieves in equilibrium (i.e. those who get positive utility from the act of stealing.)

4.4 Negative Externality of Private Security

We now calculate the negative externality that is caused by hiring private security. For this, we consider an alternative equilibrium where firms are not allowed to hire as much private security as they find optimal. That is, let $l^*(z)$ be the optimal private security hired by firm z; i.e. the value of l_s that is a solution to (9). We consider an equilibrium where firm z can only hire $\widehat{l_s}(z) \equiv Sec \times l^*(z)$, for $Sec \in (0, 1)$; that is, an equilibrium where firms can only hire a fraction of the security that they find optimal. We keep all parameters of the model as in Table 4.

Figure 11 contrasts the production in equilibrium for $Sec = 1$ (i.e. the benchmark equilibrium) and for $Sec = 0.5$ (an equilibrium where firms can only hire half as much security as they otherwise find optimal). For low values of λ, restricting private security can increase production up to 1.5%. Private security helps diminish the wedge caused by theft, as seen in (10). Nonetheless, when $Sec = 1$, workers that could be hired to produce are hired as private security guards. When λ is low, private security causes a negative externality: workers that are hired as security guards could be hired to produce the final good. Since lower λ implies a higher percentage of revenue spent on security (see Figure 9a), the effect of reducing security is much higher for lower λ.

4.5 Sensitivity Analysis

We conduct a sensitivity analysis on the remaining variables to better understand how they affect the model. An important parameter in our model is $\underline{c}$. This parameter represents the consumption level received by agents who engage in theft and are caught. As $\underline{c}$ increases, the possibility of getting caught becomes less of a deterrent. Additionally, the burden borne by those who are not caught increases, reducing the value of not engaging in theft and adding incentives towards becoming a thief. As $\underline{c}$ increases, production, the average size of firms and utility all monotonically decrease, and M_T, the measure of people who become thieves, monotonically increases in $\underline{c}$. The implication is that, if you do not care strongly about very negative outcomes for those who are caught stealing, the best policy is to implement very harsh penalties. A potential reason to avoid harsh penalties is concern for the innocent and the costly as well as potentially inaccurate verification of guilt. This is currently outside the scope of this model.

The distribution of θ represents the distribution of the moral fibre of the agents in our model. Apart from matching moments in data, it is difficult to know a proper strategy for determining what this distribution should look like. However, we are able to see how changing the distribution affects the results. Conceptually there are two important components of the distribution of θ which affect theft in our model. First, the measure of people who steal is determined by the measure of people below the cutoffs θ^W or $\theta^E(z)$ in the distribution of θ.[20] Second, the sensitivity of the model to changes in various other parameters depends on the density of the distribution over θ at the aforementioned cutoffs.

[20]See Lemma 1 for a characterization of these cutoffs.

We make the following observations. First, the model is more sensitive to changes in $\underline{\theta}$ than to changes in $\overline{\theta}$. This is because changes in $\underline{\theta}$ directly affect the measure of people who prefer to steal whereas changes in $\overline{\theta}$ affect the density of people in the range of those who prefer to steal. Lowering $\overline{\theta}$ increases the density of people in the range of those who prefer to steal and vice versa. Second, for the most part the effects of the distribution of θ on equilibrium moments are rather intuitive. The only unusual result is that total welfare is not monotonic in $\underline{\theta}$, but this is easily explained. In all real measures, lowering $\underline{\theta}$ makes the economy worse off; however, recall that θ is the measure of aversion to theft which factors directly into utility. Negative θ's can be interpreted as a rush or pleasure from stealing. As we increase the pleasure from stealing two things happen: The measure of people who steal increases and the extra utility those agents receive from stealing increases. If we make the aversion to theft negative enough, the overall utility can actually begin to decrease in $\underline{\theta}$.

4.6 Extensions

We now consider two extensions to the model: First we consider a model where theft causes a destruction of goods. That is, for every unit of good that is stolen, only a fraction δ can be consumed by thieves. In particular we replace thieves' problem (4) by (12).

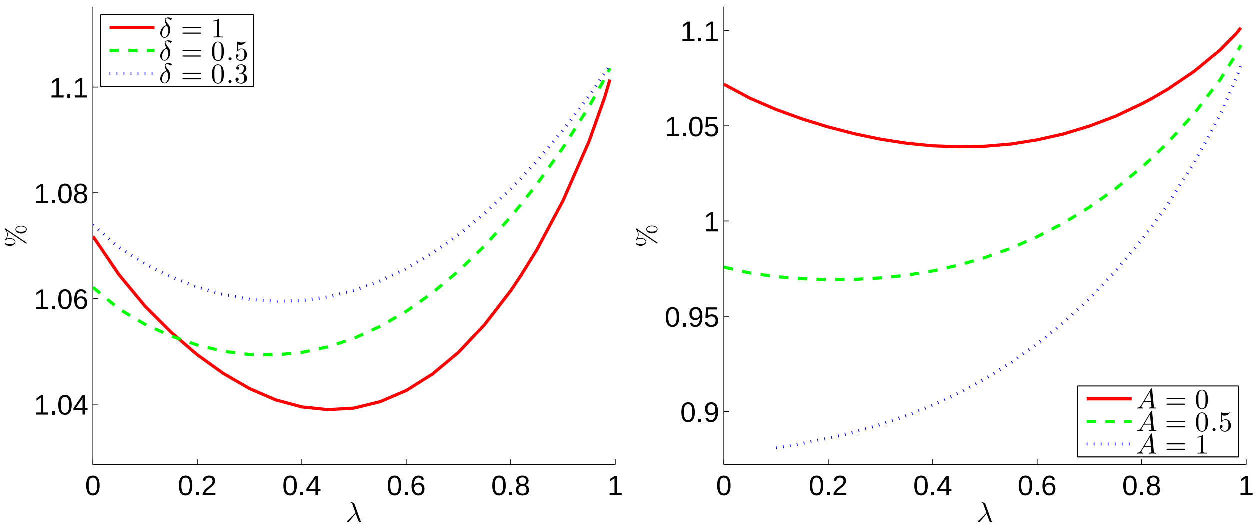
$$\pi_T(z) \equiv \max_{\tau \geq 0} \delta\tau - C_\tau(z). \tag{12}$$

Our benchmark model is given by $\delta = 1$ and we consider economies where we change the value of δ. Values such that $\delta < 1$ might act as a deterrent for thieves, since their return for stealing is decreased. However, it might also be the case that they might attempt to steal even more in order to achieve the same consumption as they would otherwise get when $\delta = 1$. In equilibrium we observe that for low levels of δ it is the first effect that dominates. For intermediate levels of δ, it depends on the level of public law enforcement: In economies with low λ theft increases, reducing total production in equilibrium.

In general, $\delta < 1$ causes production to be less sensitive to the level of public law enforcement. Moreover, for low values of δ production is higher across all levels of public law enforcement, relative to the case when $\delta = 1$. See Figure 12a.

Figure 12

(a) Production for different values of δ **(b) Production for different values of A**



We also consider a model where theft causes labor to be less productive. We can rationalize this by assuming that entrepreneurs know that their employees might be stealing from the firm they are working at, or by assuming that employees work less time, since they devote some time on their job to steal. We model this feature by replacing (3) with (13).

$$\pi(z) \equiv \max_{l_y \geq 0, l_s \geq 0} z\left((1 - AM_T)l_y\right)^{\alpha} - wl_y - wl_s - (1-\lambda)M_T\tau(z), \tag{13}$$

for $A \in [0, 1]$. Our benchmark model is given by $A = 0$ and we consider economies such that $A > 0$. The fact that workers are less productive when there is theft causes production to be lower when $A > 0$ than in our benchmark model for all levels of public law enforcement (See Figure 12a). Additionally, production becomes more sensitive to the level of λ. In particular, for lower levels of public law enforcement, an increase in the level causes higher labor productivity. For values of A that are high enough, this increment in labor productivity counteracts the removal of agents from the labor force, thus making production increasing in λ for all levels of λ.

5 Conclusion

In this paper we propose a model of theft, private security and public law enforcement which matches a number of patterns in the micro data. Theft lowers total production directly and indirectly. First, theft acts as a wedge similar to a tax for firms which causes firms to be inefficiently small since the marginal product of labor is greater than the wage rate in equilibria with positive amounts of theft. Private law enforcement helps decrease this wedge, but in order to do so, some of the labor force is taken away from producing the consumption good and used to provide security.

Perhaps the most surprising result of our model is that total production and welfare are not monotonic in levels of public law enforcement. The interaction of theft and public law enforcement is the source of the indirect mechanism that affects the total level of production in the economy. Public law enforcement can reduce total production and welfare because incarcerated agents are removed from the labor force. However, it also increases the disincentives of theft, which causes a reduction in the measure of agents who choose to become thieves. This, in turn, reduces the measure of agents who are incarcerated. The interaction of these two forces can cause non-monotonic effects on the total level of production and welfare which might explain why we observe such vastly different levels of public law enforcement. Specifically, countries with low levels of public law enforcement do not have immediate benefits from small increases to the level of public law enforcement.

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Appendix A

Appendix A.1 Proof of Lemma 1

Proof. The production function of every firm satisfies Inada conditions, so $l_y(z) > 0$ for all $z \in E$. Now, the Envelope Theorem, (9) and the assumptions on ϕ imply $\pi'(z) = l_y(z)^\alpha \left(1 - \frac{(1-\lambda)M_T}{a\phi(l_s(z)|M_T)}\right) > 0$. Additionally, $\lim_{z\to 0} \pi(z) \leq 0$. Also, $\pi(z) < w$ for all z cannot be an equilibrium since in this case there would be no entrepreneurs.

On the other hand, from (8), $(z, \theta) \in T$ if and only if $u_T(z, \theta) > u_{NT}(z)$. From (1) and (2) we have that $(z, \theta) \in T$ if and only if

$$\frac{\lambda \underline{c}}{1 - \lambda M_T} + (1-\lambda)\Pi_T - \lambda \max\{w, \pi(z)\} > \theta. \tag{A14}$$

The definition of z^E and (A14) imply the result. □

Appendix A.2 Proof of Lemma 2

Since $\alpha > 0.5$, the following first order conditions of (9) characterize the solution to this problem:

$$w + \frac{(1-\lambda)M_T}{\phi(l_s)} = \alpha z l_y^{\alpha-1} \tag{A1}$$

$$w = (1-\lambda)M_T l_y \frac{\phi'(l_s)}{\phi(l_s)^2}. \tag{A2}$$

Solving for l_y in (A1) yields

$$l_y = \left(\frac{\alpha z}{w + \frac{(1-\lambda)M_T}{\phi(l_s)}}\right)^{\frac{1}{1-\alpha}}. \tag{A3}$$

Plugging (A3) in (A2) yields

$$w = \left(\frac{\alpha z}{w\phi(l_s) + (1-\lambda)M_T}\right)^{\frac{1}{1-\alpha}} (1-\lambda)M_T \phi'(l_s)\phi(l_s)^{\frac{1}{1-\alpha}-2}.$$

Our assumption that $\phi\left(l_s\right) \equiv \left(\frac{\alpha}{1-\alpha} l_s\right)^{\frac{1-\alpha}{\alpha}}$ satisfies

$$\phi'(l_s)\phi(l_s)^{\frac{1}{1-\alpha}-2} = 1,$$

so in equilibrium

$$l_s(z) = \frac{1-\alpha}{\alpha}\left(\frac{(1-\lambda)M_T}{w}\right)^{\alpha}\left(\frac{\alpha z}{w} - \left(\frac{(1-\lambda)M_T}{w}\right)^{\alpha}\right)^{\frac{\alpha}{1-\alpha}}. \tag{A4}$$

Plugging (A4) into (A3) yields

$$l_y(z) = \left(\frac{\alpha z}{w} - \left(\frac{(1-\lambda)M_T}{w}\right)^{\alpha}\right)^{\frac{1}{1-\alpha}}. \tag{A5}$$

Plugging (A4) and (A5) into (5) yields

$$\tau(z) = \left(\frac{w}{(1-\lambda)M_T}\right)^{1-\alpha}\left(\frac{\alpha z}{w} - \left(\frac{(1-\lambda)M_T}{w}\right)^{\alpha}\right)^{\frac{\alpha}{1-\alpha}}. \tag{A6}$$

Finally, $\pi(z)$ results from plugging (A4) to (A6) into the objective function of (3):

$$\pi(z) = \frac{1-\alpha}{\alpha} w \left(\frac{\alpha z}{w} - \left(\frac{(1-\lambda)M_T}{w}\right)^{\alpha}\right)^{\frac{1}{1-\alpha}}.$$

Appendix B Model $\lambda = 1$

Assume $\lambda = 1$. Depending on parameter values, in equilibrium there could be theft. That is, even if thieves cannot consume what they steal, their aversion to becoming thieves, θ, and the consumption they get when they get caught, $\underline{c}$, can be such that some households are better off stealing. If $\lambda = 1$ then Lemma 1 implies

$$\theta^W = \frac{\underline{c}}{1-M_T} - w \tag{B1}$$
$$\theta^E(z) = \frac{\underline{c}}{1-M_T} - \pi(z).$$

There will be theft in an equilibrium with $\lambda = 1$ as long as $\theta^W \geq \inf_\theta \operatorname{supp}\{F(\theta)\}$. In this case firm z's problem is

$$\pi(z) \equiv \max_{l_y \geq 0, l_s \geq 0} z l_y^{\alpha} - w l_y - w l_s. \tag{B2}$$

The solution of (B2) is

$$
\begin{aligned}
l_y(z) &= \left(\frac{\alpha z}{w}\right)^{\frac{1}{1-\alpha}} \\
l_s(z) &= 0.
\end{aligned} \tag{B3}
$$

Plugging (B3) into (B2) we have

$$
\pi(z) = (1-\alpha) z^{\frac{1}{1-\alpha}} \left(\frac{\alpha}{w}\right)^{\frac{\alpha}{1-\alpha}}.
$$

Notice that $\pi(z)$ is strictly increasing in z, so there exists a cutoff z^E such that $\pi(z^E) = w$, which implies consumers choose to be workers for $z < z^E$ and decide to be entrepreneurs for $z \geq z^E$ and

$$
z^E = \left(\frac{1}{1-\alpha}\right)^{1-\alpha} \left(\frac{1}{\alpha}\right)^{\alpha} w.
$$

Then the equilibrium in this case is characterized by w and M_T such that

$$
\begin{aligned}
M_T &= F(\theta^W) G(z^E) + \int_{z \geq z^E} F(\theta^E(z)) dG(z) \\
\int_{z \geq z^E} l_y(z)(1 - F(\theta^E(z))) dG(z) &= (1 - F(\theta^W)) G(z^E) \\
\theta^W &\geq \inf_{\theta} \operatorname{supp} \{F(\theta)\}.
\end{aligned} \tag{B4}
$$

If the first two equations of (B4) are satisfied, but the third one is not, then we have an economy as in Lucas (1978). That is, there is no theft in equilibrium and consumers choose between being workers or entrepreneurs. Firms' profits are given by (B2) with $M_T = 0$, so the equilibrium of this economy is characterized by (B5).

$$
\begin{aligned}
M_T &= 0 \\
l_y(z) &= \left(\frac{z\alpha}{w}\right)^{\frac{1}{1-\alpha}} \\
z^E &= \left(\frac{1}{\alpha}\right)^{\alpha} \left(\frac{1}{1-\alpha}\right)^{1-\alpha} w \\
\int_{z \geq z^E} l_y(z) dG(z) &= G(z^E).
\end{aligned} \tag{B5}
$$