



# **Predation, Protection and Productivity: A Firm-Level Perspective**

**Timothy Besley  
Hannes Mueller**

**April 2016**

*Barcelona GSE Working Paper Series*

*Working Paper n° 900*

# Predation, Protection and Productivity: A Firm-Level Perspective\*

Timothy Besley  
LSE and CIFAR

Hannes Mueller  
IAE (CSIC), MOVE and Barcelona GSE

April 16, 2016

## Abstract

This paper studies the consequences of predation when firms deploy guard labor as a means of protecting themselves. We build a simple model and combine it with data for 142 countries from the World Bank enterprise surveys which ask about firm-level experiences with predation and spending on protection. We use the model to estimate the output loss caused by the misallocation of labor across firms and from production to protection. The loss due to protection effort is substantial and patterns of state protection at the micro level can have a profound impact on aggregate output losses. Various extensions are discussed.

## 1 Introduction

Although a central function of the state is to maintain law and order, it is widely appreciated that a number of states, particularly in poor countries, fail to deliver. For example, World Justice Project (2014) highlights the deficiencies in formal and informal adherence to basic principles of justice enforced by law around the world. The economic consequences of this are now given a central role in explaining differences in the level of income per capita. Acemoglu and Robinson (2012) and Besley and Persson (2011) have emphasized this theme and the institutional underpinnings of efforts to build legal capacity to support markets. One of the main approaches for assessing this has to be to exploit the correlation between cross-country differences in summary measures of private and state predation and

---

\*We thank seminar audiences at the University of Amsterdam, IBEI Barcelona, Queen Mary University of London, CIFAR, and LSE. We thank Alberto Sánchez Martín and Heather Sarsons for excellent research assistance. Mueller acknowledges support from the Ramon y Cajal Programme, Research Grant SGR 1064 by the Catalan Government and the Spanish Ministry of Economy and Competitiveness, through the Severo Ochoa Programme for Centres of Excellence in R&D (SEV-2011-0075). All errors are ours.

income differences.<sup>1</sup> These capture a wide variety of effects and are therefore difficult to link back to the underlying mechanisms and distortions in resource allocation that result.

This paper takes a different approach, building up a bottom-up picture of the misallocation due to weak law and order from a firm level perspective. Heterogeneous predation threats in different firms distort labor allocation between firms, and in addition to output losses, we also estimate the cost of predation due to the misallocation of labor towards the protection of output. These distortions are highly relevant even in developed countries. Protective service labor grew by about 2.4 percentage points of total hours worked in Europe between 1993 and 2010, for example. This made it the fastest growing occupation studied by Goos et al (2014). According to the US bureau of labor statistics about 2.2 percent of all employed in 2014 worked in protective service occupations. The model developed here gives us a way to think about the welfare loss imposed by allocating labor to protective ends when it could have been used productively. A key insight is that the threat of predation can lead to a welfare loss even when no predation is actually observed.

We expect the output loss arising from predation to be particularly important in countries with a weak protection of firms where ineffective states fail to deliver law and order. Scarcity of data is the main difficulty in getting estimates of the labor misallocation in these countries. We make use of direct measures of these distortions from the World Bank Enterprise surveys.<sup>2</sup> These can be used to create a quantitative assessment of the output loss due to factor misallocation directly. Subject to the limitations of the model we are able to bypass identification problems due to omitted variables or reverse causation by constructing counterfactuals based on the theory. This isolates some specific output effects which, under reasonable assumptions, are likely to be a lower bound. Most of the additional ways in which weak law and order would affect output, such as deterring innovation, would occur on top of those that we can measure and make the output effects even larger.

The theoretical framework that we propose models how firms allocate labor to productive activity or predation. It provides a way of thinking about the firm-specific predation threat and a firm's response in terms of a lower level of total factor productivity which

---

<sup>1</sup>See, for example, Hall and Jones (1999), Acemoglu, Johnson and Robinson (2001) and Djankov et al (2002).

<sup>2</sup>These surveys are used to look at international productivity differences in Bartelsman et al (2013).

is greater among firms where predation is a bigger problem. The crucial advantage of having firm level data on both dimensions, predation and protection, is that we do not need to make any assumptions regarding the complicated endogenous relationship between the two factors. We use the model and data to generate an expression for the aggregate output loss which depends on the joint distribution of predation, protection and firm level productivity. In line with the recent literature on resource misallocation (Restuccia and Rogerson, 2008, and Hsieh and Klenow, 2009), the theoretical framework also allows us to consider what would be a counter-factual "no predation" outcome with which to compare the actual allocation of labor. In this counter-factual labor gets re-allocated from protection to production and from firms that are least affected by crime to those who are most affected by crime. We show that the aggregate output loss is particularly large when productive firms are vulnerable to crime. An additional key finding in this framework is that the labor misallocation caused by the threat of predation can generate a welfare loss even if it is a pure transfer to predators.<sup>3</sup>

The paper offers an empirical estimate of how predation losses vary across countries, illustrating the importance of firm-level heterogeneity. For some countries, these losses are around 10 per cent of output. Moreover, we estimate that around two thirds of these losses come from reallocating labor to protection rather than using it productively. On the whole, larger firms appear to be more susceptible to predation although countries do vary in the extent to which this is true. Our estimates allow us to run a thought experiment in which consider how much output different countries would gain or lose from adopting a Chinese pattern of protection firm size. We estimate that output in Mexico, for example, would increase by about 3 percent if this happened.

We allow for sectoral heterogeneity in the production technology using US labor shares. This reveals an interesting pattern of sectoral differences in output losses which is, however, not very large on average. The model can be used to give an expression for sectoral labor reallocation if the threat of predation were eliminated. In countries with high predation, we estimate large increases in labor supplied to the formal enterprise sector of the economy, more than 20 percent in the case of the construction sector which is both labor intensive and relatively susceptible to predation.

---

<sup>3</sup>This idea goes back to Tullock (1967, 1971) who discusses theft as an example.

The analysis is also extended to consider investment decisions by firms. We find that predation also has a negative effect on investment while protection seems to enhance it. This allows us to speculate on a wider range of effects which could further create an output cost from weak law and order. We also model the reaction of managerial effort which affects firm-level productivity to predation. Here, we find that the loss estimates can increase substantially from around 2.6 percent on average to 4.8 percent.

The symptoms of lawlessness and disorder that we study here are specific. However, they provide a different way of engaging in debates about the value of state effectiveness by building a “bottom up” picture based on micro-foundations and micro-data. The World Bank enterprise surveys are the only firm-level data that we are aware of which have a wide coverage of countries, including those in the developing world and have not previously been used to look at these issues. But a bottom-up exercise also has its limitations; a firm-level perspective is not able to engage in wider debates about a whole range of additional factors which shape the macro-economic picture and we are implicitly taking as fixed those other factors which influence productivity across countries. Thus, what we are offering is only one piece of a bigger picture based on a direct measure of an important distortion. However, there is also value in specificity because we can isolate a specific channel rather than trying to look at state effectiveness at large where the specific role of any given channel is hard to discern.<sup>4</sup> Hence, we view the top-down and bottom-up approaches as ultimately complementary lines of work in trying to engage in debates in why poorly functioning states can have adverse economic consequences.

The remainder of the paper is organized as follows. In the next section, we discuss related literature. Section three introduces the data and documents some basic facts. In section four, we lay out a model which we use to derive a measure of the output loss in the enterprise sector relative to undistorted output. Section five shows how this can be brought to the data and section six presents estimates of output losses by aggregating firm level data and illustrates how heterogeneous productivity matters for this. In section seven, we use a constant elasticity model for the protection technology and use this to calibrate

---

<sup>4</sup>Section H in the on-line appendix follows Bartelsman et al (2013) to show how the covariance between different productivity measures and firm size is affected by predation. The fact that we can measure distortions directly means that we can also assess the extent of productivity rank reversals as discussed by Hopenhayn (2014).

its parameters as a means of looking at patterns of protection across firms and countries. Section eight presents some additional analysis, including firm investment, sector-specific technologies and allowing for a labor reallocation effect between the enterprise sector and other parts of the economy. Section nine concludes.

## 2 Related Literature

There is now a growing literature on the quantitative implications of resource misallocation beginning with Restuccia and Rogerson (2008) and Hsieh and Klenow (2009).<sup>5</sup> This has led to a debate about what it would take for distortions in factor and product markets to have large effects – see, for example, Hopenhayn (2014). This paper has two novel features compared to the existing work in this area. First, we consider the consequences of private actions to limit distortions. This shifts the form of the distortion from predation to protection. Second, we work from actual measures of a particular distortion faced by firms since the data provides reported losses by firms and the share of sales spent on protection. We share with this literature the desire to gauge the aggregate implications of this for the economies concerned. We find that the costs of predation are significant and change markedly when an effort is made to adjust these from firm-level productivity differences.

The paper also speaks to the literature on the welfare cost of imperfect property rights protection and the costs of predation.<sup>6</sup> There is now a large macro-economic literature such as Acemoglu et al (2001) and Hall and Jones (1999) which argues that large differences in income per capita are due to the risk of expropriation. Micro studies in developing countries have provided proof of fairly large effects on investment associated with these distortions.<sup>7</sup> Private protection through guard labor in this context has been studied by Field (2007) who shows that there is a significant misallocation of household labor due to the need of families with weak property rights having to remain in the home to guard their property. Jayadev and Bowles (2006) discuss the use of guard labor in a cross-section of

---

<sup>5</sup>For an overview of some of the wider issues involved in explaining cross-country income differences in terms of differences in factor endowments and technology, see Caselli (2005).

<sup>6</sup>This literature is reviewed in Besley and Ghatak (2009).

<sup>7</sup>See, for example, Besley (1995) and Goldstein and Udry (2008).

countries.<sup>8</sup>

There is a large related literature which calculates the cost of crime.<sup>9</sup> The standard accounting approach is to estimate this cost simply by adding the costs and losses due to crime. For example, Van Ours and Vollaard (2014) use estimates from an accounting approach to study the welfare gain from installing electronic engine immobilizers in the Netherlands.<sup>10</sup> Other approaches include individual valuations of counter-factuals, contingent-valuation, and changes in market prices to estimate the welfare costs. For example, Cook and MacDonald (2011) use both contingent-valuation surveys and jury awards to victims of violent crimes to calculate the social welfare gains from crime reductions. The estimates which emerge from both of these methods turn out to be quite similar which somewhat surprising given that the ex-ante willingness to pay and ex-post damage are conceptually different. One reason is spending on protection which we analyze here.

An example of a paper which uses market prices to assess the cost of crime is Gibbons (2004) which estimates the costs of property crimes on property prices in London. Besley, Fetzer and Mueller (2015) exploit shipping prices in the spot market for bulk shipping to calculate the welfare cost of Somali piracy. Their key finding is that total costs in the shipping industry were a multiple of what pirates managed to extract through ransoms. One of the reasons is the spending on protection in the shipping industry like, for example, spending on armed security guards. Due to spending on protection, successful predation decreased and welfare costs shifted from costs from predation to costs from protection. The early literature on the costs of predation such as Tullock (1967) observed that protection spending should be factored into the costs.<sup>11</sup>

---

<sup>8</sup>They find much higher numbers than we do here. However, their definition of guard labor includes police and prison guards, supervisors in firms, the unemployed and military personal.

<sup>9</sup>See Soares (2009) for a review.

<sup>10</sup>Their benchmark measures of the cost comes from the UK Home Office. The methodology is based on Brand and Price (2000). This is an accounting exercise in which security expenditures, insurance costs and damages are added up to derive a per case cost.

<sup>11</sup>In line with the argument developed here, he notes that:

"The theft itself is a pure transfer, and has no welfare cost, but the existence of theft as a potential activity results in very substantial diversion of resources to fields where they essentially offset each other, and produce no positive product. The problem with income transfers is not that they directly inflict welfare losses, but that they lead people to employ resources in attempting to obtain or prevent such transfers. A successful bank robbery will inspire potential thieves to greater efforts, lead to the installation of improved protective equipment in other banks, and perhaps result in the hiring of additional policemen. These are its social costs, and they can be very sizable." (Tullock (1967), p. 231)

The role of private spending in driving up the welfare costs is an old theme in the crime literature starting with Becker (1968). Benson and Mast (2001), for example, discuss how spending on protection can be quantified in assessing the costs of crime. Our focus here is on the costs to firms rather than individuals and hence how it affects output in the economy also how it is distributed across types of firms.

### 3 Data

Our data comes from the World Bank enterprise surveys which are plant-level surveys of a representative sample of an economy's formal private sector – agriculture, small informal firms and pure government-owned businesses are excluded. They cover a range of topics measuring the business climate including access to finance, corruption, infrastructure, crime, competition, and performance measures. Since 2002, the World Bank has collected this data from face-to-face interviews with top managers and business owners. This allows us to use data from over 140,000 companies in 142 economies.<sup>12</sup> The data is made available both at the plant level and at different levels of aggregation. Further details on the data and the collection methods can be found in Appendix A.

We focus on answers to two specific survey questions: (i) *"In fiscal year [insert last complete fiscal year], what percentage of this establishment's total annual sales was paid for security?"* and (ii) *"In fiscal year [insert last complete fiscal year], what were the estimated losses as a result of theft, robbery, vandalism or arson that occurred on this establishment's premises either as a percentage of total annual sale?"*. While not all questions are answered by every enterprise that is surveyed, we have more than 140,000 observations where we can calculate both pieces of data. In what follows, we will use the term predation to capture the various forms of loss that could be experienced by firms, i.e. "theft, robbery, vandalism or arson". Most of these acts are likely to have been perpetrated by criminals rather than the state itself.

Table 1 gives summary statistics for the plant level where we report weighted averages using the survey weights provided by the World Bank. These numbers reveal that the average expenditure by a firm was 1.8 percent of sales for security (protection) and the

---

<sup>12</sup>We discuss our modifications to the raw data in appendix A.



loss in sales was around 1 percent due to theft, robbery, vandalism (predation).<sup>13</sup> The share of firms that report paying for security is at 60 percent and is more than double the 25 percent reporting a loss. This makes intuitive sense. Not everybody who spends on security is or has been victim of predation - this implies that losses due to predation are spread throughout the population through the investment in security. The average firm size in our sample is about 84 workers which varies between 1 worker and just under 66,000. Table 1 also reports the sample size by country where the average is nearly 1200 firms per country. Finally, we report the fraction of firms in our sample which report crime as most important obstacle to doing business. This is about 4.4 percent.

In Figure 1 we show a scatter plot of the country-level averages to the two core questions for different years. These numbers are close to what the World Bank reports at the country level. They illustrate the significant variation across countries. There is also a clear positive correlation between protection spending and damages. The latter suggests, in line with common sense, that high levels of predation are associated with high efforts at protection. There are two quite striking outliers in the data: Cambodia is an outlier in terms of spending on protection and the Central African Republic is an outlier in terms of predation.

For our analysis we use the number of workers, losses, spending on protection and our model to make statements on firm productivity. In other words, we do not rely on value-added calculations in the data. Data on sales and costs contain large errors so that dropping outliers becomes a crucial issue. Our model allows us to use some of the three most commonly reported parts of the data. This should minimize errors at the cost of additional assumptions regarding the production function and the absence of distortions in the labor market of the economy. We will return to these issues in section 6 and discuss value added measures in Appendix C.

More generally, there is a trade-off involved in using the World Bank enterprise surveys. They are not as carefully collected as some country's manufacturing surveys. However, they cover a wide range of sectors and unusually give information about some specific distortions such as what we are examining here. The fact that they cover a wide range of countries also widens the experience that we study. We are also comfortable in the belief

---

<sup>13</sup>In appendix Figure A1 we show that, on average, losses and spending on protection are relatively constant (falling slightly) across firm size.

that employment which we use in our main calculations is reasonably well measured.

## 4 Conceptual Framework

Consider the enterprise sector of the economy, as defined by the World Bank Enterprise surveys, which is populated by a finite set of firms with productivity levels,  $\theta_i$ , indexed by  $i = 1, \dots, N$  where  $\pi_i$  denotes the proportion of firms type  $i$  in the population of all firms.<sup>14</sup> We will think of the  $N$  firms in our data as representing a sample of firm types that we aggregate to get the effect of predation on the economy as a whole. Thus we think of firm  $i$  as a specific type of plant in our data.

The enterprise sector allocates a fixed amount of labor,  $L$ , with the wage rate  $w$  being determined endogenously. This benchmark case is in effect assuming that labor markets in different parts of the economy are segmented. However, we will consider below what happens if labor can migrate between the enterprise sector and other activities such as agriculture, the informal sector or government employment.

A firm of type  $i$  hires labor  $l_i$ , taking the wage as given, and can choose to allocate a part of this labor to security, denoted by  $e_i$ . There is a type-specific protection technology which determines the fraction of output that a firm of type  $i$  realizes which is denoted by  $p^i(e_i, g) \in [0, 1]$  where  $g$  denotes investment by the state in protection. We assume that  $p^i(\cdot, g)$  is increasing and concave. Thus having more protection reduces the amount of output that is lost. Our formulation of the protection technology allows for firm-level heterogeneity. This makes sense since we expect exposure to predation to be quite idiosyncratic, depending on the firm's location, its political connections, the nature of its production process/location of its client base. In particular, we make no a priori assumption about how the protection technology covaries with productivity  $\theta_i$ . We will rely on the data to tell us about this.

The arbitrary function  $p^i(e_i, g)$  allows for several interesting features in the data. For example, our model could easily incorporate the possibility of spillovers between firms, e.g. where

$$p^i(e_i, g) = p^i(e_i, g, \bar{e}_i)$$

---

<sup>14</sup>We use  $\pi_i$  to capture the survey weights in the empirical implementation.

and  $\bar{e}_i$  is a vector of protection effort by other relevant firms in the same location or sector. Our model also allows both  $e_i$  and  $p^i(e_i, g)$  to be endogenous to factors which we cannot measure. In fact, it can be shown that, even controlling for location, sector and year of the survey, firms with high  $e_i$  are also firms which have low values of  $p^i(e_i, g)$ . Under the assumption that  $\theta_i$  does not change without predation this is not a concern for our identification strategy as we measure both  $e_i$  and  $p^i(e_i, g)$  directly. In section (6) we discuss the effect on our results if this assumption is violated.

The fraction  $1 - p^i(e_i, g)$  of output is either transferred to criminals or destroyed by their activity. Let  $\tau \in [0, 1]$  be the fraction that is a transfer. We do not have a breakdown between vandalism and theft in the data. In the case of pure vandalism then we would expect  $\tau = 0$  i.e. no part of the lost output is transferred to criminals whereas with theft it is reasonable to suppose that  $\tau > 0$ . In this case output is transferred rather than destroyed. We will report our results for different values of  $\tau$  to see how much this parameter matters to the conclusions that we reach.<sup>15</sup>

The output of a type  $i$  firm net of predation losses is:

$$y_i = p^i(e_i, g) \theta_i [l_i - e_i]^\alpha. \quad (1)$$

The production function is a standard constant elasticity formulation with  $\alpha < 1$  being the labor share. Hence, this is basically, a “span-of-control” model in the spirit of Lucas (1977). Here, we assume a common production technology, i.e.  $\alpha$  is the same for all firms. This constitutes a somewhat extreme case with unlimited heterogeneity in the protection technology alongside a common production function (albeit with heterogeneous productivity levels). Below, we will relax this by allowing  $\alpha$  to be sector specific. We will also extend the approach to allow both labor and capital to be used in production. The value of the simple case that we begin with is that it allows us to home in on the novel aspect of the approach before including complications.

The function  $p^i(e_i, g)$  in (1) is formally similar to the kind of policy distortion studied in Restuccia and Rogerson (2008). However, we add a key difference of approach by allowing firms to mitigate this distortion by choice of  $e_i$ , i.e. choosing a level of protection.

---

<sup>15</sup>Another interpretation of setting  $\tau = 0$  is that we do not value the share of output that goes to criminals even when GDP is not lower.

However, this just shifts where the consequences of the distortion is felt since firms are not using all of the labor that they hire productively.

A firm of type  $i$  chooses  $\{e_i, l_i\}$  to maximize

$$p^i(e_i, g) \theta_i [l_i - e_i]^\alpha - w l_i.$$

There are two conditions which hold at an interior solution. First, there is the standard condition stating that the marginal product of labor is set equal to the wage:

$$p^i(e_i, g) \alpha \theta_i [l_i - e_i]^{\alpha-1} = w \tag{2}$$

The second is that the marginal product of labor employed in protection is equal to that of productive labor:

$$\frac{p_e^i(e_i, g)}{p^i(e_i, g)} = \frac{\alpha}{l_i - e_i}. \tag{3}$$

Our analysis of the cost of predation will use this model to construct a counter-factual without predation. In the general model we simply assume  $p^i(e_i, g) = 1$  and  $e_i = 0$  for all  $i$ , i.e. we construct a situation in which there is not even a threat of predation.

Note that using the model and data on  $l_i$  implies that we calculate the output loss from predation as if labor use is not distorted otherwise. We are therefore studying the marginal effect of our measured distortions assuming that any others remain in place, i.e. these are contained in  $\theta_i$ . We regard this a conservative approach which prevents us from attributing other factors of firm productivity to predation.

## 5 Bringing the Model to the Data

We now use the model to derive an expression for aggregate output lost to predation in terms of measurable factors. We will then consider the allocation effects of the labor market equilibrium and use this to derive an expression for the aggregate output loss.

**Spending on Security** In the data, we observe the share of sales that are spent on protection by firm  $i$  in our data set. This can be related to the model by noting that this

is given by

$$\begin{aligned}\sigma_i &= \frac{we_i}{p^i(e_i, g)\theta_i[l_i - e_i]^\alpha} \\ &= \alpha \frac{e_i/l_i}{1 - e_i/l_i}\end{aligned}\tag{4}$$

after using (2). Another way to think about this is that the share of total labor hired that is used as protection is  $e_i/l_i = \sigma_i/[\sigma_i + \alpha]$ . This relates the labor misallocation directly to the share of sales variable from the data after we plug in an assumed value for  $\alpha$ . We choose  $\alpha = 0.66$  as our core case below, i.e. a two thirds labor share. In the extensions we relax this assumption.

**Losses by Firms** The share of losses due to predation experienced by firm  $i$  can also be expressed in terms of the model as:

$$\text{value of sales lost by firm } i = \mu_i = \frac{1 - p^i(e_i, g)}{p^i(e_i, g)}.$$

The data give us a direct measure of  $\mu_i$  and  $p^i(e_i, g) = 1/[1 + \mu_i]$ .

**Labor Market Equilibrium** We assume that labor is allocated across firms to equalized marginal products and with the wage adjusting to achieve this. This assumption allows us to back out the relative productivities from firm size. Write firm  $i$ 's labor demand as:

$$l_i = \left(\frac{\hat{\theta}_i \alpha}{w}\right)^{\frac{1}{1-\alpha}}\tag{5}$$

where

$$\hat{\theta}_i = \theta_i \frac{1}{(1 + \mu_i)} \left(\frac{\alpha + \sigma_i}{\alpha}\right)^{1-\alpha}\tag{6}$$

can be thought of as “adjusted” firm-level productivity as a function of our two observables  $\{\mu_i, \sigma_i\}$ .<sup>16</sup> Equation (5) states that firms that are intrinsically more productive (higher  $\theta_i$ ), experience smaller predation losses (lower  $\mu_i$ ) and allocate more labor to protection spending (higher  $\sigma_i$ ) hire more laborers.

---

<sup>16</sup>Note that with  $\mu_i = \sigma_i = 0$  we have  $\hat{\theta}_i = \theta_i$ .

To solve for the labor allocation across all firms, we sum the labor demands of all firms, using sample weights, and equate labor supply,  $L$ , with demand to yield:

$$\sum_i \pi_i l_i = \left( \frac{\alpha \hat{\Theta}}{w} \right)^{\frac{1}{1-\alpha}} = L.$$

where  $\hat{\Theta} = \left( \sum \pi_i (\hat{\theta}_i)^{\frac{1}{1-\alpha}} \right)^{1-\alpha}$  is an aggregate measure of productivity for the enterprise sector as a whole.<sup>17</sup> The share of total employment in firm  $i$  can then be written as:

$$\frac{l_i}{L} = \left( \frac{\hat{\theta}_i}{\hat{\Theta}} \right)^{\frac{1}{1-\alpha}}. \quad (7)$$

This share of total labor employed in firm  $i$  can be seen to depend exclusively on its relative “adjusted” productivity level.

In interpreting these equations, it is important to recall that  $e^i$  will be chosen optimally and hence determine  $\{\mu_i, \sigma_i\}$  in equilibrium as a function of the protection technology and the perceived threat of predation that a firm faces. Below, we will work with a specific technology where we can calibrate the parameters of the protection technology from the data explicitly. For the time being, we will state everything in terms of observables without restricting the form of the protection function  $p^i(e_i, g)$ .

**Firm Level Productivity** In order to estimate the output loss from predation and protection, we need a measure of the undistorted firm productivity,  $\theta_i$ . We can estimate  $\theta_i/\Theta$  where  $\Theta = \left( \sum \pi_i (\theta_i)^{\frac{1}{1-\alpha}} \right)^{1-\alpha}$ , i.e. the firm’s relative productivity from the distribution of firm size. To see this note that

$$\frac{\theta_i}{\Theta} = \frac{(1 + \mu_i) (l_i)^{1-\alpha} \left( \frac{\alpha}{\alpha + \sigma_i} \right)^{1-\alpha}}{\left( \sum_j \pi_j \left( (1 + \mu_j) (l_j)^{1-\alpha} \left( \frac{\alpha}{\alpha + \sigma_j} \right)^{1-\alpha} \right)^{\frac{1}{1-\alpha}} \right)^{1-\alpha}} \quad (8)$$

using the fact that in the undistorted allocation,  $\sum \pi_j l_j = L$ . Equation (8) is useful in bringing the model to the data since it allows us to estimate the undistorted labor

---

<sup>17</sup>In practice we use firm shares as sample weights  $\pi_i$  so that  $\sum_i \pi_i l_i$  is the average firm size. As we do not consider firm entry and exit this does not change our results.

allocation and hence the output level in the absence of predation. We will use it to create productivity weights,  $\theta_i/\Theta$ , for each firm in the data based on its observed firm size, along with its reported loss from predation and spending on protection.

Although we refer to,  $\theta_i$  as the “undistorted level of firm productivity”, we are using this term in a very specific sense. The distortion which we observe in the data is specific to predation losses and spending on protection. It is quite likely that, even if these were removed, others would remain in place. We think of these other distortions remaining in  $\theta_i$  and that we are capturing only the marginal effect of the distortion due to predation with a view to measuring how important it is in affecting the level of output.

**Aggregate Output Costs of Predation** To create a benchmark, consider aggregate output in the formal enterprise sector in the absence of predation and protection, i.e. when  $\mu_i = \sigma_i = 0$ . It is important to note that this should not be regarded as any kind of first best benchmark as we are only removing the specific distortion that we are measuring. This level of output is given in terms of the model parameters by:

$$Y^* = \sum_i \pi_i \theta_i (l_i)^\alpha = L^\alpha \Theta \sum_i \pi_i \left( \frac{\theta_i}{\Theta} \right)^{\frac{1}{1-\alpha}} \quad (9)$$

where we have used the fact that without predation  $l_i = \left( \frac{\theta_i}{\Theta} \right)^{\frac{1}{1-\alpha}}$ . By contrast, productive labor with predation is given by  $l_i - e_i = l_i \frac{\alpha}{\alpha + \sigma_i}$ . Total output with predation can therefore be written as

$$\begin{aligned} \hat{Y} &= \sum_i \pi_i \theta_i \left[ \tau + \frac{(1-\tau)}{1+\mu_i} \right] (l_i)^\alpha \left( \frac{\alpha}{\alpha + \sigma_i} \right)^\alpha \\ &= L^\alpha \Theta \sum_i \pi_i \frac{\theta_i}{\Theta} \left[ \tau + \frac{(1-\tau)}{1+\mu_i} \right] \left( \frac{\hat{\theta}_i}{\hat{\Theta}} \right)^{\frac{\alpha}{1-\alpha}} \left( \frac{\alpha}{\alpha + \sigma_i} \right)^\alpha \end{aligned} \quad (10)$$

after substituting in  $l_i$  from equation (7). This gives aggregate output with predation as a function of  $\{\theta_i, \sigma_i, \tau, \mu_i\}$ . Using this together with (9), yields the following expression for the proportional output loss from predation and protection:

$$\Delta = \frac{Y^* - \hat{Y}}{Y^*} = 1 - \frac{\sum_i \pi_i \frac{\theta_i}{\Theta} \left[ \tau + \frac{(1-\tau)}{1+\mu_i} \right] \left( \frac{\hat{\theta}_i}{\hat{\Theta}} \right)^{\frac{\alpha}{1-\alpha}} \left( \frac{\alpha}{\alpha + \sigma_i} \right)^\alpha}{\sum_i \pi_i \left( \frac{\theta_i}{\Theta} \right)^{\frac{1}{1-\alpha}}} \quad (11)$$

This is a key equation that we bring to the data. We make four key observations about it.

First observe that if  $\mu_i = 0$  and  $\sigma_i = 0$  for all  $i$  then  $\frac{\hat{\theta}_i}{\hat{\Theta}} = \frac{\theta_i}{\Theta}$  for all  $i$  and hence  $\Delta = 0$ .

Second, note that a convenient feature of (11) is that, with the exception of  $\tau$  and  $\alpha$ , it is stated entirely in terms of variables which are either observable or can be estimated from the firm-level data using (8). We are therefore able to calculate  $\Delta$  for each country in our data set.

Third, equation (11) illustrates the importance of the heterogeneous pattern of predation  $\mu_i$ , protection  $\sigma_i$ , and productivity  $\theta_i$ , in determining aggregate output losses. The output loss from predation depends on how the threat of predation is correlated with firms' undistorted productivity levels. Thus if large firms are more susceptible to predation, this can lead to higher losses in three ways – directly higher  $\mu_i$  or indirectly through them spending more on protection, i.e. higher  $\sigma_i$ . These distortions will also affect allocation of labor across firms indirectly through changes in  $\hat{\Theta}$ . Without predation, labor will be reallocated towards firms that are heavily affected as  $\hat{\theta}_i/\hat{\Theta}$  increases to  $\theta_i/\Theta$ .

Fourth, equation (11) makes clear why  $\tau$  matters. If more of the predation is in the form of output transfers ( $\tau$  close to one) then the output cost is lower. However, even with  $\tau = 1$  there is still an output loss since some labor may be allocated to protection. Another way to think of this is also to imagine that  $\mu_i = 0$ . Now the parameter  $\tau$  has no impact on the output loss in (11); the loss is given entirely by  $\sigma_i$ . Thus even an economy which appeared to face no predation could in fact have a distorted level of output if the threat is latent and it employs workers to guard against it. Below, we will explore how assumptions regarding  $\tau$  affect the calculation of the output loss due to predation.

## 6 Results

Our estimates of the output loss is based on the sample of firms in the World Bank enterprise surveys.<sup>18</sup> We look at variation across both countries and firms. Hence we write  $\theta_{ic}$  for firm type  $i$  in country  $c$  with corresponding weights  $\pi_{ic}$ . We allow  $g$  to vary

---

<sup>18</sup>We are not therefore able to say anything about losses from predation and/or protection experienced by fully government-owned, agricultural or informal firms. Moreover, it is an open question whether such firms' experience with law and order is different from the firms on which we do have data and this is, in any case, likely to be heterogeneous by country and firm type.



across countries so that  $p_{ic} = p^i(e_{ic}, g_c)$  is the loss experienced by a firm type  $i$  in country  $c$  when it allocates labor  $e_{ic}$  to protection. We could also allow  $\tau$  or  $\alpha$  to be country specific. However, we will maintain common values for these parameters in what follows.

It is important in interpreting the results that follow to realize that  $\theta_{ic}$  does not have to be a purely technological parameter but could reflect a range of other pre-existing distortions in the economy. We are considering what would happen if we removed the specific distortion that we are interested in while holding all others in place. The data we have on  $\sigma_i$  and  $\mu_i$  together with our model allow us to do this. However, this is quite separate from whether, if one actually removed the distortion that we are considering, there would be changes in  $\theta_i$  due to spillovers to other sources of inefficiency. A case in point would be a generalized improvement in the legal system which could have a range of effects.

**Benchmark: Identical Firms** As a benchmark, consider the case where all firms within a country are the same with the same losses and spending on protection as well as the same level of productivity:  $\theta_{ic} = \Theta_c$  for all  $i$  in country  $c$ . Equation (11) now boils down to a very simple form:

$$\Delta_c = 1 - \left[ \tau + \frac{(1 - \tau)}{(1 + \bar{\mu}_c)} \right] \left( \frac{\alpha}{\alpha + \bar{\sigma}_c} \right)^\alpha \quad (12)$$

where  $\bar{\mu}_c$  and  $\bar{\sigma}_c$  are the country (weighted) averages for the share of sales lost to predation and the share of sales spent on protection. Note that the share of workers employed in protection is given through  $\frac{\alpha}{\alpha + \bar{\sigma}_c} = 1 - \bar{e}_c/\bar{l}_c$ .

Given direct measures of  $\bar{\mu}_c$  and  $\bar{\sigma}_c$ , we can estimate the loss in (12) without any assumptions about the technology  $p^i(e_i, g)$  and without the typical identification issues. In our data,  $\bar{p}_c = 1/(1 + \bar{\mu}_c)$  varies between 94.6 percent and 100 percent. Table 2 depicts averages of  $\bar{e}_c/\bar{l}_c$  and  $\Delta_c$ . The parameter  $\alpha$  enters in both estimates. To explore how much this affects the results, Table 2 gives some summary statistics for the country/year level averages assuming three different values,  $\alpha = 0.9$ ,  $\alpha = 0.66$  and  $\alpha = 0.5$ . The first three rows of Table 2 show that our estimate of the fraction of the work force employed in protection,  $\bar{e}_c/\bar{l}_c$ , varies from around 1.8 percent to 2.9 percent as we vary  $\alpha$ .<sup>19</sup> The next

---

<sup>19</sup>These are reasonable numbers given the employment share of protection in the US in 2014 was between

rows present estimates of the output loss for the benchmark case where  $\tau = 0$  and for the three values of  $\alpha$ . The estimated average output loss is about 2.4 percent regardless of the choice of  $\alpha$ . In what follows we focus on the case  $\alpha = 0.66$  until we look at sectoral variation in  $\alpha$  as an extension below.

Table 2 also gives the average loss for  $\tau = 1$  which is 1.6 percent. Thus, about two thirds of the output loss from predation in the enterprise sector is estimated to be from expenditure on protection. In Figure 2, we plot the output loss from equation (12) when  $\tau = 0$  and plot it against the share of the loss that comes from spending on protection, i.e. the value of  $\Delta_c$  in (12) when  $\tau = 1$  divided by  $\Delta_c$  when  $\tau = 0$ . This gives a feel for the balance of the loss coming from protection and predation. Figure 2 shows that the total loss is negatively correlated with the share of the loss due to protection. This suggests that protection technologies could be more effective in some countries. In as far as publicly provided security,  $g$ , is the ultimate driver of the total loss this pattern could be explained by the private sector action as being complementary to  $g$ .

The loss from protection varies significantly across countries and is over 5 percent in several cases. Thus, even in an economy in which all predation is an “efficient” transfer from firms to criminals, the loss in output caused by predation can still be substantial. This is an interesting finding given that the main focus of the discussion about the cost of predation and the misallocation that it causes has been on the fact that it reduces the output retained by firms rather than the private actions that firms take to prevent it happening.

**Heterogeneous Firms** We now explore the implications of firm level heterogeneity in productivity, predation and protection. As an intermediate step, Figure 3 plots the loss in different deciles of the firm productivity distribution,  $\frac{\theta_i}{\bar{\theta}}$ , in two countries: China and Mexico. We choose these two cases since both have decent-sized samples of firms. Moreover, the pattern found in these two cases appear somewhat representative of the pattern of output losses in Asian and Latin American economies. Asian countries tend to show consistently lower output losses.

Figure 3 illustrates the variation in losses across the firm-size distribution. It shows

---

0.7 and 2.2 percent depending on which definition we use.

that losses in Mexico tend to be proportionately greater in large firms compared to China. This suggests that there will be distortions across firms in the way that labor is allocated. In Mexico there will be a strong drive of labor away from larger firms. We will return to some further implications of this in section 7 where we report the result of a thought experiment which increases protection for larger firms.

The main point to take away from Figure 3 is that there is considerable variation across countries regarding which part of the firm-size distribution is most affected by predation. A model with heterogeneous firms can take this into account in the calculation of aggregate losses. The estimated output loss in country  $c$  is given by:

$$\Delta_c = 1 - \frac{\sum_i \pi_{ic} \frac{\theta_{ic}}{\Theta_c} \left[ \tau + \frac{(1-\tau)}{1+\mu_{ic}} \right] \left( \frac{\hat{\theta}_{ic}}{\hat{\Theta}_c} \right)^{\frac{\alpha}{1-\alpha}} \left( \frac{\alpha}{\alpha+\sigma_{ic}} \right)^\alpha}{\sum_i \pi_{ic} \left( \frac{\theta_{ic}}{\Theta_c} \right)^{\frac{1}{1-\alpha}}} \quad (13)$$

where we exploit firm level variation in productivity, losses and security expenditures in the enterprise survey data.<sup>20</sup> Again, given direct measures of  $\mu_{ic}$  and  $\sigma_{ic}$ , we can estimate the loss in (13) without any assumptions about the technology or exogeneity of  $p^i(e_i, g)$ . Note also that we have made no assumption regarding whether  $e_i$  is provided by the firm internally or whether  $e_i$  is provided by another firm. Both are consistent with the data we have. We discuss organized crime in the Appendix B.

Equation (13) also allows us to return to the key identifying assumption underlying our output loss estimates. We assume that a change in predation does not change the relative productivity  $\theta_{ic}/\Theta_c$  of firms. This assumption is violated if, for example, managerial effort or investment is hindered by predation so that productivity of firms would increase without predation. In section (8) we discuss these possibilities further. Note, however, that in this scenario the most affected firms are the ones who would benefit most from the absence of predation. The change from  $\hat{\theta}_{ic}/\hat{\Theta}_c$  to  $\theta_{ic}/\Theta_c$  would then be even larger and our estimates provide a lower bound to the true output loss.

Figure 4 compares the estimate from equation (13) to the estimates that come out the model with identical firms, i.e. equation (12). Observations on the red line would mean

---

<sup>20</sup>We validate this approach by looking at the correlation between the most comparable measure of crime at the country level, homicides, in Table A1. We find a positive correlation between our loss measure and this measure both in pooled regressions and in panel regressions with country fixed effects.

that the output loss estimate is identical with and without firm heterogeneity. Around 55 percent of the observations lie above the 45<sup>0</sup> line and the loss increases on average by about 0.3 percentage points. In other words, allowing for heterogeneity tends to increase the size of the estimated loss modestly. There are a few countries like Sierra Leone or Afghanistan where the increased output loss with heterogeneity is particularly pronounced. This is due to large firms being particularly susceptible to predation in these countries. In line with Figure 3, Mexico is a notable member of this group of countries. We will see in the following section that these are also countries that suffer particularly from weak protection of firms.

We have run several robustness checks regarding both output loss estimates shown in Figure 4. For example, we exclude firms with very large weights  $\pi_{ic}$ , drop outliers in terms of firm size and restrict the analysis to countries with many observations. The findings are fairly robust to all of these changes.<sup>21</sup> Our model allows us to calculate the productivity weights from firm size alone and so we do not rely on data on sales and costs which are reported less often and contain larger errors. Two findings emerge if we calculate productivity weights from sales and costs data, i.e. if we use value added estimates.<sup>22</sup> First, if we focus on large, comparable samples and exclude outliers of the value added data the two ways to calculate weights yield very similar results. Second, moving away from large, comparable samples the output loss measures look less similar.

According to our model, some part of the estimated losses in Figure 4 are due to firms which are most affected by predation losses shedding labor and we would expect such firms to expand were predation to be eliminated. This effect can be captured empirically in our framework by computing the difference between  $\left(\hat{\theta}_{ic}/\hat{\Theta}_c\right)^{\frac{\alpha}{1-\alpha}}$  in the numerator of (13) and  $(\theta_{ic}/\Theta_c)^{\frac{\alpha}{1-\alpha}}$  in the denominator. The output loss is always smaller without labor reallocation. However, this decrease is fairly small; around 0.2 percent of output on average.<sup>23</sup> Note however, that we are not allowing the total amount of labor supplied to

---

<sup>21</sup>However, most of the extreme losses we find in Figure 4 are in countries with small samples (except Cambodia). This is illustrated in Figure A2 where we restrict the sample to countries with more than 500 observations.

<sup>22</sup>For calculations and discussion see Appendix C.

<sup>23</sup>Figure A6 tries to gauge the importance of the labor reallocation effect by plotting the output loss in (13) when we replace  $(\theta_{ic}/\Theta_c)^{\frac{1}{1-\alpha}}$  by  $(\theta_{ic}/\Theta_c)\left(\hat{\theta}_{ic}/\hat{\Theta}_c\right)^{\frac{\alpha}{1-\alpha}}$  in the denominator. This is like assuming that in the hypothetical no-predation scenario, labor allocation remains as it is in our data i.e., does not

the enterprise sector of the economy to vary and we are assuming that all firms use the same technology. We will see below that when we look at this from a sectoral perspective with sector-specific technologies and the possibility of inflows of labor from other parts of the economy, these labor reallocation effects can be considerably larger.

## 7 Patterns of Protection

Our estimates so far have kept government policy firmly in the background. However, a central role of government is to determine the level of spending and the effectiveness of state institutions in maintaining social order by limiting predation. Accordingly, developed countries spend around 0.8 percent of their GDP on policing, prosecution, courts and prisons.<sup>24</sup> If this is the case, we would expect to find that our measures of output loss are correlated with proxies for the extent to which governments are actively fighting predation through having an effective criminal justice system.

As a proxy for the policy environment, we use the World Justice project index which is intended to measure the effectiveness of the criminal justice system on a scale between 0 and 1. The index summarizes many sub-factors which capture, for example, effectiveness and impartiality of the criminal investigation system, the criminal adjudication system and the correctional system. We relate this index to our output loss measures in Figure 5 for the case where  $\tau = 0$ , i.e. all predation is destructive. There is a strong correlation between our two output loss measures (with and without heterogeneity among firms) and this measure.<sup>25</sup> If we interpret this correlation as causal (which is obviously problematic), it says that the adoption of a system of criminal justice in Venezuela with the effectiveness of Chile would boost Venezuelan output by around 2 percent. If it were to adopt a legal system with the effectiveness of Sweden, it would gain more than 3 percent. Of course, we would expect other gains from improving the effectiveness of criminal justice beyond

---

move across firms because  $(\hat{\theta}_{ic}/\hat{\Theta}_c)^{\frac{\alpha}{1-\alpha}} = (l_{ic}/L_c)^\alpha$ .

<sup>24</sup>Estimate based on Farrell and Clark (2004). The lions share of this, around 60 percent, is spent on policing.

<sup>25</sup>This relationship is robust to controlling for GDP per capita, political institutions and continent fixed effects. This is not surprising given that many poor autocracies have relatively low crime rates. We also find that our estimate of  $p^i(e_{ic}, g_c)$  is positively correlated with the firm reporting that the court system in the country is effective, fair and free of corruption. This holds controlling for country/year fixed effects and firm productivity.

those highlighted here.<sup>26</sup>

To explore the policy environment and its implications further, it is useful to home in on the case where the predation technology has a constant elasticity form where:

$$p^i(e, g) = \begin{cases} \varepsilon^i(g) \times e_i^{\gamma^i(g)} & \text{for } \varepsilon^i(g) \times e_i^{\gamma^i(g)} \leq 1 \\ 1 & \text{otherwise.} \end{cases} \quad (14)$$

The best way to interpret  $\varepsilon^i(g)$  is as the *perceived* level of protection by a firm which is consistent with its protection behavior and its reported loss while  $\gamma^i(g)$  is the protection effort elasticity. Both can depend on the policy environment,  $g$ , as well as other country-specific factors. This functional form has the convenient property that a constant fraction of any firm's labor force is used for protection purposes, i.e.

$$\frac{e_i}{l_i} = \frac{\gamma^i(g)}{\alpha + \gamma^i(g)}.$$

Using (14) gives a specific interpretation to the heterogeneity in firms' decisions.<sup>27</sup>

Our data allow us to calculate the productivity of protection effort and the degree of protection that a firm enjoys. To estimate  $\gamma^i(g)$  directly from the share of sales that is spent on protection in firm  $i$ , we use the observation that  $\gamma^i(g) = \sigma_i / [\sigma_i + \alpha]$ . The parameter  $\varepsilon^i(g)$  can be backed out from observables by observing that, when firms make their optimal decisions, then:

$$\varepsilon^i(g) = \frac{[l_i \gamma^i(g)]^{-\gamma^i(g)}}{(1 + \mu_i)}. \quad (15)$$

---

<sup>26</sup>We have also analysed the relationship between the output loss and the relative size of police force from the United Nations Office on Drugs and Crime (UNODC) and found no significant relationship. In addition, the share of the police in total employment is an order of magnitude smaller than the average  $e_i/l_i$ . This indicates that we do not merely capture a substitution of public and private security efforts with our protection measure. Finally, we gathered data on the prison populations from International Centre for Prison Studies (ICPS) and find a negative correlation between prison population per employed and our measure of the output loss.

<sup>27</sup>We suppose that  $\alpha + \gamma^i(g) < 1$ . Note that

$$l_i = [\alpha + \gamma^i(g)] \left( \frac{\left( \varepsilon^i(g) \theta_i (\gamma^i(g))^{\gamma^i(g)} (\alpha)^\alpha \right)^{\frac{1}{1-\alpha-\gamma^i(g)}}}{w} \right)$$

so that variation in labor hired is increasing in  $\varepsilon^i(g)$  and  $\theta_i$ .

Firm size  $l_i$  is increasing in  $\theta_i$  in equation (15) which implies that, in theory at least, more productive firms should be less well-protected (all else equal). However, it is still an open empirical question whether this is indeed the case in the data.<sup>28</sup> Figure A7 plots our estimates of protection,  $\varepsilon^i(g)$ , against the percentile of firms in the firm-size distribution. This measure ranges from around 1.04 to 0.93 and, as we expected, we find a downward relationship with firm size. In the Appendix D we explore correlates of perceived protection. We find that firms that expect more protection (higher  $\varepsilon^i(g)$ ) report crime less as an obstacle. We also find that firms located in the capital city perceive that they are better protected from predation and that state owned and foreign firms seem better able to defend against predation.

Following on from what we showed in Figure 3, Figure 6 returns to the case of China and Mexico where we now plot the distribution of protection by productivity decile. They illustrate two archetypal patterns in the data. Some countries seem to offer reasonably equal levels of protection across firms, regardless of firm size whereas in others it tails off markedly as firms get larger. The latter pattern is well illustrated by Mexico while the pattern in China shows little difference in protection across the firm-size distribution. Drilling down this way into country-specific patterns shows the value of being able to look at these issues through a parametric interpretation of the firm-level data.

This observation about the difference between China and Mexico inspires us to ask what would happen if the protection and predation environment in China applied in other countries.<sup>29</sup> Protection like in China is a more reasonable benchmark than zero predation and will, in particular, highlight the potential value in protecting larger, more productive firms. To do this we proceed as follows. First, we divide all firms in each country into fifty equal-size groups based on their relative productivity,  $\frac{\theta_{ic}}{\Theta_c}$ . We then draw values of  $\{\varepsilon^i(g), \gamma^i(g)\}$  at random from the observed distribution in each productivity group in China.<sup>30</sup> Third, we give these values to firms in the same productivity group in other countries in our data. We then compute the gains/losses in output that this would yield.

---

<sup>28</sup>This will depend in part on the covariance of  $\theta_i$  and  $\gamma^i(g)$ .

<sup>29</sup>While we use values from China, the pattern is similar in other East Asian countries such as South Korea, Thailand and Vietnam.

<sup>30</sup>Since some countries have quite small sample sizes we need to make sure we repeat this procedure and use the mean. We do so five hundred times and calculate the mean and the standard deviation of the gains/losses in output as a form of "bootstrapping". Details of the procedure are in Appendix D.

Table 3 shows the change in output that we estimate in countries with statistically significant output gains from this thought experiment.<sup>31</sup> For this, the gain or loss needs to be more than 1.65 times its standard deviation above or below zero. European and Asian countries are largely absent from the table since we do not find significant gains from having a Chinese-style protection environment. This contrasts with many African and Latin American countries which mostly show positive and significant gains. Column (1) of Table 3 focuses on the output gain if  $\tau = 0$ . In some cases the output gains from the policy experiment are substantial. For example, we estimate that Sierra Leone could increase output in the enterprise sector by almost 8 percent by adopting a Chinese pattern of protection and Mexico might increase output in the enterprise sector by 3.5 percent. Of course, this says nothing about how practically to achieve this nor the cost of doing so. But it does give a sense of how much willingness to pay there might be for bringing about changes which protect larger firms better.

In columns (2) we assume that  $\tau = 1$ . In this case, all changes are due to labor re-allocation towards or away from protection. The gains remain substantial in most countries. This column shows that the losses are very significantly linked to protection; the average change in output reported on the bottom of each column suggests that over 70 percent of all changes in output can be attributed to protection spending. This shows how important it is to consider the protection margin in considering the output effects of lawlessness.

Columns (3) report the difference between columns (1) and (2), i.e. the change in output that is only due to differences in predation losses. There is a significant amount of heterogeneity in the gains here with many countries gaining very little. Cambodia, for example, would gain 4.3 percent of output entirely due to a reallocation from unproductive to productive labor. In fact, most countries with moderate gains would benefit most from a reduction in protection efforts. The average gain in this group is 0.99 percentage points and 0.94 would come from changes in protection spending. This finding is in line with Figure 2 which showed that most countries with low output losses face relatively minor predation losses. This is, perhaps, due to the fact that for intermediate values of public security

---

<sup>31</sup>We exclude small territories with a population of less than one million as well as countries with less than 100 observations in the enterprise surveys.



provision the private response manages to prevent significant losses from predation.<sup>32</sup> The countries that would gain most from an adoption of Chinese parameter values tend to gain through both channels.

## 8 Further Analysis

**Adding the Cost of Predation in Transit** The more recent section of the World Bank enterprise survey asks two additional questions on predation to measure the losses incurred due to predation in transit.<sup>33</sup> These questions are i) *"In fiscal year [insert last complete fiscal year] what percentage of the value of the products exported directly was lost while in transit because of theft?"* and ii) *"In fiscal year [insert last complete fiscal year], what percentage of the value of products this establishment shipped to supply domestic markets was lost while in transit because of theft?"*. These represent additional losses which should be taken into account.

Call these two losses  $\mu_i^{transit}$  and  $\mu_i^{export}$ . We combine this data with the share of sales in firm  $i$  which goes to domestic markets  $d_i$  to calculate the following measure of the loss due to predation:

$$p^i(e_i, g) = 1 / [1 + \mu_i + d_i \mu_i^{transit} + (1 - d_i) \mu_i^{export}] .$$

Incorporating this into the analysis results in an output loss for the case of homogeneous and heterogeneous firms in Figure 7. Some countries, Sierra Leone and the Republic of Congo for example, experience a dramatic increase in the estimated output loss if we allow firms to be heterogeneous. The changes under the assumption of homogeneous firms tend to be small. This makes sense given that large firms are more likely to sell their products outside of local markets and hence are more subject to predation in transit.

**The Size of the Enterprise Sector** The model implicitly assumes that the level of employment in the enterprise sector as covered by the World Bank enterprise surveys remains constant. This can be thought of as a segmented labor-markets assumption.

---

<sup>32</sup>There is indeed a U-shape relationship between the share due to predation and our criminal justice measure.

<sup>33</sup>We are grateful to Hannes Malberg for drawing these survey questions to our attention.

The efficiency effects are therefore exclusively due to labor reallocation within the segment rather than between this segment of the private sector and other parts of the economy. We now discuss how a further margin can matter due to entry and exit of labor from working in the sector that is surveyed.

Our approach to this is very simple, supposing that there is a fixed outside wage set in either public employment or agriculture which we denote by  $\omega$ . This could be thought of as a Lewis-style dual economy model where  $\omega$  for the whole economy is the wage set in agriculture. But labor reallocation could be from the public sector or the informal sector. We show in the Appendix G that if we assume that  $\omega$  is fixed, i.e. there is no general equilibrium response in the sector that is supplying labor to the formal enterprise sector, then we can approximate the aggregate output loss as:

$$\Delta \simeq \frac{\alpha}{1 - \alpha} \left[ 1 - \left( \frac{\hat{\Omega}}{\Omega} \right) \right].$$

In interpreting this, it is useful to observe that  $1 - \left( \frac{\hat{\Omega}}{\Omega} \right)$  is the measure of output loss from our original expression (11). Thus, allowing for the aggregate labor force in the enterprise sector to respond to increases the size of the welfare loss by a factor which is approximately:  $\alpha / (1 - \alpha) \simeq 2$ , i.e. allowing for labor reallocation between sectors could be thought of as roughly doubling the output loss that we estimated above. Of course, this is only approximate and, given that  $\omega$  does not respond, could be viewed as an upper bound on the output loss. Moreover, it throws into sharp relief the fact that we have maintained the assumption that  $\alpha$  is assumed to be the same across economies. While it would be straightforward to relax this for the purposes of calculation, it would affect how much labor reallocation across sectors to expect as predation changes as well as the returns to labor reallocation within the sector.

It is worth underlining that we have assumed that  $\omega$  is fixed in this exercise. If  $\omega$  did respond to increased productivity in the formal enterprise sector, then we would expect the output effect to be dampened. However, part of the benefit of reduced predation and protection would then be experienced by increases in wages in other sectors of the economy.<sup>34</sup> Moreover, as this would be a shift from profits to wages, it would also be

---

<sup>34</sup>Also, according to findings in Gould et al (2002) and Machin and Meghir (2004) criminals will leave

likely to create pro-worker redistributive effects.

This discussion underlines the idea that we have been quite conservative in our core estimates of the output loss from predation.

**Reallocation Between Sectors** We have assumed up until now that  $\alpha$  is the same for all firms. We now relax this assumption by assuming a sector-specific technology, i.e.  $\alpha_s$  for sector  $s$ . For sectoral labor intensity, we use the US economy as a benchmark. Specifically, we use payroll shares from Elsbey et al (2013).<sup>35</sup> Based on this, we use 32.2 percent as the labor share in the primary sector for which we use the natural resources and mining sector in the US. Construction in the US has a payroll share of 72.4 percent. For manufacturing we calculate an average US labor share of 55.1 percent from durable goods manufacturing and non-durable good manufacturing and for the services sector we calculate an average of 57.5 percent from across all services sectors weighted by their value added. Using this, we will estimate the sectoral output loss when labor allocation does not move as well as the labor reallocation effect from for every sector/country/year.<sup>36</sup>

In the case in which labor does not move then, following (11), the output loss from predation in sector  $s$  is given by:

$$1 - \frac{\hat{\Omega}_s}{\Omega_s} = 1 - \frac{\sum_i \pi_{is} \frac{\theta_{is}}{\Theta_s} \left[ \tau + \frac{(1-\tau)}{1+\mu_{is}} \right] \left( \frac{\theta_{is}}{\Theta_s} \right)^{\frac{\alpha_s}{1-\alpha_s}} \left( \frac{\alpha_s}{\alpha_s + \sigma_{is}} \right)^{\alpha_s}}{\sum_i \pi_{i\alpha_s} \left( \frac{\theta_{is}}{\Theta_s} \right)^{\frac{1}{1-\alpha_s}}}. \quad (16)$$

Following the calculations in Table 2, allowing  $\alpha_s$  to vary across sectors does not affect our estimate of the output loss in equation (11) substantially.<sup>37</sup> Table 4 summarizes the results from looking at the loss in each sector for the quartiles of countries that are most (panel A) and least affected (panel B) by predation. We first report raw data averages of  $\mu_{is}$  and  $\sigma_{is}$  by sector. In the third column of Table 4 we report our estimates of (16)

---

the predatory sector. This will free up additional labor. For example, the prison populations in Rwanda and Russia are around 1 percent of the employed population.

<sup>35</sup>A similar argument is made in Hsieh and Klenow (2009). Specifically, we use a weighted average of the payroll share from the year 2011 using the shares of value added as weights. All data is from Table 2 in Elsbey et al (2013).

<sup>36</sup>We exclude sector/country/years with less than 10 firms in this and the following section.

<sup>37</sup>We plot the output loss at the country/sector level under the assumption of US labor shares (explained below) against the estimate with constant labor share in Figure A8. The estimated output loss is only slightly higher with the assumption of higher labor shares.

by sector which now takes into account firm heterogeneity. Panel A shows that the least affected countries lose around 0.7 per cent of output due to predation with little variation across sectors. The most affected countries in panel B show a little more variation across sectors with the construction sector losing most (6.87 percent).

Allowing  $\alpha_s$  to vary does, however, have substantial consequences for the estimated employment effects using a model of the kind that we developed in the previous section where we assumed a fixed outside wage,  $\omega$ .<sup>38</sup> Table 4, Panel A reports the employment loss from predation for the least affected countries which lies between 0.9 percent in the primary sector and 2.4 percent in construction. The greater output loss in construction is an immediate consequence of this being a more labor intensive sector where labor distortions matter more. In the most affected countries in panel B we estimate a 12 percent gain in manufacturing employment and a whopping 23.9 percent gain in construction employment from eliminating predation. Here, relaxing the assumption of a common technology has an important bearing on the findings with labor intensive sectors being much more affected in their total employment.<sup>39</sup>

To provide further insight into effects of predation/protection on sector size, we conduct an exercise along the lines of section (7) at the sector level. We do this by attributing values of  $\{\varepsilon^i(g), \gamma^i(g)\}$  from the Chinese construction sector to firms in the construction sector in other countries. Since the sample of firms at the sector level is smaller, the standard errors are inevitably somewhat larger. Nonetheless, we will get a feel for how much a sector might expand with lower levels of predation. As above, we focus on countries where the output change is statistically significant; the results are presented in Table 5. This draws attention in particular to a number of African economies where there are considerable gains. For example, we estimate that output in the construction sector in Togo, Senegal, Zambia

---

<sup>38</sup> Specifically, we allow the labor allocated to sector  $s$ , denoted by  $L_s$  to vary when predation is eliminated so that the marginal product of labor used in sector  $s$  is equal to  $\omega$ . Using this observation and taking logs in a sector-specific version of equation (3) in Appendix G, we can estimate the proportionate difference in the size of the labor force in sector  $s$  with and without predation from:

$$\ln \frac{L_s^*}{L_s} = \frac{1}{1 - \alpha_s} \ln \frac{\hat{\Omega}_s}{\Omega_s}.$$

<sup>39</sup>As we mentioned above, use of a Lewis-style model of labor allocation where there is an unlimited supply of laborers tends to make these effects labor allocation an upper bound. If  $\omega$  were to increase due to the elimination of predation in the enterprise sector, then these effects would tend to be smaller.

and Botswana would expand by more than 10 percent if Chinese levels of protection were available to firms in the construction sector.

**Impact on Investment and Firm Growth** We have so far focused on a production structure with only labor and a single distortion due to predation/protection. However, it is straightforward to embed the approach in a more general setting while preserving the insights that we use in fitting the model to the data. Suppose, for example, that there is both labor and capital and we have a Lucas (1978) span of control model with a decreasing returns parameter  $\eta$ ,<sup>40</sup> i.e.

$$y_i = \theta_i p^i(e_i, g) \left[ (l_i - e_i)^\alpha k_i^{(1-\alpha)} \right]^\eta.$$

This extension of the model allows us to think about how productivity affects investment in the constant elasticity model with parameters  $\{\varepsilon^i(g), \gamma^i(g)\}$ . Appendix F shows that the optimal capital stock is increasing in  $\varepsilon^i(g)$  and  $\gamma^i(g)$  if  $p^i(e_i, g) < 1$ .<sup>41</sup>

Our data allow us to look at this empirically by looking at investment by firms.<sup>42</sup> Specifically, we look at whether a firm reports purchasing any fixed asset and/or expenditure in fixed assets over the previous year. The results are reported in Table 6 and include country-year fixed effects, sector fixed effects and dummies for firm-size class. Columns (1) through (3) show that there is positive correlation between investment and our measure of firm-level protection as well as our measure of the productivity of protection. Column (1) uses data on a general question regarding the purchase of any fixed asset. A one standard deviation increase in the protection parameter increases investments by 1.6 percent. An increase in the elasticity of protection effort increases the likelihood of an investment by 3.4 percent.

Columns (2) and (3) use data on fixed asset purchases which is reported less frequently

---

<sup>40</sup>It would be straightforward to have a standard monopolistic competition model with a constant markup instead.

<sup>41</sup>This assumption implies decreasing returns in  $\{l_i, k_i\}$  overall. To see this observe that in this case, we can write:

$$y_i = \theta_i \varepsilon^i(g) [\gamma^i(g)]^{\gamma^i(g)} [1 - \gamma^i(g)]^{\alpha\eta} \left[ (l_i)^{\gamma^i(g) + \alpha\eta} (k_i)^{(1-\alpha)\eta} \right]$$

<sup>42</sup>To map formally from the capital stock to investment, it would be straightforward to introduce adjustment costs along with shocks to  $\theta_i$ .

by firms. Column (2) finds patterns that are broadly consistent with the findings on the correlation with protection in column (1). Column (3) focuses on the intensive margin of firm investments as the log function leads to the exclusion of all zero investments. Effects on this margin are consistent with the theory and fairly large. A standard deviation increase in protection implies an increase of investment by 9.5 percent. An increase of the protection elasticity by one standard deviation implies an increase in investment by more than 16 percent. Thus, as we would expect, predation and protection are also related to investment decisions. This pattern of investment effects largely corroborates our findings on firm perceptions reported in the Appendix D.

**Selection and Incentive Effects on Productivity** While investment is important, it is only one dimension of a wider set of margins on which predation can affect firm performance. Returning to the base line model with only labor, note that firm profits as a function of  $\theta_i$  with optimal labor allocation decisions  $\{l_i^*(g, w), e_i^*(g, w)\}$  are:

$$S^i(g, w, \theta_i) = \theta_i p^i(e_i^*(g, w), g) (l_i^*(g, w) - e_i^*(g, w))^\alpha - w l_i^*(g, w).$$

There are possible selection and incentive effects which can affect  $\theta_i$  and which respond to the threat of predation. The selection effect comes from making endogenous which firms are active. Suppose that there is a fixed cost  $F$  of being active then the critical efficiency level above which a firm is active, given by  $\tilde{\theta}_i(g, w)$ , is defined by:

$$S^i(g, w, \tilde{\theta}_i(g, w)) = F.$$

If  $p_g^i > 0$ , then a marginal increase in  $g$  reduces  $\tilde{\theta}_i(g, w)$ .<sup>43</sup> Hence less efficient firms can afford to be active in the market all else equal when there is a lower threat of predation. Note, however, the distribution of predation and productivity matters for the selection effect. If predation is concentrated among high productivity firms, then they may close

---

<sup>43</sup>This follows from noting that:

$$S_g^i(g, w, \theta_i) = \theta_i p_g^i(e_i^*(g, w), g) (l_i^*(g, w) - e_i^*(g, w))^\alpha > 0$$

and

$$S_\theta^i(g, w, \theta_i) = p^\theta(e_i^*(g, w), g) (l_i^*(g, w) - e_i^*(g, w))^\alpha > 0.$$

down. In that case average productivity in the economy as a whole could be higher when  $g$  is increased. This has implications for the countries identified above, such as Mexico.

There is also the possibility of an incentive effect which applies to efforts by firms to increase their productivity. This could be due to variety of decisions that firms make. Here, we will focus on managerial decision-making as a source of productivity differences.<sup>44</sup> To model this simply suppose that  $\theta_i(I_i)$  where  $I_i$  is firm-level managerial effort measured in units of labor input. The first order condition for managerial effort is:

$$\frac{\partial \theta_i(I_i^*(g))}{\partial I_i} [p^i(e_i^*(g, w), g) (l_i^*(g, w) - e_i^*(g, w))^\alpha] = w$$

where we have used the envelope condition for  $\{l_i^*(g, w), e_i^*(g, w)\}$ . We show in the appendix that, with a constant elasticity functional form for the value of managerial effort given by  $\theta_i = \frac{\theta_i}{1-\kappa} (I_i)^{1-\kappa}$ , then the relative productivity of a firm with and without predation, in terms of the observable  $\mu_i$  is<sup>45</sup>

$$\left( \frac{1}{1 + \mu_i} \right)^{\frac{1-\kappa}{\alpha-\kappa}} < 1$$

if  $\alpha > \kappa$  which is the empirically plausible case since we expect  $\alpha \simeq 2/3$  and  $\kappa \simeq 0.2$ .<sup>46</sup> To illustrate the productivity consequences of predation via this channel, note that if  $\alpha = 0.66$  and  $\kappa = 0.2$ , a firm that loses 2% of its output due to predation experiences a 4% fall in productivity due to lower managerial effort.

We can use this simple model to see what happens to the aggregate loss with heterogeneous firms when  $\alpha = 0.66$  and  $\kappa = 0.2$ . On average this loss increases from about 2.6 percent to 4.8 percent. Three things about this are worth noting. First, regardless our assumptions on  $\tau$  the predation loss  $\mu_i$  will lower output as managerial effort does not internalize the gain to predators. Second, the effect will shift the magnitude of the loss due to predation compared to that due to spending on security; the share of the loss due to predation increases from around 30% to 50%. Third, the effect differs depending on both the level of predation and its distribution across firms. The estimated output loss in

---

<sup>44</sup>Bloom and VanReenen (2007) suggests that this is empirically important.

<sup>45</sup>The adjusted to productivity depends only on  $\mu_i$ . We show in Appendix I that this is due to security spending being chosen optimally by the firm.

<sup>46</sup>Prendergast (2015) estimates the effect of managerial effort in the U.S. to be lower than 0.25.

Cambodia, for example, barely changes from 5.2 percent under the model in equation (13) to a loss of 5.5 percent in the modified model. However, the estimate for Mexico increases from 4.5 percent to 7.9 percent in the modified model which reflects the fact that large firms are more exposed to predation.

Although specific to one channel, the analysis in this section illustrates why our estimates of the put loss from predation are likely to be a lower bound on true losses. It also illustrates the value of an approach which builds up to the macro-picture from specific distortions which can be studied in micro-economic terms.

## 9 Concluding Comments

One important feature of many developing and emerging market economies is the extent to which firms face threats of predation due to weakness in law and order. We have emphasized the possibility that firms will respond to this threat by diverting labor from productive uses towards protecting themselves. While this reduces the expected loss from predation it also reduces labor available for productive purposes.

We have incorporated the possibility of predation and protection into a simple model to illustrate how it affects the allocation of labor across firms. The model was used to derive an expression for productivity which reflects the costs of predation. By writing this in terms of observables, we are able to use data from the World Bank enterprise surveys to estimate these losses based on answers to survey questions posed to firms about losses from robbery, theft, arson and vandalism as well as the amount that they spend on security.

Heterogeneity in predation threats and protection technologies mean that firms vary in the extent to which they experience an output loss. All else equal, firms that suffer less or have no viable protection technology hire more productive workers as a fraction of their total employment. This results in labor misallocation across firms even when the marginal product of labor is equalized across firms. We quantify this and show sizeable output losses which vary by country and firm-size. Around two thirds of these losses are due to protection rather than predation. Given the size and growth of the private security sector in developed countries this point is of considerable importance here as well.

By extending the model to allow for sector-specific labor intensities, we can estimate the extent of labor across sectors that we might expect if predation were eliminated. We estimate that employment in the sector with the highest labor intensity, construction, might expand by more than 20 percent if predation could be eliminated in high predation



countries.

We have also use a specific parametrization of the protection technology to look at patterns of predation across and within countries. Our analysis suggests that East Asian countries protect their large firms better than most other developing countries. Adopting the pattern of protection found in China, for example, would provide significant output gains for countries most affected by predation. That said, it is clear that this finding is only suggestive with a more complete policy analysis having to consider the costs of different policy interventions.

The analysis developed here is deliberately simple in order to home in on the new issues. We have focused on one distortion and have not considered a wider range of policy failures which could also be important including taxes, corruption or regulations. These are all part of the  $\theta_i$  term in the model. We have also abstracted from a range of frictions in firm level decisions such as adjustment costs and capital constraints. To the degree that they are positively correlated with the vulnerability to crime, for example due to a general absence of the state, we would expect our estimates to be a lower bound on the cost of crime.

While the analysis provides a range of insights, much remains to be done to provide a more complete picture of how predation affects labor allocation and productivity. First, we are holding other distortions in the economy as fixed when we look at the effect of improving protection. It is quite possible that distortions other than that focused on here are more quantitatively important in explaining low levels of productivity in some countries. Following Hsieh and Klenow (2009), capital market misallocation is a case in point. Moreover, it is possible that both capital and labor enters the protection technology. Second, our data allows us to sidestep the discussion of positive and negative spillovers between firms who choose their levels of protection.<sup>47</sup> However, for policy this is an important issue. Third, we have not considered the role of public protection and how it interacts with protection decisions at the firm level. Our estimates suggest that the level of private protection might exceed the share of labor force allocated to public protection. The

---

<sup>47</sup>Ayres and Levitt (1998) discuss the importance of spillovers and provide empirical evidence for a positive spill over from investing in protection. Bandiera (2003) provides evidence for a negative spill-over in the context of Sicilian land protection. See also Draka and Machin (2015) for a discussion. Clotfelter (1977) provides an early discussion and empirical investigation of the interplay between private and public provision of protection.

interaction between firms' decisions to protect and policy making requires investigation. Fourth, more could be done to capture a wider range of channels through which predation affects productivity through selection and incentives. A full treatment of this would require modeling firm dynamics but would also provide a link to the growth literature.

This paper has shown that in study the consequences of predation in any context, the distortionary effect of private protection needs to be taken into consideration. And understanding this requires modeling specific micro-economic consequences of predation. Only then can the full range of consequences of state ineffectiveness be appreciated.

## References

- [1] Acemoglu, Daron, Simon Johnson and James A. Robinson [2001], "The Colonial Origins of Comparative Development: An Empirical Investigation", *American Economic Review*, 91, 1369-1401.
- [2] Acemoglu, Daron and James A. Robinson [2012], *Why Nations Fail*, New York: Crown Publishers.
- [3] Aghion, Philippe and Peter Howitt [1998], *Endogenous Growth Theory*, Cambridge, MA: MIT Press.
- [4] Ayres, I., and S. D. Levitt (1998) Measuring Positive Externalities from Unobservable Victim Precaution: An Empirical Analysis of Lojack. *The Quarterly Journal of Economics*, 113(1), 43-77.
- [5] Bandiera, Oriana, [2003], "Private States and the Enforcement of Property Rights: Theory and Evidence on the Origins of the Sicilian Mafia." *Journal of Law, Economics and Organization*, 19(1): 218-244.
- [6] Bartelsman, Eric, John Haltiwanger and Stefano Scarpetta, [2013], "Cross-Country Differences in Productivity," *American Economic Review*, 103(1), 305-334.
- [7] Becker, Gary S., [1968], "Crime and Punishment: An Economic Approach," *Journal of Political Economy*, 76, 169-217.
- [8] Benson, Bruce and Brent D. Mast, [2001], "Privately Produced General Deterrence," *Journal of Law and Economics*, 44, 725-746.
- [9] Besley, Timothy, [1995], "Property Rights and Investment Incentives: Theory and Evidence from Ghana," *Journal of Political Economy*, 103(5), 903-37.
- [10] Besley, Timothy, Thiemo Fetzer and Hannes Mueller, [2015], "The Welfare Cost of Lawlessness: Evidence from Somali Piracy," *Journal of the European Economic Association*, forthcoming.
- [11] Besley, Timothy and Maitreesh Ghatak, [2010], "Property Rights and Economic Development," in Mark Rosenzweig and Dani Rodrik (eds), *Handbook of Development Economics*, Amsterdam: Elsevier.

- [12] Besley, Timothy and Torsten Persson, [2011], *Pillars of Prosperity: The Political Economics of Development Clusters*, Princeton: Princeton University Press.
- [13] Bloom, Nicholas and John VanReenen, [2007], “Measuring and Explaining Management Practices Across Firms and Countries,” *Quarterly Journal of Economics*, 122 (4), 1351-1408.
- [14] Caselli, Francesco, [2005], “Accounting for Cross-Country Income Differences,” in Philippe Aghion & Steven Durlauf (ed.), *Handbook of Economic Growth*, Volume 1, chapter 9, 679-741 Elsevier.
- [15] Charles T. Clotfelter, [1977], “Public Services, Private Substitutes, and the Demand for Protection against Crime,” *American Economic Review*, 67(5), 867-877.
- [16] Cook, Philip J. and John MacDonald, [2011], “Public Safety Through Private Action: an Economic Assessment of BIDs,” *Economic Journal*, 121, 445–462.
- [17] Djankov, Simeon, Rafael La Porta, Florencio Lopez-de-Silanes and Andrei Shleifer, [2002], “The Regulation of Entry,” *Quarterly Journal of Economics*, 117(1): 1-37.
- [18] Draca, Mirko and Stephen Machin, [2015], “Crime and Economic Incentives.” *Annual Review of Economics*, 7, 389–408
- [19] Elsby, Michael W.L., Bart Hobijn Aysegül Sahin [2013] “The Decline of the U.S. Labor Share,” *Brookings Papers on Economic Activity*, Fall 2013.
- [20] Farrell, Graham and Ken Clark, [2004], “What Does the World Spend on Criminal Justice?”, mimeo, The European Institute for Crime Prevention and Control.
- [21] Field, Erica, [2007], “Entitled to Work: Urban Tenure Security and Labor Supply in Peru,” *Quarterly Journal of Economics*, 4(122), 1561-1602.
- [22] Gibbons, Steve, [2004], “The Costs of Urban Property Crime,” *Economic Journal*, 114(499): F441–63.
- [23] Goldstein, Markus and Christopher Udry [2008], “The Profits of Power: Land Rights and Agricultural Investment in Ghana,” *Journal of Political Economy*, 116(6), 981-1022.
- [24] Gould, Eric, Weinberg Bruce and David Mustard, [2002], “Crime rates and local labor market opportunities in the United States: 1979–1997,” *Review of Economics and Statistics*, 84, 45–61.
- [25] Hall, Robert and Charles Jones [1999], “Why Do Some Countries Produce so Much More Output per Worker than Others?”, *Quarterly Journal of Economics*, 114, 83-116.
- [26] Hopenhayn, Hugo A., [2014], “On the Measure of Distortions,” typescript, UCLA.
- [27] Hsieh, Chang-Tai and Peter J. Klenow, [2009], “Misallocation and Manufacturing TFP in China and India,” *Quarterly Journal of Economics*, 124(4), 1403-48.
- [28] Jayadev, Arjun and Samuel Bowles, [2006], “Guard Labor,” *Journal of Development Economics*, 79, 328-348.

- [29] Lucas, Robert E. [1978], “On the Size distribution of business firms” *Bell Journal of Economics*, 9(2), 508-523.
- [30] Machin, Stephen, and Costas Meghir, [2004], “Crime and Economic Incentives.” *Journal of Human Resources*, 39, 958–79.
- [31] Prendergast, Canice, [2015], “The Empirical Content of Pay-for-Performance.” *Journal of Law Economics and Organisation*, 31 (2): 242-261.
- [32] Restuccia, Diego and Richard Rogerson, [2008], “Policy Distortions and Aggregate Productivity with Heterogeneous Establishments,” *Review of Economic Dynamics*, 11(4), 707-20.
- [33] Soares, Rodrigo [2009], “Welfare Costs of Crime and Common Violence: A Critical Review,” in World Bank *Cost of Violence: Work in Progress Report*, Social Development Department.
- [34] Tullock, Gordon [1967] “The Welfare Costs of Tariffs, Monopolies, and Theft,” *Economic Inquiry*, 5(3), 224-322.
- [35] Tullock, Gordon [1971], “The Cost of Transfers,” *Kyklos*, 24(4), 629–643.
- [36] World Justice Project, [2014], The Rule of Law Index 2014 Report, available at [http://worldjusticeproject.org/sites/default/files/files/wjp\\_rule\\_of\\_law\\_index\\_2014\\_report.pdf](http://worldjusticeproject.org/sites/default/files/files/wjp_rule_of_law_index_2014_report.pdf)

Table 1: Summary Statistics on the Firm Level

|   | Obs.   | Mean     | SD       | Min | Max   |
|---|--------|----------|----------|-----|-------|
| percentage of total annual sales paid for security                                  | 142135 | 0.018    | 0.051    | 0   | 0.991 |
| loss due to theft, robbery, vandalism or arson as a percentage of total annual sale | 142135 | 0.010    | 0.045    | 0   | 0.990 |
| firm size (number of workers)   | 142135 | 83.676   | 408.201  | 1   | 65994 |
| firm reports paying for security  | 142135 | 0.608    | 0.488    | 0   | 1     |
| firm reports a loss due to predation  | 142135 | 0.252    | 0.434    | 0   | 1     |
| number of firms interviewed in country/year   | 142135 | 1229.591 | 1163.574 | 59  | 9183  |
| firm reports crime as worst obstacle  | 95082  | 0.044    | 0.205    | 0   | 1     |

Notes: Table shows summary statistics for our main variables. The response to "percentage of total annual sales paid for security" is our measure of spending on security. The response to "loss due to theft, robbery, vandalism or arson as a percentage of total annual sale" is our main measure of predation.

Table 2: Simple Output Loss Calculations

| Estimate                                | $\alpha$ | Mean Share | SD    |
|---|----------|------------|-------|
| share of workers employed in protection | 0.9      | 0.018      | 0.041 |
|   | 0.66     | 0.023      | 0.051 |
|   | 0.5      | 0.029      | 0.062 |
| output loss ( $\tau=0$ )                | 0.9      | 0.024      | 0.051 |
|   | 0.66     | 0.024      | 0.050 |
|   | 0.5      | 0.024      | 0.049 |
| output loss ( $\tau=1$ )                | 0.66     | 0.016      | 0.036 |

Notes: The table shows estimates from our benchmark model with identical firms. The parameter  $\alpha$  is the standard parameter on labor from the production function. The parameter  $\tau$  captures the extent to which predation is a transfer to the criminal, under  $\tau=1$  all predation losses for the firm are gains for the criminal. The only loss from crime is then generated by security spending.

Table 3: Policy Experiment - Adoption of Chinese Protection Parameters

|                       | (1)                        | (2)                                     | (3)                                    |                | (1)                        | (2)                                     | (3)                                    |
|-----------------------|----------------------------|---|--|----------------|----------------------------|---|--|
| country               | estimated change in output | estimated change in output (protection) | estimated change in output (predation) | country        | estimated change in output | estimated change in output (protection) | estimated change in output (predation) |
| Lesotho               | 12.98%                     | 4.46%                                   | 8.52%                                  | Tajikistan     | 1.88%                      | 2.30%                                   | -0.42%                                 |
| Central Afr. Republic | 11.24%                     | 6.74%                                   | 4.50%                                  | North Sudan    | 1.86%                      | 2.18%                                   | -0.33%                                 |
| Malawi                | 9.60%                      | 5.58%                                   | 4.02%                                  | Mauritius      | 1.82%                      | 1.40%                                   | 0.42%                                  |
| Sierra Leone          | 7.73%                      | 6.28%                                   | 1.45%                                  | Botswana       | 1.79%                      | 0.58%                                   | 1.21%                                  |
| Afghanistan           | 4.58%                      | 2.33%                                   | 2.25%                                  | El Salvador    | 1.69%                      | 1.14%                                   | 0.54%                                  |
| Zambia                | 4.45%                      | 2.73%                                   | 1.72%                                  | Russia         | 1.63%                      | 1.36%                                   | 0.27%                                  |
| Angola                | 4.44%                      | 4.41%                                   | 0.02%                                  | Azerbaijan     | 1.59%                      | 2.15%                                   | -0.56%                                 |
| Honduras              | 4.43%                      | 2.92%                                   | 1.51%                                  | Tanzania       | 1.53%                      | 1.39%                                   | 0.14%                                  |
| Cambodia              | 4.38%                      | 4.33%                                   | 0.05%                                  | Moldova        | 1.36%                      | 1.59%                                   | -0.23%                                 |
| Gambia, The           | 3.96%                      | 3.28%                                   | 0.69%                                  | Ukraine        | 1.35%                      | 1.32%                                   | 0.03%                                  |
| Burkina Faso          | 3.90%                      | 4.42%                                   | -0.52%                                 | Brazil         | 1.31%                      | 1.09%                                   | 0.22%                                  |
| Congo, Dem. Rep.      | 3.79%                      | 3.35%                                   | 0.44%                                  | Swaziland      | 1.28%                      | 0.63%                                   | 0.65%                                  |
| Liberia               | 3.64%                      | 2.25%                                   | 1.38%                                  | Kazakhstan     | 1.23%                      | 1.24%                                   | -0.01%                                 |
| Mexico                | 3.44%                      | 1.09%                                   | 2.35%                                  | Mongolia       | 1.21%                      | 1.13%                                   | 0.07%                                  |
| Cameroon              | 3.35%                      | 2.43%                                   | 0.92%                                  | Macedonia, FYR | 1.20%                      | 1.06%                                   | 0.14%                                  |
| Congo, Rep.           | 3.25%                      | 2.66%                                   | 0.59%                                  | Zimbabwe       | 1.05%                      | 1.04%                                   | 0.01%                                  |
| Cote d'Ivoire         | 3.09%                      | 1.97%                                   | 1.12%                                  | Ghana          | 1.03%                      | 1.24%                                   | -0.21%                                 |
| Timor-Leste           | 3.08%                      | 2.15%                                   | 0.92%                                  | Sri Lanka      | 1.03%                      | 0.87%                                   | 0.16%                                  |
| Chad                  | 2.97%                      | 1.76%                                   | 1.21%                                  | Togo           | 1.01%                      | 0.77%                                   | 0.24%                                  |
| South Sudan           | 2.88%                      | 1.81%                                   | 1.06%                                  | Serbia         | 1.00%                      | 0.48%                                   | 0.53%                                  |
| Kosovo                | 2.77%                      | 3.20%                                   | -0.44%                                 | Romania        | 0.96%                      | 0.98%                                   | -0.02%                                 |
| Ecuador               | 2.51%                      | 1.73%                                   | 0.78%                                  | Madagascar     | 0.95%                      | 0.94%                                   | 0.02%                                  |
| Philippines           | 2.33%                      | 1.74%                                   | 0.59%                                  | Guyana         | 0.91%                      | 0.92%                                   | -0.02%                                 |
| Venezuela             | 2.30%                      | 2.16%                                   | 0.14%                                  | Panama         | 0.86%                      | 0.79%                                   | 0.08%                                  |
| Kenya                 | 2.21%                      | 1.52%                                   | 0.69%                                  | Turkey         | 0.80%                      | 1.06%                                   | -0.26%                                 |
| Dominican Republic    | 2.19%                      | 1.97%                                   | 0.23%                                  | Malaysia       | 0.79%                      | 0.82%                                   | -0.03%                                 |
| Guatemala             | 2.18%                      | 1.45%                                   | 0.73%                                  | South Africa   | 0.77%                      | 0.38%                                   | 0.40%                                  |
| Mozambique            | 2.18%                      | 1.41%                                   | 0.77%                                  | Estonia        | 0.75%                      | 0.66%                                   | 0.09%                                  |
| Guinea                | 2.07%                      | 1.99%                                   | 0.08%                                  | Pakistan       | 0.75%                      | 1.12%                                   | -0.37%                                 |
| Namibia               | 2.06%                      | 1.65%                                   | 0.41%                                  | Bolivia        | 0.72%                      | 0.44%                                   | 0.27%                                  |
| Nigeria               | 1.97%                      | 2.31%                                   | -0.34%                                 | Czech Republic | 0.63%                      | 0.54%                                   | 0.09%                                  |
| Uganda                | 1.96%                      | 2.01%                                   | -0.05%                                 | Argentina      | 0.59%                      | 0.23%                                   | 0.35%                                  |
| Paraguay              | 1.91%                      | 1.83%                                   | 0.08%                                  | Slovenia       | -0.49%                     | -0.17%                                  | -0.32%                                 |
| Rwanda                | 1.91%                      | 2.26%                                   | -0.35%                                 | Jordan         | -0.60%                     | -0.32%                                  | -0.28%                                 |
| Nicaragua             | 1.90%                      | 1.61%                                   | 0.29%                                  | Eritrea        | -1.63%                     | -0.50%                                  | -1.13%                                 |
| Kyrgyzstan            | 1.89%                      | 1.80%                                   | 0.09%                                  |                |                            |   |  |
| Average in column:    | 3.76%                      | 2.71%                                   | 1.05%                                  |                | 0.99%                      | 0.94%                                   | 0.05%                                  |

Notes: Change in output is calculated by replacing the gamma and protection elasticity in each firm by a random draw from the Chinese parameter values for firms of similar relative productivity (50 categories). We do this repeatedly (500 iterations) and report the mean of those countries whose mean change in output is larger in absolute terms than 1.65 the standard deviations of the change in output. "Change in output (protection)" uses the assumption  $\tau=1$  to estimate the loss just from the distortions caused by protection. "Change in output (predation)" is the difference between the first two columns and captures the output change that derives from just predation. We drop countries and territories with less than 1 million inhabitants and less than 100 interviewed firms.

Table 4: Estimated Output Loss and Employment Loss by Sector

*Panel A: countries least affected by crime*

| sector        | losses due to predation | spending on security | average output loss | average employment loss |
|---------------|-------------------------|----------------------|---------------------|-------------------------|
| Primary       | 0.18%                   | 0.71%                | 0.52%               | 0.76%                   |
| Manufacturing | 0.20%                   | 0.66%                | 0.67%               | 1.51%                   |
| Services      | 0.31%                   | 0.64%                | 0.75%               | 1.77%                   |
| Construction  | 0.37%                   | 0.73%                | 0.60%               | 2.18%                   |

*Panel B: countries most affected by crime*

| sector        | losses due to predation | spending on security | average output loss | average employment loss |
|---------------|-------------------------|----------------------|---------------------|-------------------------|
| Primary       | 3.78%                   | 4.06%                | 6.41%               | 9.96%                   |
| Manufacturing | 2.04%                   | 3.19%                | 5.11%               | 11.75%                  |
| Services      | 1.78%                   | 3.30%                | 5.52%               | 13.46%                  |
| Construction  | 2.22%                   | 4.52%                | 6.87%               | 26.45%                  |

Notes: "Losses due to predation" and "spending on security" are relative to sales. Other numbers are relative to output and employment in that sector respectively. "Countries least affected by crime" are countries in the quartile with the lowest estimated output loss. "Countries most affected by crime are countries" in the quartile with the highest estimated output loss. Calculations assume  $\alpha=0.322$  for the primary sector,  $\alpha=0.551$  for manufacturing,  $\alpha=0.575$  for services and  $\alpha=0.724$  for construction.

Table 5: Policy Experiment - Adoption of Chinese Protection Parameters in Construction

| country                | estimated change in output in the construction sector | country        | estimated change in output in the construction sector |
|------------------------|---|----------------|---|
| Togo                   | 32.79%  | Czech Republic | 2.13%   |
| Senegal                | 30.78%  | Albania        | 2.01%   |
| Zambia                 | 20.98%  | Argentina      | 1.93%   |
| Cambodia               | 13.99%  | Germany        | 1.93%   |
| Botswana               | 10.19%  | Russia         | 1.90%   |
| Nicaragua              | 9.75%   | Timor-Leste    | 1.72%   |
| Namibia                | 8.46%   | Moldova        | 1.68%   |
| Mauritius              | 7.34%   | Paraguay       | 1.58%   |
| El Salvador            | 7.19%   | Estonia        | 1.56%   |
| South Sudan            | 6.96%   | Macedonia, FYR | 1.39%   |
| Congo, Dem. Rep.       | 6.40%   | Armenia        | 1.32%   |
| Madagascar             | 6.04%   | Belarus        | 1.32%   |
| Burkina Faso           | 5.58%   | Mongolia       | 1.24%   |
| Kyrgyzstan             | 5.57%   | Romania        | 1.18%   |
| Brazil                 | 4.14%   | Bulgaria       | 1.16%   |
| Tunisia                | 4.05%   | Lithuania      | 1.15%   |
| Colombia               | 3.37%   | India          | 1.09%   |
| Kosovo                 | 3.31%   | Ethiopia       | 1.00%   |
| Bolivia                | 3.11%   | Poland         | 0.86%   |
| Nigeria                | 2.94%   | Lao PDR        | 0.82%   |
| Ukraine                | 2.89%   | Ghana          | 0.81%   |
| Ecuador                | 2.84%   | Spain          | -1.09%  |
| Tajikistan             | 2.66%   | Israel         | -1.57%  |
| Mali                   | 2.56%   | Lebanon        | -1.58%  |
| Bosnia and Herzegovina | 2.48%   | Sweden         | -1.81%  |
| Azerbaijan             | 2.21%   | Afghanistan    | -2.26%  |
| Kazakhstan             | 2.17%   | Mexico         | -4.07%  |
| Average in column:     | 7.81%   |                | 0.64%   |

Note: Change in output is calculated by replacing the gamma and protection elasticity in each firm by a random draw from the Chinese parameter values for firms in the construction sector. We do this repeatedly (500 iterations) and report the mean for those countries whose mean change in output is larger in absolute terms than 1.65 the standard deviations of the change in output. We drop countries and territories with less than 1 million inhabitants and less than 20 interviewed firms in construction.

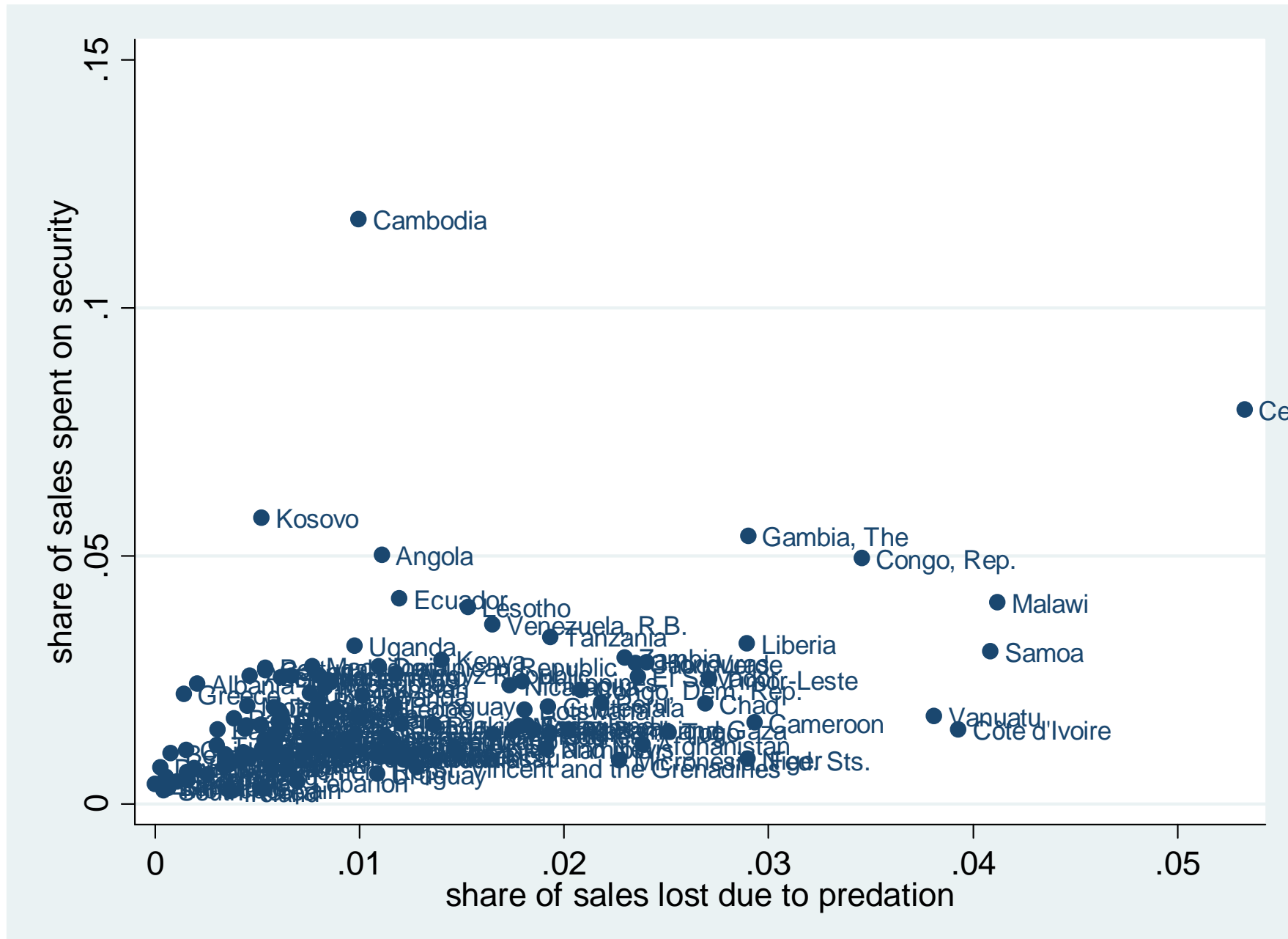
Table 6: Crime and Firm Growth

| VARIABLES                        | (1)<br>firm purchased asset | (2)<br>firm purchased fixed asset | (3)<br>ln(fixed asset expenditure) |
|----------------------------------|-----------------------------|-----------------------------------|------------------------------------|
| perceived protection             | 0.0160***<br>(0.00403)      | 0.00633*<br>(0.00378)             | 0.0950***<br>(0.0333)              |
| protection effort elasticity     | 0.0344***<br>(0.00429)      | 0.00617<br>(0.00383)              | 0.163***<br>(0.0305)               |
| firm productivity decile dummies | yes                         | yes                               | yes                                |
| country/year fixed effects       | yes                         | yes                               | yes                                |
| sector fixed effect              | yes                         | yes                               | yes                                |
| Observations                     | 121,802                     | 72,941                            | 55,467                             |
| R-squared                        | 0.244                       | 0.397                             | 0.751                              |

Robust standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. All estimates assume  $\alpha=0.66$ . "perceived protection" is the estimate of the epsilon parameter. "protection effort elasticity" is the estimate of the  $\gamma$  parameter. Both variables are weighted by their standard error.

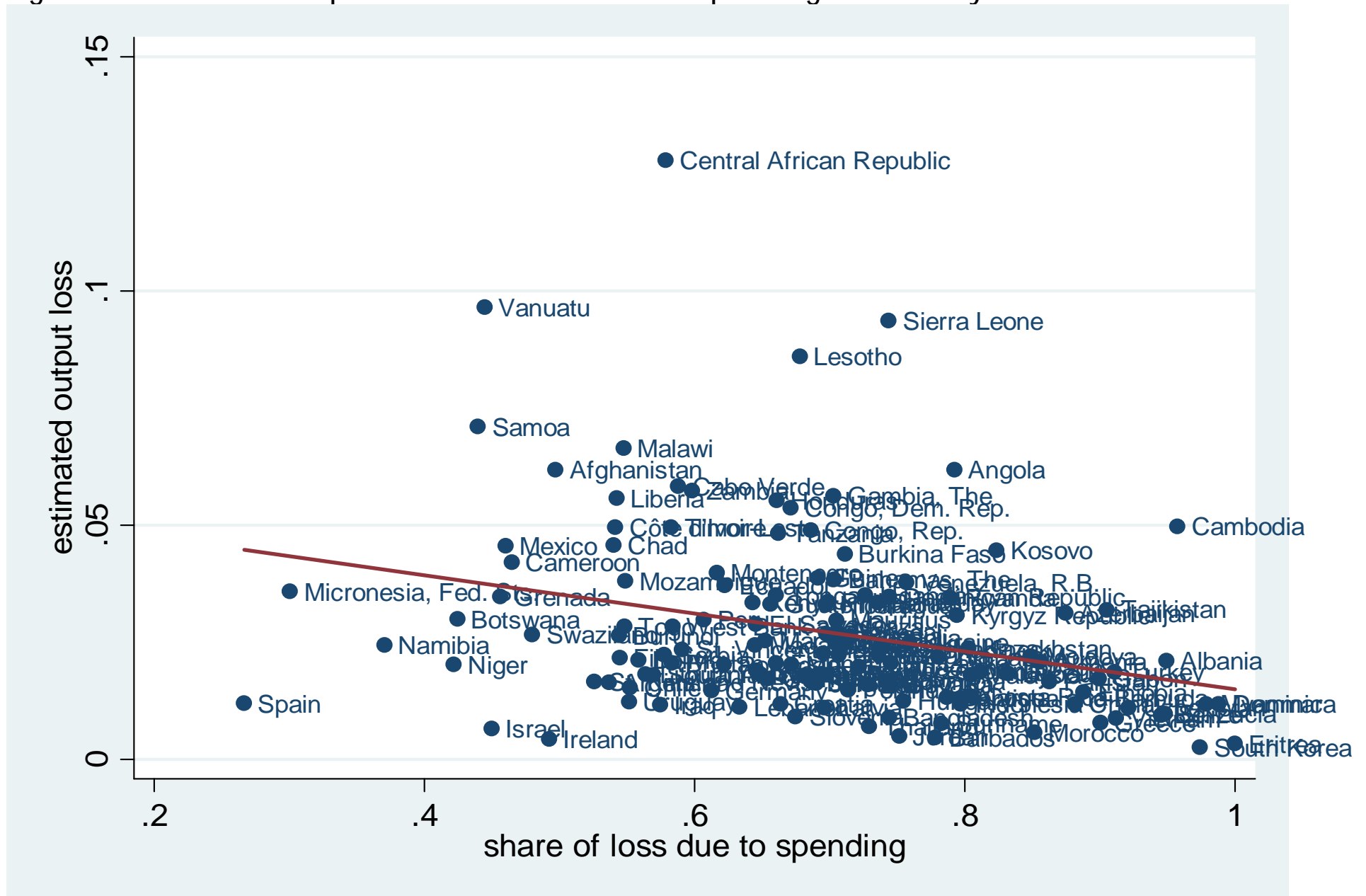


Figure 1: Country Averages of Predation Loss and Security Spending



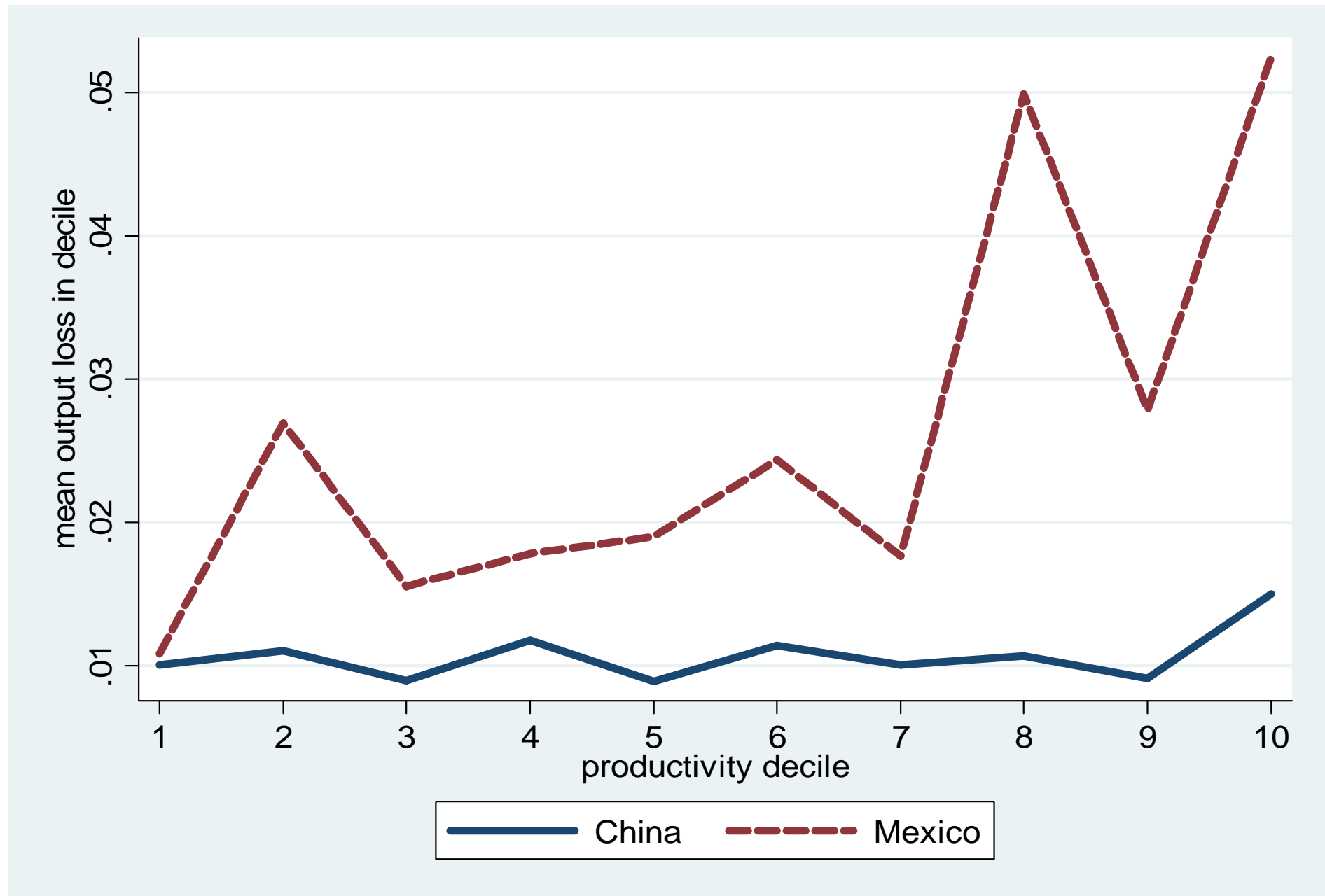
Notes: Figure shows simple mean values for the responses to two survey questions. We first calculate the weighted mean for every country/year using the survey weights. This is close to what the World Bank reports. The Figure displays the mean value for each country across years.

Figure 2: Estimated Output Loss and Share due to Spending on Security



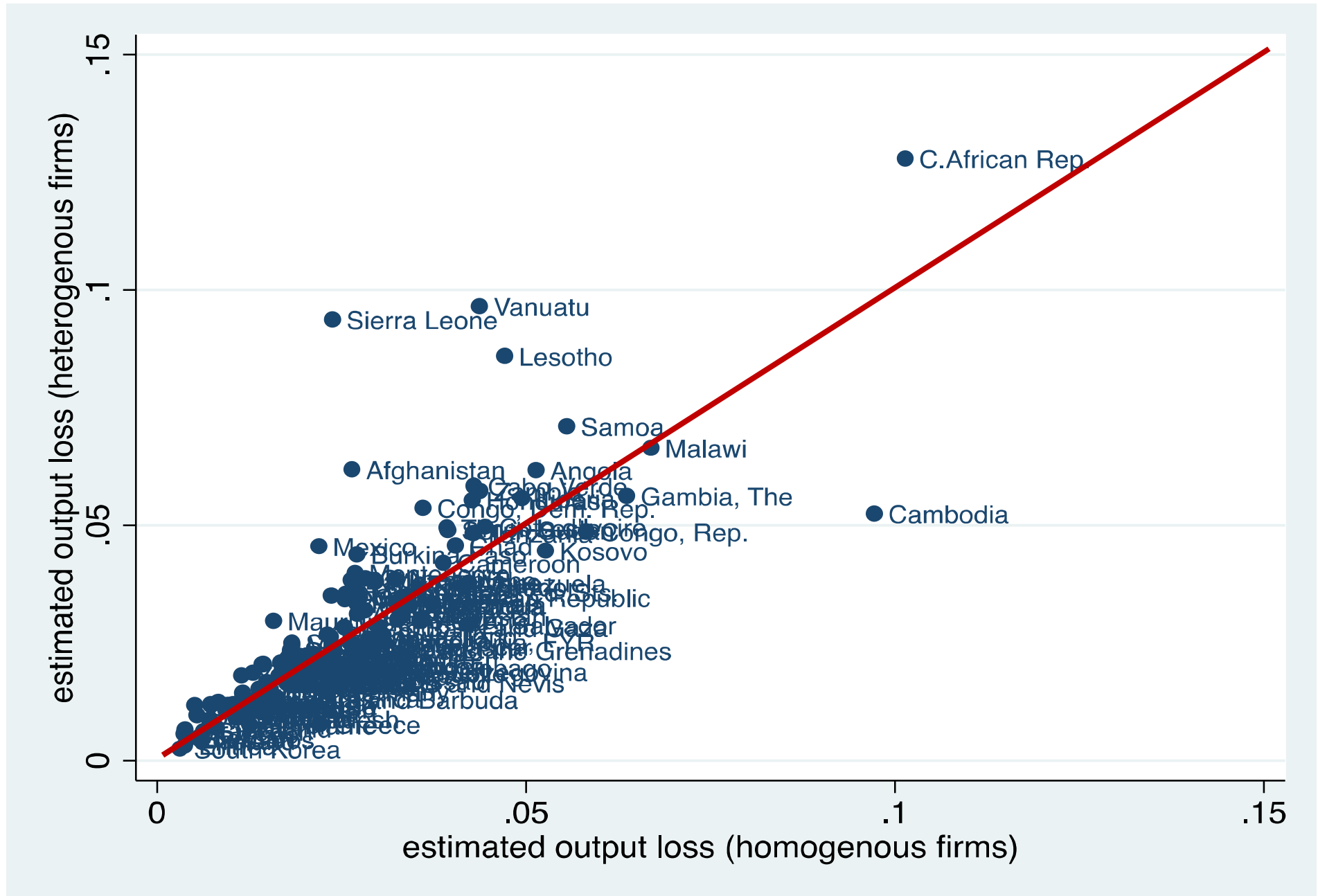
Notes: Figure contrasts two ways of calculating the output,  $\Delta c$ , from equation (12). The overall loss is calculated under the assumption that all predation constitutes a loss ( $\tau=0$ ). The loss due to spending is calculated by assuming that all predation is an efficient transfer ( $\tau=1$ ). The y-axis displays the first value, the x-axis displays the second value divided by the first value.

Figure 3: Estimated Loss by Firm Productivity Deciles



Notes: Figure shows the output loss,  $\Delta c$ , from equation (12) calculated by productivity decile, i.e. each point represents one tenth of the firms in the respective sample ordered by our estimate of  $\theta/\theta$ .

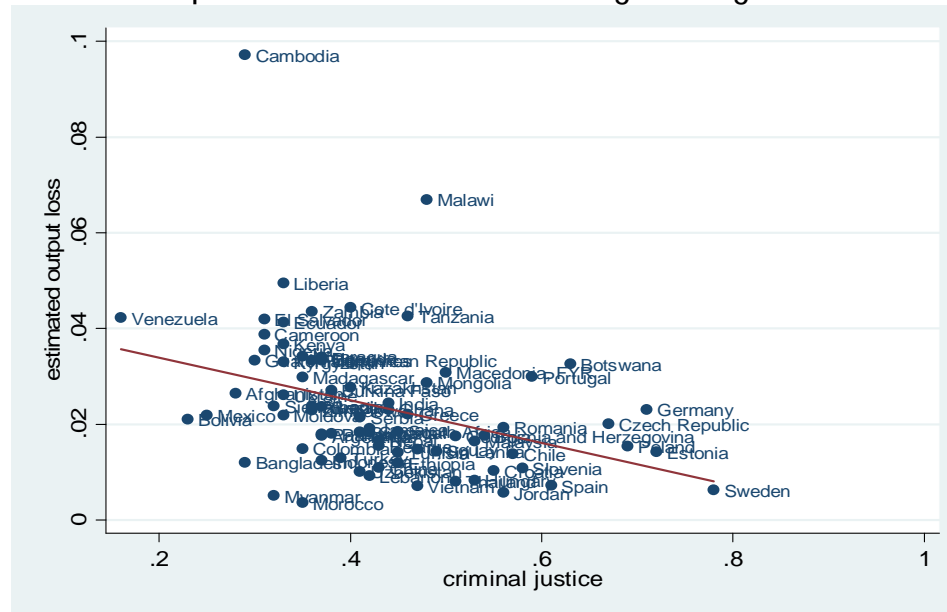
Figure 4: Introducing Productivity Weights



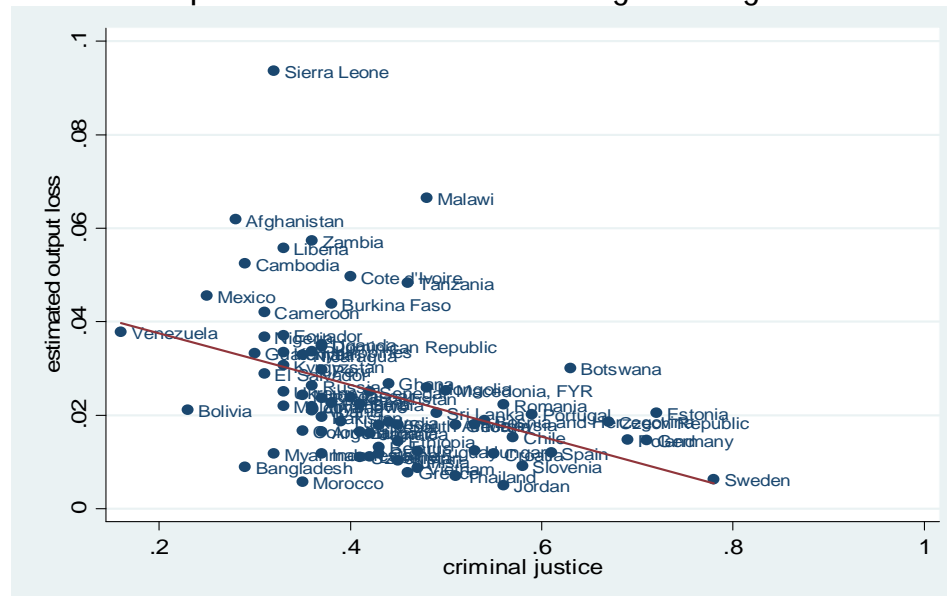
Notes: Figure contrasts the output loss,  $\Delta c$ , from equation (12) on the x-axis with the output loss,  $\Delta c$ , from equation (13). In each case we first calculate the output loss for each country/year and then take the mean value for the respective country. The red line represents the points at which the two losses are the same.

Figure 5: Estimated Output Loss and State Action

Panel A: Output Loss Estimated Assuming Homogenous Firms

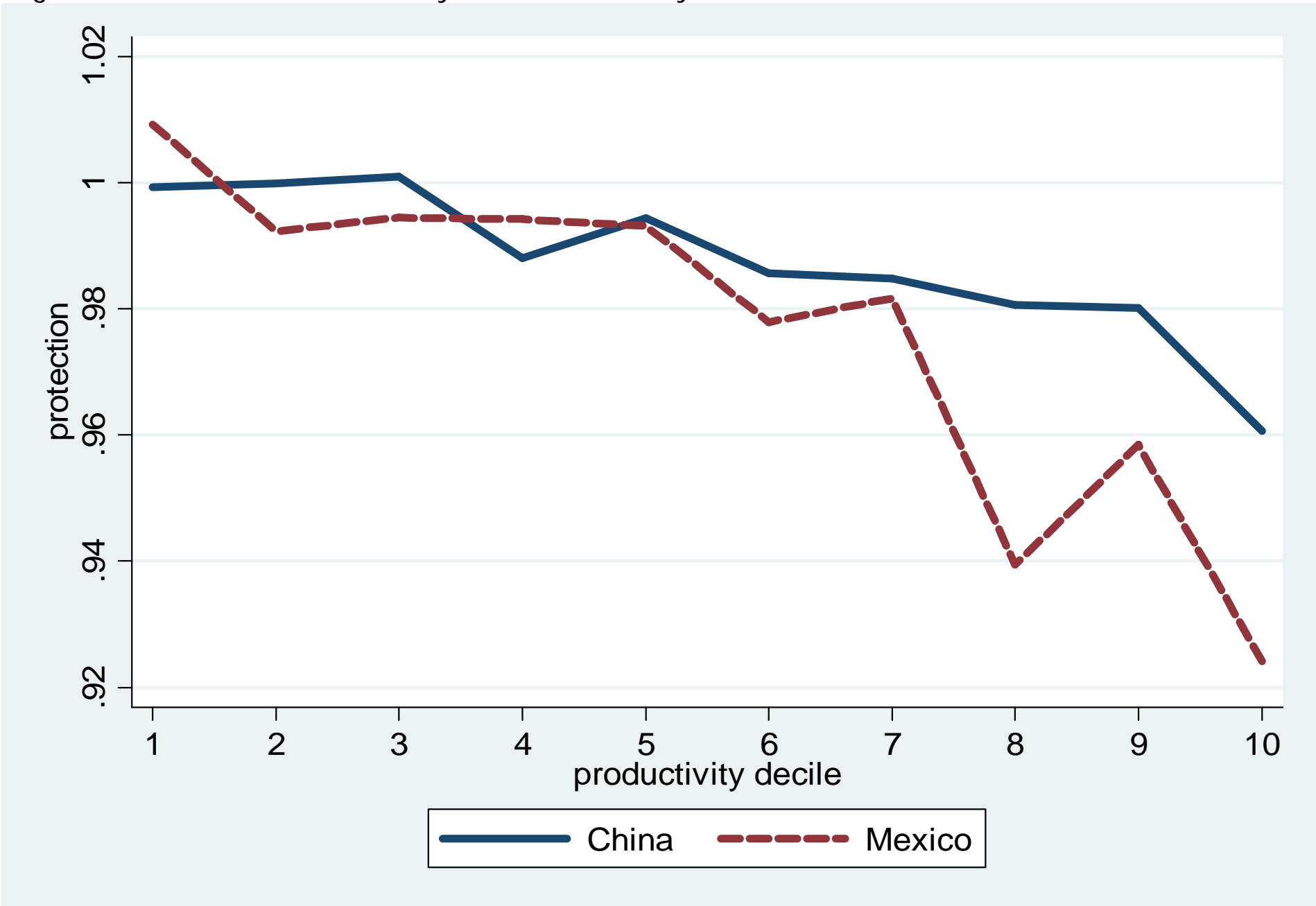


Panel B: Output Loss Estimated Assuming Heterogenous Firms



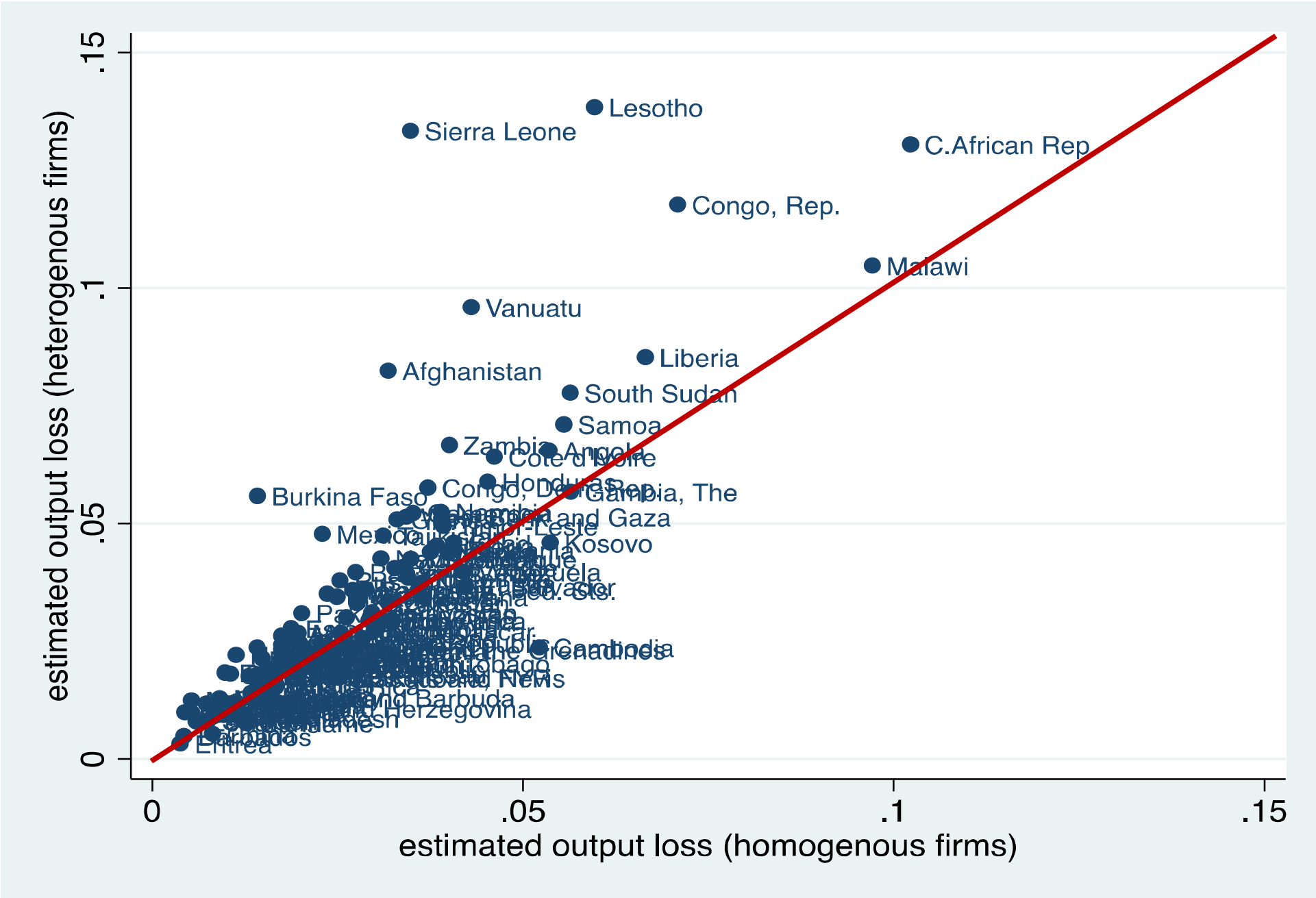
Notes: Panel A shows the output loss,  $\Delta c$ , from equation (12) and Panel B shows the output loss,  $\Delta c$ , from equation (13). This is contrasted with the World Justice project index which measures the effectiveness of the criminal justice system on a scale between 0 and 1.

Figure 6: Protection Estimates by Firm Productivity Deciles



Notes: The Figure displays the average value of  $\epsilon$  from equation (15) by productivity decile, i.e. each point represents one tenth of the firms in the respective sample ordered by our estimate of  $\theta/\theta$ .

Figure 7: Adding Predation During Transport



Notes: Figure contrasts the output loss from equation (12) on the x-axis with the output loss from equation (13). The only difference to Figure 4 is that we add predation losses due to theft in transit or export. For details see section 8 in the main text.

# Appendix

## A Data Description

**Enterprise Survey Data** We use data base on Enterprise Survey of the World Bank Group for the period 2002-2014 . Details on the methodology and data collection are available at <http://www.enterprisesurveys.org/methodology>. The data are collected on behalf of the World Bank by private contractors since they asked a range of sensitive questions and respondents are assured of confidentiality. The survey is answered by business owners and top managers with 1200-1800 interviewed in larger economies, 360 interviews are conducted in medium-sized economies, and for smaller economies, 150 interviews take place. The aim is to cover both the manufacturing and services sectors. Formal (registered) companies with 5 or more employees are targeted for interview. Services firms include construction, retail, wholesale, hotels, restaurants, transport, storage, communications, and IT. Firms with 100% government/state ownership are excluded. Most of the coverage is in the cities/regions of major economic activity.

There are two main instruments: one for manufacturing and one for services. The standard survey includes firm characteristics, gender participation, access to finance, annual sales, costs of inputs/labor, workforce composition, bribery, licensing, infrastructure, trade, crime, competition, capacity utilization, land and permits, taxation, informality, business-government relations, innovation and technology, and performance measures. The data are collected in face-to-face interviews.

We merge two standardize data sets, the Standardized data for 2002-2005 and the Standardized data 2006-2014. We describe the construction of the variables for each of the two periods.

For the 2002-2005 period, Security Costs as percentage of sales (SCAS) is computed as the sum of two variables, namely, Cost of providing security as percentage of sales and Cost of providing protection payments as percentage of sales. Loss due to theft, robbery, vandalism or arson as a percentage of sales (LDTV) is directly reported in the data set. For the 2005-2014 period, respondents indicate either the absolute amount, which one can use to compute as percentage of total sales, or directly the amount as percentage of total annual sales. SCAS and LDTV are the two type of answers combined. We disregard observed loss shares or security costs above 100% of total sales. By doing it, we lose 46 observations for LDTV and 104 observations for SCAS.

The number of employees is constructed as the sum of permanent employees and temporary employees adjusted by the average length of employment of temporary workers. Finally, capital is computed as the sum of the net book value of machinery and equipment and the net book value of land and buildings. In most of our analysis we only use observations with data on all three variables which gives us 142,315 observations of originally 183,451 observations.

For 2002-2005, Sector is constructed from the variable industry which specifies the sector of activity. We divide sector into four; primary sector which includes mining, manufacturing, services, and construction. For 2006-2014, data set includes information about the industry accordingly to the two-digit ISIC Rev 3.1. We use the ISIC digits 1-14 as primary sector including mining, digits 15-37 as manufacturing, the digits 40-44 and 46-99 as services, and 45 as construction. The web site for the surveys



(<http://www.enterprisesurveys.org/Methodology>) describes the sample process as follows:

“The sampling methodology for Enterprise Surveys is stratified random sampling. In a simple random sample, all members of the population have the same probability of being selected and no weighting of the observations is necessary. In a stratified random sample, all population units are grouped within homogeneous groups and simple random samples are selected within each group. This method allows computing estimates for each of the strata with a specified level of precision while population estimates can also be estimated by properly weighting individual observations. The sampling weights take care of the varying probabilities of selection across different strata. Under certain conditions, estimates’ precision under stratified random sampling will be higher than under simple random sampling (lower standard errors may result from the estimation procedure). The strata for Enterprise Surveys are firm size, business sector, and geographic region within a country. Firm size levels are 5-19 (small), 20-99 (medium), and 100+ employees (large-sized firms). Since in most economies, the majority of firms are small and medium-sized, Enterprise Surveys oversample large firms since larger firms tend to be engines of job creation. Sector breakdown is usually manufacturing, retail, and other services. For larger economies, specific manufacturing sub-sectors are selected as additional strata on the basis of employment, value-added, and total number of establishments figures. Geographic regions within a country are selected based on which cities/regions collectively contain the majority of economic activity. Ideally the survey sample frame is derived from the universe of eligible firms obtained from the country’s statistical office. Sometimes the master list of firms is obtained from other government agencies such as tax or business licensing authorities. In some cases, the list of firms is obtained from business associations or marketing databases. In a few cases, the sample frame is created via block enumeration, where the World Bank “manually” constructs a list of eligible firms after 1) partitioning a country’s cities of major economic activity into clusters and blocks, 2) randomly selecting a subset of blocks which will then be enumerated. In surveys conducted since 2005-06, survey documentation which explains the source of the sample frame and any special circumstances encountered during survey fieldwork are included with the collected datasets.”

The survey weights play an important role in our analysis. If weights are not given (this is the case for about 30,000 observations from the 2002-2005 data) we give a weight of  $w_t=1$  to the observation which is below the mean of 37.7. In all calculations we first aggregate by country/year and then calculate means across years of the same country to get to the country values.

**World Justice Project Data** The website of the World Justice Project describes the construction of the index as follows. *"An effective criminal justice system is a key aspect of the rule of law, as it constitutes the natural mechanism to redress grievances and bring*

*action against individuals for offenses against society. An effective criminal justice system is capable of investigating and adjudicating criminal offences effectively, impartially, and without improper influence, while ensuring that the rights of suspects and victims are protected."*

The index consists of 97 variables combined to form the following seven sub-factors: criminal investigation system is effective, criminal adjudication system is timely and effective, correctional system is effective in reducing criminal behavior, criminal justice system is impartial, criminal justice system is free of corruption, criminal justice system is free of improper government influence, due process of law and rights of the accused, effective investigations, timely and effective adjudication, effective correctional system, no discrimination, no corruption, no improper government influence, due process of law. We use the aggregate score from 2013.

**Prison Population Data** Data on prison populations is from International Centre for Prison Studies. The purpose of the centre is to conduct research into prisons and imprisonment; to develop and disseminate a body of knowledge about the principles on which the use of imprisonment should be based; and to inform improvements in prison policies and practice, within a human rights framework. It collects data on prison population and its composition for a wide range of countries in its *World Prison Brief*. We use the latest data on prison population rate (per 100,000 of national population) - downloaded May 2015.

**Penn World Table Data** We also use data on Penn World Tables 8.0 from 2002 onwards. Particularly we use data on employment and population from the data and merge by country/year to countries in our sample. For survey data in 2014 we use data from the previous year. Details about this data can be found in Appendix B of Inklaar and Timmer (2013).

## **B Protection by Organized Criminals**

In countries with weak law and order, criminal networks can attract surplus from firms by offering protection, e.g. charging firms to desist from predation. We now show how this can be brought into the framework and its implications for the measurement of output loss and the misallocation of labor.

To approach this consider a situation where firm  $i$ 's protection depends on their own protection effort  $e_i$  and the protection of organized criminals  $c_i$ . We will suppose that the predation loss is now:

$$p(e_i + \psi_i c_i, g)$$

where  $\psi_i$  is a parameter which determines whether organized crime is more or less effective in reducing predation. In our base line  $\psi_i = 0$  for all firms. If  $\psi_i > 1$ , then we will see that organized protection is relevant. In the data, we do not observe  $\psi_i$  or  $c_i$ . Let the firm's profit with organized protection  $c_i$  be

$$\Pi^i(c_i) = \arg \max_{(e,l)} p(e + \psi_i c_i, g) \theta_i (l - e) - wl$$

We will assume that the firm bargains with organized criminals over  $c_i$  and pays a transfer  $T^i(c_i)$  which can be thought of as a "payment" for protection  $c_i$ . We consider the simplest bargaining model where all of the surplus goes to the criminal network, i.e. a take or leave offer. Let  $\underline{\Pi}$  be the firm's "outside option" which could be  $c_i = 0$  or joining a competing criminal network to gain protection. Thus:

$$T^i(c_i) = \Pi(c_i) - \underline{\Pi}.$$

Now define  $\hat{c}_i$  from  $\psi_i p_e(\psi_i \hat{c}_i, g) \theta_i(l_i^*) = w$ . If organized criminals face the same labor market as firms, then

$$c_i^* = \arg \max_c [T^i(c) - wc] = \begin{cases} \hat{c}_i & \text{if } \psi_i > 1 \\ 0 & \text{otherwise.} \end{cases}$$

is the optimal protection by criminals. Thus, if  $\psi_i \leq 1$ , then we have the model exactly as above with all protection being by the firm. We think of this as the case where organized crime is ineffective. With  $\psi_i > 1$ , then there is no firm-based protection and all protection is through organized criminals. Moreover, since organized criminals are more efficient at protecting against crime when they are active, predation will be lower than when the firm does protection.

We now consider the implications of this for our estimates of the output cost. This will be an issue only in so far as there are firms for which  $\psi_i > 1$ . Assuming that protection costs to organized criminals are not reported by firms in the data, then we will observe firms

which do not spend on protection and yet have lower predation than otherwise. However, there is a cost to the economy due to the labor used in protection by criminal networks  $c_i^*$ . This reduces the stock of labor available for production and our estimate of the output cost based on the calculation above would be an underestimate of the true output cost. It is difficult to know by how much this is the case.<sup>1</sup> Credible quantitative data on organized crime across countries are hard to come by and so we cannot test this hypothesis explicitly. However, using mentions in Wikipedia we can show that, controlling for our institutional measure of criminal justice, firms in countries that are mentioned report systematically lower predation and protection losses. Although this awaits proper empirical testing, this is suggestive that our output measures which ignore organized crime would tend to be a lower bound on output losses.

## C Using Value Added as a Productivity Measure

In our baseline estimates, we calibrate productivity from firm size. We now assess how robust our measures of output loss are to using a value-added measure of productivity computed using information on sales and input cost data from the enterprise surveys. This has the advantage of giving a direct measure of productivity. However, it suffers the usual difficulty with residual-based measures of loading more measurement error into the productivity estimate. There are good reasons to think that number of employees is measured more accurately.

We begin by estimating measure of value-added for firm  $i$ ,  $VA_i$ , as the value of sales minus costs for raw materials and intermediate goods, electricity, generators and fuel. We then compute productivity and adjusted productivity as a function of  $\{l_i, \sigma_i, \mu_i\}$  as:

$$\theta_i = \frac{[1 + \mu_i] VA_i}{\left[\frac{\alpha}{\alpha + \sigma_i}\right]^\alpha l_i^\alpha} \text{ and } \hat{\theta}_i = \frac{VA_i}{l_i^\alpha}$$

As our measure of  $l_i$  we use total labor cost which should pick up both variation in the

---

<sup>1</sup>Another possibility is that firms report  $T^i(c_i^*)$  as part of the share of sales spent on protection. In this case, we would be including this in the calculation of the output cost but not correctly since all labor hired by the firm would be productive labor since guard protection is now being hired via organized crime. Moreover, the cost of protection would include any monopoly rent earned by the criminal network which could exceed the value of labor allocated to criminal network protection.

quantity and quality of labor input. However, our results are essentially the same if we use total employment to measure  $l_i$ .

We use these estimates of productivity and adjusted productivity to construct firm weights  $\theta_i/\Theta$  and  $\hat{\theta}_i/\hat{\Theta}$  to estimate output loss from equation (13). Reinforcing the point about the importance of measurement error using this method, we do find that there are sometimes very large productivity differences across firms which contain orders of magnitude. We therefore work with calculations which mitigate the influence of outliers on the estimates. We propose the following procedure. First, we exclude firms with negative  $VA_i$  and focus on the sample of countries where there are more than 500 firms included in the survey. Second, we calculate the mean level of productivity using two different methods: (i) excluding outliers that have more than 50 times the mean productivity level, (ii) including all firms. We then calculate the output loss measure as before.

Figure A3 illustrates the measures of output loss using these two different methods. It shows how the treatment of outliers matter for estimating the output loss. Kenya, for example is estimated to have an output loss of almost 20 percent if we do not exclude outliers using the rule that we have specified but only a little over 4 percent if we do. Another example is Ukraine which is estimated to have an output loss below 1 percent when outliers are excluded but is closer to 5 percent if they are included. In Figure A4 we focus on manufacturing and show that this apparent randomness due to outliers is mitigated although it does not disappear completely.

Pulling this together, Figure A5 shows that, if we restrict the comparison to firms in the same sector and remove outliers according to our specified rule, then the estimates of output loss using value added are quite close to the estimates using the firm-size based approach if we drop the same set of firms from both estimates. This is true both whether we look at the overall loss or the way that output loss is ranked across countries; the mean is around two to three percent in both cases and the rank correlation is 0.85. However, we do find that moving away from large, comparable samples the output loss measures look less similar. For example, were we to add countries with more than 300 firms in manufacturing, then the rank correlation of the two measures would fall to 0.68.

## D Patterns of Protection at the Firm Level

Table A2 reports some firm level regressions to explore correlates of perceived protection. In all regressions we include country/year fixed effects, sector fixed effects for four sectors

and dummy variables representing the decile of the productivity distribution that the firm is in. In columns (1) and (2), we relate  $\{\varepsilon^i(g), \gamma^i(g)\}$  to some subjective questions on the perception of crime at the firm level. We find that firms that expect more protection (higher  $\varepsilon^i(g)$ ) reduce the extent to which they report crime as an obstacle on a 0-4 scale and are less likely to say that crime is the worst obstacle the firm faces. Interestingly,  $\gamma^i(g)$  is negatively correlated with reports that crime is an obstacle. Thus despite experiencing higher losses due to spending on defence, the fact that a firm is able to defend against crime appears to make it less inclined to state that predation is an obstacle to doing business.

In column (3) of Table A2 we find that firms located in the capital city perceive that they are better protected from predation. This makes a lot of sense given that many state institutions are most robust in the capital cities of the developed countries. In column (4), the dependent variable is the protection effort elasticity  $\gamma^i(g)$ . Here, we find that state owned and foreign firms seem better able to defend against predation. The elasticity of defending against predation is lower in the capital city. This, together with the results in column (3), points to the possibility of some substitutability between public and private protection.

## E Simulation using the Chinese Protection Parameters

We run two simulation exercises in the paper. In section 7 we apply the Chinese protection parameters,  $\{\varepsilon^i(g), \gamma^i(g)\}$ , to firms in other countries within the same relative productivity. To do this, we divide all firms in each country into fifty equal-size groups based on their relative productivity,  $\frac{\theta_i}{\Theta_c}$ . We then draw values of  $\{\varepsilon^i(g), \gamma^i(g)\}$  at random from the observed distribution in each productivity group in China. Third, we impose these values on firms in the same productivity group in other countries in our data. For example, we sample values of  $\{\varepsilon^i(g), \gamma^i(g)\}$  for the least productive firms in China and then impose them on the least productive firms in Afghanistan. Specifically, we calculate

$$\frac{e_i}{l_i} = \frac{\gamma^i(g)}{\alpha + \gamma^i(g)}, l_i \approx L \left( \frac{\theta_i}{\Theta} \right)^{\frac{1}{1-\alpha}}$$

and the probability in equation (14). Note that the second equation is an approximation as we use  $\frac{\theta_i}{\Theta}$  to back out the counter-factual firm size with the Chinese parameters. Since

China is relatively close to the non-crime scenario this approximation has very little impact on the final loss estimate.<sup>2</sup> We then use the draws  $\{\varepsilon^i(g), \gamma^i(g)\}$  to calculate  $\frac{\hat{\theta}_i}{\hat{\Theta}}$  from

$$\frac{\hat{\theta}_{ic}}{\hat{\Theta}_c} = \frac{\frac{\theta_{ic}}{\Theta_c} \left[ \varepsilon^i(g) \left( l_i \frac{\alpha + \sigma_i}{\alpha} \right)^{\gamma^i(g)} \right]^{1-\alpha}}{\left( \sum \pi_i \left( \frac{\theta_{ic}}{\Theta_c} \left[ \varepsilon^i(g) \left( l_i \frac{\alpha + \sigma_i}{\alpha} \right)^{\gamma^i(g)} \right]^{1-\alpha} \right)^{\frac{1}{1-\alpha}} \right)^{1-\alpha}}$$

and replace the no-crime output in equation (13) by these new values. In this way we compare the output under the Chinese parameters with the actual output to calculate gains and losses.

Since some countries have quite small sample sizes we repeat this procedure five hundred times and calculate the mean and the standard deviation of the gains/losses in output as a form of "bootstrapping". We only report results if the gain or loss is larger than 1.65 times the standard deviation. Section 8 uses the same procedure except that we do not distinguish different productivity levels due to sample sizes being quite small. In that section, we also focus exclusively on the construction sector.

## F The Optimal Capital Stock in the Constant Elasticity Model

In this Appendix, we discuss the dependence of the capital stock on the parameters  $\{\varepsilon^i(g), \gamma^i(g)\}$  in the constant elasticity model. Let  $\{w, r\}$  be the factor prices for labor and capital respectively, then solving for the factor demands in this case yields:

$$l_i = \frac{\alpha \eta}{w} A \left( \theta_i p^i(e_i, g) \left( \frac{\sigma_i + \alpha}{\alpha} \right)^{1-\eta} \right)^{\frac{1}{1-\eta}}$$

and

$$k_i = \frac{(1-\alpha)\eta}{r} A \left( \theta_i p^i(e_i, g) \right)^{\frac{1}{1-\eta}} \quad (1)$$

---

<sup>2</sup>We verify this by comparing  $l_i/L$  to  $\left(\frac{\hat{\theta}_i}{\hat{\Theta}}\right)^{\frac{1}{1-\alpha}}$ .

where  $A = \left[ \left( \frac{\alpha\eta}{w} \right)^\alpha \left( \frac{(1-\alpha)\eta}{r} \right)^{1-\alpha} \right]^{\frac{\eta}{1-\eta}}$  is an economy-wide constant. In this case, observe that we have two dimensions to the productivity distortion. For capital  $\hat{\theta}_i^k = \theta_i p^i(e_i, g)$  which is decreasing in the share of output loss. For labor we have  $\hat{\theta}_i^l = \theta_i p^i(e_i, g) \left( \frac{\sigma_i + \alpha}{\alpha} \right)^{1-\eta}$  which is increasing in  $\sigma_i$ .<sup>3</sup> Notice that the adjustment in productivity has a general firm-specific part and a labor-specific part from the distortion in the labor market due to employing guard labor as security.

We now turn towards discussing how capital stock changes with the parameters  $\{\varepsilon^i(g), \gamma^i(g)\}$ . We start from equation (1) for the optimal capital stock which implies that if  $p^i(e_i, g)$  increases capital stock will increase. Looking at comparative statics, we need to allow for  $e_i$  to be endogenous.

Note that in the constant elasticity model we have

$$p^i(e, g) = \begin{cases} \varepsilon^i(g) \times e_i^{\gamma^i(g)} & \text{for } \varepsilon^i(g) \times e_i^{\gamma^i(g)} \leq 1 \\ 1 & \text{otherwise.} \end{cases}$$

We assume an interior solution for  $e_i$  which implies that if  $\varepsilon^i(g)$  increases then  $p^i(e_i, g)$  increases as long as  $e_i$  does not fall. Using the first order condition for the choice of  $e_i$ :

$$\frac{p_e^i(e_i, g)}{p_i(e_i, g)} = \frac{\eta\alpha}{l_i - e_i} = \frac{\gamma^i}{e_i}$$

which implies that  $e_i$  does not change with  $\varepsilon^i(g)$  for fixed  $l_i$  and that  $k_i$  is increasing in  $\varepsilon^i(g)$ .

The first order condition for firm's optimal labor supply is given by

$$\theta_i \frac{\alpha\eta}{w} p^i(e_i, g) \left[ (l_i - e_i)^\alpha k_i^{(1-\alpha)} \right]^\eta = l_i - e_i. \quad (2)$$

Substituting in (1) and using the constant elasticity formula for  $p^i(e_i, g)$ , substituting in

---

<sup>3</sup>Note that

$$\frac{l_i}{L} = \frac{\left[ \theta_i \frac{1}{1+\mu_i} \left( \frac{\sigma_i + \alpha}{\alpha} \right)^{1-\eta} \right]^{\frac{1}{1-\eta}}}{\sum_j \left[ \theta_j \frac{1}{1+\mu_j} \left( \frac{\sigma_j + \alpha}{\alpha} \right)^{1-\eta} \right]^{\frac{1}{1-\eta}}}.$$

Hence, as in the core model, adjusted firm-level productivity is reflected in labor shares.



$l_i - e_i$  from (2) and collecting terms we obtain:

$$\gamma^i(g) = e_i^{\frac{1-\eta-\gamma^i(g)}{1-\eta}} C_i$$

where  $C_i$  is a constant at the firm level. This implies that  $e_i$  is increasing in  $\gamma^i$  as long as  $\gamma^i + \eta < 1$ . Since  $p_i(e_i, g)$  is an increasing function of  $e_i$ , we can conclude that the optimal capital stock  $k_i$  is increasing in  $\gamma^i(g)$ .

## G Size of the Enterprise Sector

Here we show that if we assume that  $\omega$  is fixed, i.e. there is no general equilibrium response in the sector that is supplying labor to the formal enterprise sector, then a back-of-the-envelope calculation suggests that the output loss could be about double that which we estimated above. To formalize this point, let  $L^*$  be labor allocated to the enterprise sector without predation/protection and  $\hat{L}$  be the amount with predation/protection. Write output as:

$$Y^* = (L^*)^\alpha \Omega \text{ and } \hat{Y} = \hat{L}^\alpha \hat{\Omega}$$

where  $\Omega = \Theta \sum_i \pi_i \left(\frac{\theta_i}{\Theta}\right)^{\frac{1}{1-\alpha}}$  and  $\hat{\Omega} = \Theta \sum_i \pi_i \frac{\theta_i}{\Theta} \left[\tau + \frac{(1-\tau)}{1+\mu_i}\right] \left(\frac{\hat{\theta}_i}{\hat{\Theta}}\right)^{\frac{\alpha}{1-\alpha}} \left(\frac{\alpha}{\alpha+\sigma_i}\right)^\alpha$  using equations (9) and (10) in the main text. Now labor allocation to the enterprise sector will equate the marginal product of labor in the enterprise sector to the outside wage, i.e.

$$\omega = \alpha (L^*)^{\alpha-1} \Omega = \alpha \left(\hat{L}\right)^{\alpha-1} \hat{\Omega}.$$

From this we have an expression for the relative size of the labor force in the distorted and undistorted cases given by:

$$\frac{\hat{L}}{L^*} = \left(\frac{\hat{\Omega}}{\Omega}\right)^{\frac{1}{1-\alpha}}. \quad (3)$$

Now let  $M$  be the total workforce and denote aggregate productivity as  $Z \in \{\Omega, \hat{\Omega}\}$ . Then with  $\tau = 0$  we have that aggregate labor demand to the enterprise sector is:

$$L = \left(\frac{\alpha Z}{\omega}\right)^{\frac{1}{1-\alpha}} \quad (4)$$

and the level of national income is:

$$\begin{aligned} Y(Z) &= \omega M + L^\alpha Z - \omega L \\ &= \omega M + (1 - \alpha) Z^{\frac{1}{1-\alpha}} (\alpha/\omega)^{\frac{\alpha}{1-\alpha}} \end{aligned}$$

after using (4). Given the economy as specified here, this is the sum of labor earnings at the fixed wage,  $\omega$ , plus profit generated in the enterprise sector which we are implicitly assuming is the source of all profits. Our expression for the loss from predation/protection is now:

$$\begin{aligned} \Delta &= \frac{Y(\Omega) - Y(\hat{\Omega})}{Y(\Omega)} \\ &= \frac{\Omega^{\frac{1}{1-\alpha}} (1 - \alpha) \left(\frac{\alpha}{\omega}\right)^{\frac{\alpha}{1-\alpha}}}{(1 - \alpha) \Omega^{\frac{1}{1-\alpha}} \left(\frac{\alpha}{\omega}\right)^{\frac{\alpha}{1-\alpha}} + \omega M} \left[ 1 - \left(\frac{\hat{\Omega}}{\Omega}\right)^{\frac{1}{1-\alpha}} \right]. \end{aligned}$$

To give a back-of-the-envelope measure of this and its effect on our core output loss measures, we can estimate  $\frac{\Omega^{\frac{1}{1-\alpha}} (1-\alpha) \left(\frac{\alpha}{\omega}\right)^{\frac{\alpha}{1-\alpha}}}{(1-\alpha) \Omega^{\frac{1}{1-\alpha}} \left(\frac{\alpha}{\omega}\right)^{\frac{\alpha}{1-\alpha}} + \omega M}$  from the profit share in GDP. Putting this together, then to a first-order approximation, we have the following expression for the aggregate output loss as:

$$\Delta \simeq \frac{\alpha}{1 - \alpha} \left[ 1 - \left(\frac{\hat{\Omega}}{\Omega}\right) \right].$$

## H The Covariance between Firm-Size and Productivity

A popular way of looking at the extent of misallocation suggested by Bartelsman et al (2013) is through measuring the covariance between firm size and productivity. We now explore this approach exploiting the fact that we have direct measures of distortions to work with. For this purpose, we no longer use the constant elasticity specification but revert to general model of the protection technology.

As a preliminary step, we first check whether large firms are more or less heavily affected by predation/protection distortions by examining the covariance between firm size,  $\mu_i$  and  $\sigma_i$ . This is important in light of the discussion in section 7. Comparing the within-country covariance between firm size and  $\mu_i$  allows us to look at whether countries which are more heavily affected by predation are less likely to prevent predation in large firms. Thus the

covariance between firm size and  $\mu_i$  is positive and relatively high in Mexico, Afghanistan and Sierra Leone even though it is negative on average. But we can go one step further by looking at differences across sectors within the same country. Column (1) of Table A3 shows that, controlling for country fixed effects, the predation loss,  $\mu_{is}$ , is decreasing with firm size while protection spending  $\sigma_{is}$  is increasing with firm size. In other words, larger firms tend on average to lose a smaller share of their output to predation but hire more unproductive labor.

The covariance between firm size and productivity allows us to summarize these distortions. We look at two covariance measures suggested by the model. The covariance between labor productivity and firm size can be written as:

$$cov \left( \log \frac{y_{is}}{l_{is}}, \log \frac{l_{is}}{L_s} \right) = cov \left( \log \frac{w}{\alpha_s + \sigma_{is}}, \log \frac{l_{is}}{L_s} \right). \quad (5)$$

This formula reveals immediately that, in absence of other distortions, the covariance depends upon the relationship between  $\sigma_{is}$  and  $l_{is}$ .<sup>4</sup> If larger firms hire more labor for protection, we would expect the covariance in (5) to be lower, i.e. labor productivity would be a weaker predictor, all else equal, of the number of workers that a firm employs.

An alternative way to look at this is to use the covariance between firm size and overall firm productivity instead. In terms of our notation this covariance is

$$cov \left( \log \frac{\theta_{is}}{\Theta_s}, \log \frac{l_{is}}{L_s} \right) = cov \left( \log \frac{(1 + \mu_{is}) (l_{is})^{1-\alpha_s} \left( \frac{\alpha_s}{\alpha_s + \sigma_{is}} \right)^{1-\alpha_s}}{\Theta_s}, \log \frac{l_{is}}{L_s} \right) \quad (6)$$

where  $\Theta_s$  and  $L_s$  are fixed at the country/year/sector level. The covariance will depend mainly on the variance of firm size,  $l_{is}$ , within a sector. Firm level distortions have two opposing effects on our estimates of productivity through the term  $\frac{1}{(1+\mu_{is})} \left( \frac{\alpha_s + \sigma_{is}}{\alpha_s} \right)^{1-\alpha_s}$ . Predation losses,  $\mu_{is}$ , lower the optimal firm size while protection spending,  $\sigma_{is}$ , increases firm size by increasing the amount of labor that a firm hires. The change in the covariance induced by predation and protection will depend on whether such distortions are correlated with a firm's productivity.

---

<sup>4</sup>Note that in (5), the wage rate,  $w$  and sector labor shares  $L_s$  are fixed at the country/year/sector level.

We calculate the covariances in (5) and (6) within each sector/country/year under the assumption that the labor share,  $\alpha_s$ , varies by sector.<sup>5</sup> Two patterns are worth noting. First, both the median and mean covariance in (5) are negative. This implies that larger firms tend to protect themselves more. Second, the covariance in (6) decreases in  $\alpha_s$  as the formula suggests, i.e. more labor intensive sectors have a lower covariance. Thus, the covariance between firm productivity and firm size is higher in manufacturing than in construction.

Table A3 shows that a lower covariance between firm size and productivity in a sector is associated with a higher estimated loss of output due to predation. We would expect this if we regard predation as inducing a misallocation of labor across firms with heterogeneous productivity levels.<sup>6</sup> The pattern holds for the covariance in (5) as shown in columns (2) and (3) and for the covariance in (6) as shown in columns (4) and (5). The findings are robust to controlling for country/year and sector fixed effects and constitute an economically meaningful relationship; an increase of 4 percentage points in the output loss in column (3) is associated with a decrease of the covariance between labor productivity and firm size by one standard deviation.

The mechanism at work here is worth elaborating further. The negative covariance in columns (2) and (3) is driven by the fact that protection spending is positively correlated with firm size. This is not entirely surprising in our framework as it is protection which leads a firm to expand its level of employment. This negative relationship becomes more pronounced if we relate output losses to the covariance measure given by equation (6). If we use the constant elasticity model, we know that this is not due to the fact that large firms are better protected by the state but is due to the fact that they spend more on protection. This also highlights the importance of including endogenous firm protection effort in the analysis of the distortions caused by predation. Our finding that large firms are less protected in some countries, for example, is a direct consequence of having protection spending in the model – absent protection spending we would observe a lower level of the distortions due to predation for larger firms.

---

<sup>5</sup>We drop sector/country/years with less than 10 firms.

<sup>6</sup>In interpreting this, we should emphasise that we are only looking at the marginal misallocation that is being attributed to the distortion in the labor market due to predation. Our benchmark measure of  $\frac{\theta_i}{\bar{\theta}}$  takes any other sources of misallocation and/or productivity loss as given.

Hopenhayn (2014) suggests that for distortions to matter for TFP they must lead to rank reversals in the firm size distribution. The fact that we observe measures of the distortion allows us to look at this directly. To do this, we calculate Spearman's rank correlation coefficients between  $\frac{\theta_{ic}}{\Theta_c}$  and  $\frac{\hat{\theta}_{ic}}{\hat{\Theta}_c}$  and plot the result with our output loss estimate at the country level in Figure A9. There is a very strong negative relationship between our output loss measure and the rank correlation confirming the idea that the rank correlation is indeed a way of thinking about distortions which affect output losses.

## I Incentive Effects on Productivity

Suppose that

$$\theta_i = \frac{\underline{\theta}_i}{1 - \kappa} (I_i)^{1-\kappa}$$

where  $I_i$  is managerial effort whose cost is the wage. Then managerial effort maximizes:

$$\frac{\underline{\theta}_i}{1 - \kappa} (I_i)^{1-\kappa} \left[ (l_i)^\alpha \left( \frac{\alpha}{\alpha + \sigma_i} \right)^\alpha \frac{1}{1 + \mu_i} \right] - w [I_i + l_i].$$

The first order condition for such effort is

$$\underline{\theta}_i (I_i)^{-\kappa} \left[ (l_i)^\alpha \left( \frac{\alpha}{\alpha + \sigma_i} \right)^\alpha \frac{1}{1 + \mu_i} \right] = w,$$

where we have used the envelope condition for the choice of  $l_i$ . Combining this with (??) and (??) yields:

$$\underline{\theta}_i (I_i)^{-\kappa} \left[ \left( \frac{\alpha}{w} \frac{\underline{\theta}_i}{1 - \kappa} (I_i)^{1-\kappa} \frac{1}{1 + \mu_i} \left( \frac{\alpha}{\alpha + \sigma_i} \right)^{\alpha-1} \right)^{\frac{\alpha}{1-\alpha}} \left( \frac{\alpha}{\alpha + \sigma_i} \right)^\alpha \frac{1}{1 + \mu_i} \right] = w$$

Collecting terms

$$(\underline{\theta}_i)^{\frac{1}{1-\alpha}} \left( \frac{\alpha}{w(1-\kappa)} \right)^{\frac{\alpha}{1-\alpha}} (I_i)^{\frac{\alpha-\kappa}{1-\alpha}} \left( \frac{1}{1 + \mu_i} \right)^{\frac{1}{1-\alpha}} = w$$

This implies that

$$I_i^* = \text{constant}_i \times \left( \frac{1}{1 + \mu_i} \right)^{\frac{1}{\alpha-\kappa}}.$$

So higher  $\mu_i$  results in lower managerial effort if  $\alpha > \kappa$ . The relative productivity is scaled down by a factor:

$$\left( \frac{1}{1 + \mu_i} \right)^{\frac{1-\kappa}{\alpha-\kappa}}$$

which, given the parameter values supposed the exponent is approximately 1.96. This additional term can then be added to the calculations.

## References

- [1] Bartelsman, Eric, John Haltiwanger and Stefano Scarpetta, [2013], “Cross-Country Differences in Productivity,” *American Economic Review*, 305-334.
- [2] Hopenhayn, Hugo A., [2014], “On the Measure of Distortions,” typescript, UCLA.
- [3] Inklaar, Robert and Marcel Timmer, [2013] “Capital, Labor and TFP in PWT 8.0”.

Table A1: Estimated Output Loss and Homocide Rate

| VARIABLES                                 | (1)<br>estimated<br>output loss | (2)<br>estimated<br>output loss | (3)<br>estimated<br>output loss |
|---|---------------------------------|---------------------------------|---------------------------------|
| homocide rate<br>(per 100,000 population) | 31.38**<br>(14.93)              | 130.9**<br>(53.74)              | 135.8***<br>(48.56)             |
| country fixed effects                     | no                              | yes                             | yes                             |
| Observations                              | 167                             | 167                             | 256                             |
| R-squared                                 | 0.057                           | 0.103                           | 0.079                           |
| Number of countries                       |                                 | 86                              | 125                             |

Robust standard errors in parentheses. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

"estimated output loss" is estimated under the assumption of heterogenous firms. Column (3) expands the data on the homocide rate 3 years in the future and past to gain more matches to the enterprise survey data.

Table A2: Protection and Crime as an Obstacle

| VARIABLES                           | (1)<br>degree to which crime<br>is an obstacle (0-4) | (2)<br>crime is worst<br>obstacle | (3)<br>perceived<br>protection | (4)<br>protection effort<br>elasticity |
|-------------------------------------|--|-----------------------------------|--------------------------------|--|
| perceived protection                | -0.136***<br>(0.0104)                                | -0.0132***<br>(0.00294)           |                                |  |
| protection effort<br>elasticity     | -0.0335***<br>(0.0112)                               | -0.00715***<br>(0.00264)          |                                |  |
| foreign owned firm                  |  |                                   | 0.0135<br>(0.0132)             | 0.0267**<br>(0.0112)                   |
| state owned firm                    |  |                                   | -0.0348<br>(0.0213)            | 0.0480***<br>(0.0159)                  |
| firm in capital                     |  |                                   | 0.00578**<br>(0.00245)         | -0.00582**<br>(0.00237)                |
| firm productivity decile<br>dummies | yes  | yes                               | yes                            | yes                                    |
| country/year fixed<br>effects       | yes  | yes                               | yes                            | yes                                    |
| sector fixed effect                 | yes  | yes                               | yes                            | yes                                    |
| Observations                        | 139,032  | 95,070                            | 110,901                        | 110,901                                |
| R-squared                           | 0.248  | 0.088                             | 0.100                          | 0.099                                  |

Robust standard errors in parentheses. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . All estimates assume  $\alpha = 0.66$ . "perceived protection" is the estimate of the epsilon parameter. "protection effort elasticity" is the estimate of the gamma parameter. Both variables are weighted by their standard error.



Table A3: Covariance Between Firm Size and Productivity

| VARIABLES   | (1)<br>ln(firm size) | (2)<br>covariance<br>(size, output per<br>worker) | (3)<br>covariance<br>(size, output per<br>worker) | (4)<br>covariance<br>(size, firm<br>productivity) | (5)<br>covariance<br>(size, firm<br>productivity) |
|---|----------------------|---|---|---|---|
| loss due to theft, robbery,<br>vandalism or arson as a<br>percentage of total annual sale | -0.760***<br>(0.177) |   |   |   |   |
| percentage of total annual sales<br>paid for security                                     | 0.447***<br>(0.161)  |   |   |   |   |
| estimated output loss in sector   |                      | -0.204***<br>(0.0639)                             | -0.377***<br>(0.0580)                             | -1.905***<br>(0.573)                              | -2.269***<br>(0.737)                              |
| country/year/sector fixed effects   | yes                  | no  | no  | no  | no  |
| country/year fixed effect   | no                   | no  | yes   | no  | yes   |
| sector fixed effects  | no                   | no  | yes   | no  | yes   |
| Observations  | 141,093              | 774   | 774   | 774   | 774   |
| R-squared   | 0.232                | 0.117   | 0.614   | 0.016   | 0.665   |

Robust standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. "covariance (size, firm productivity)" is the covariance between log firm size and estimated log relative theta at the sector level. "covariance (size, output per worker)" is the covariance between log firm size and -log of spending on protection plus the sector labor share ( $\gamma+\alpha$ ).

Figure A1: Predation Loss and Spending on Security Across Firm Size

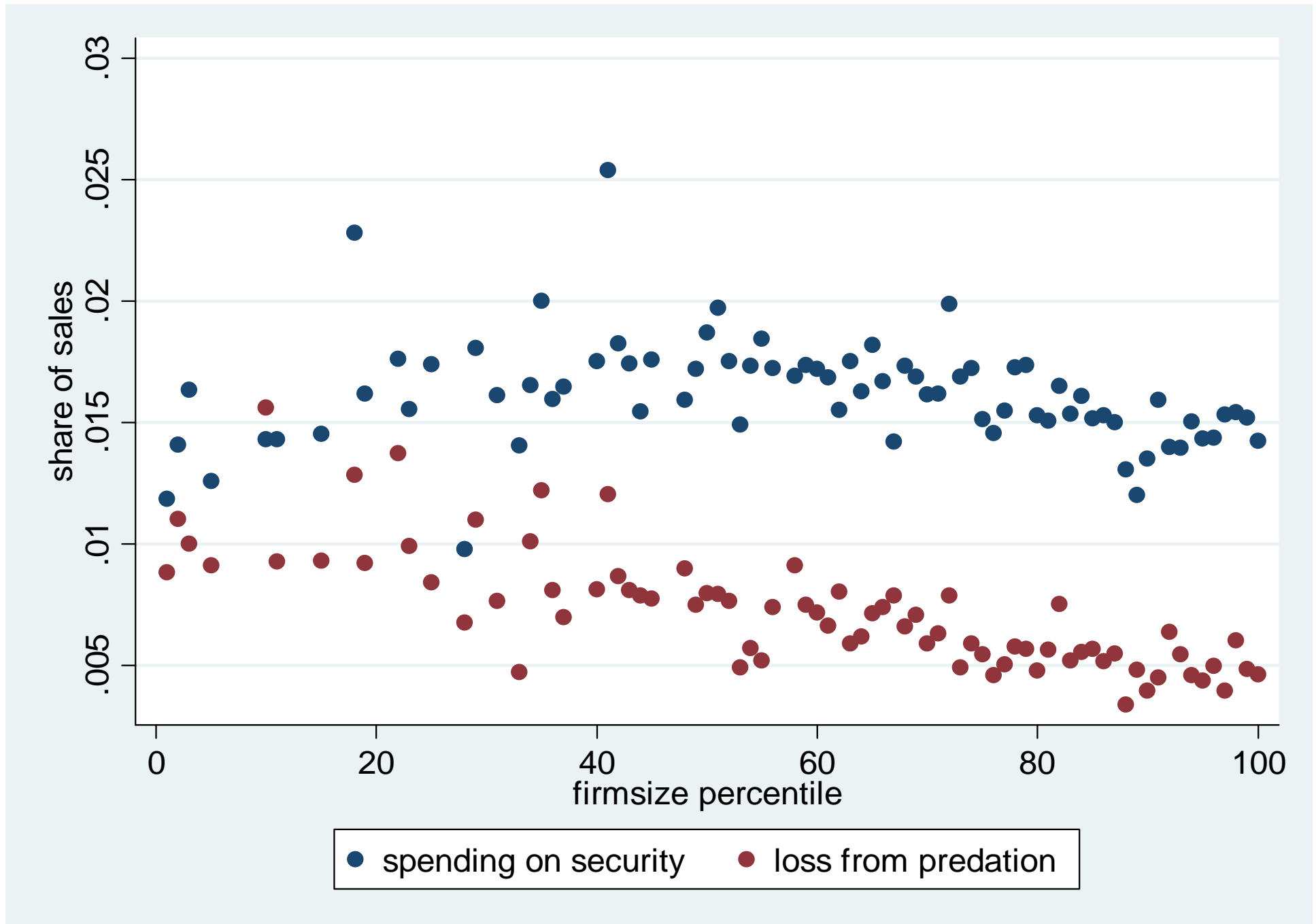


Figure A2: Estimated Output Losses (Countries with 500+ Observations)

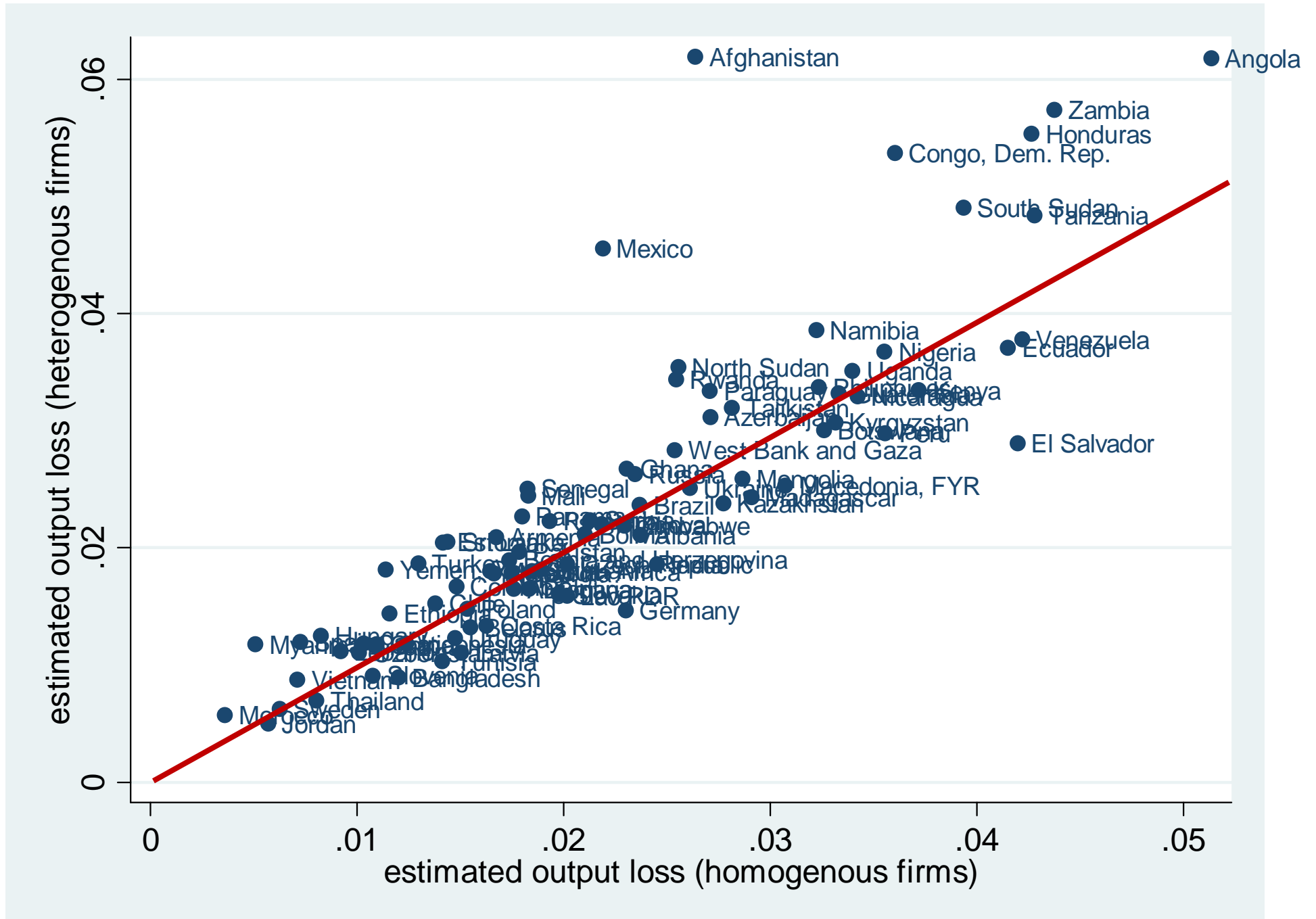


Figure A3: Non-Robustness to Dropping Outliers (all sectors)

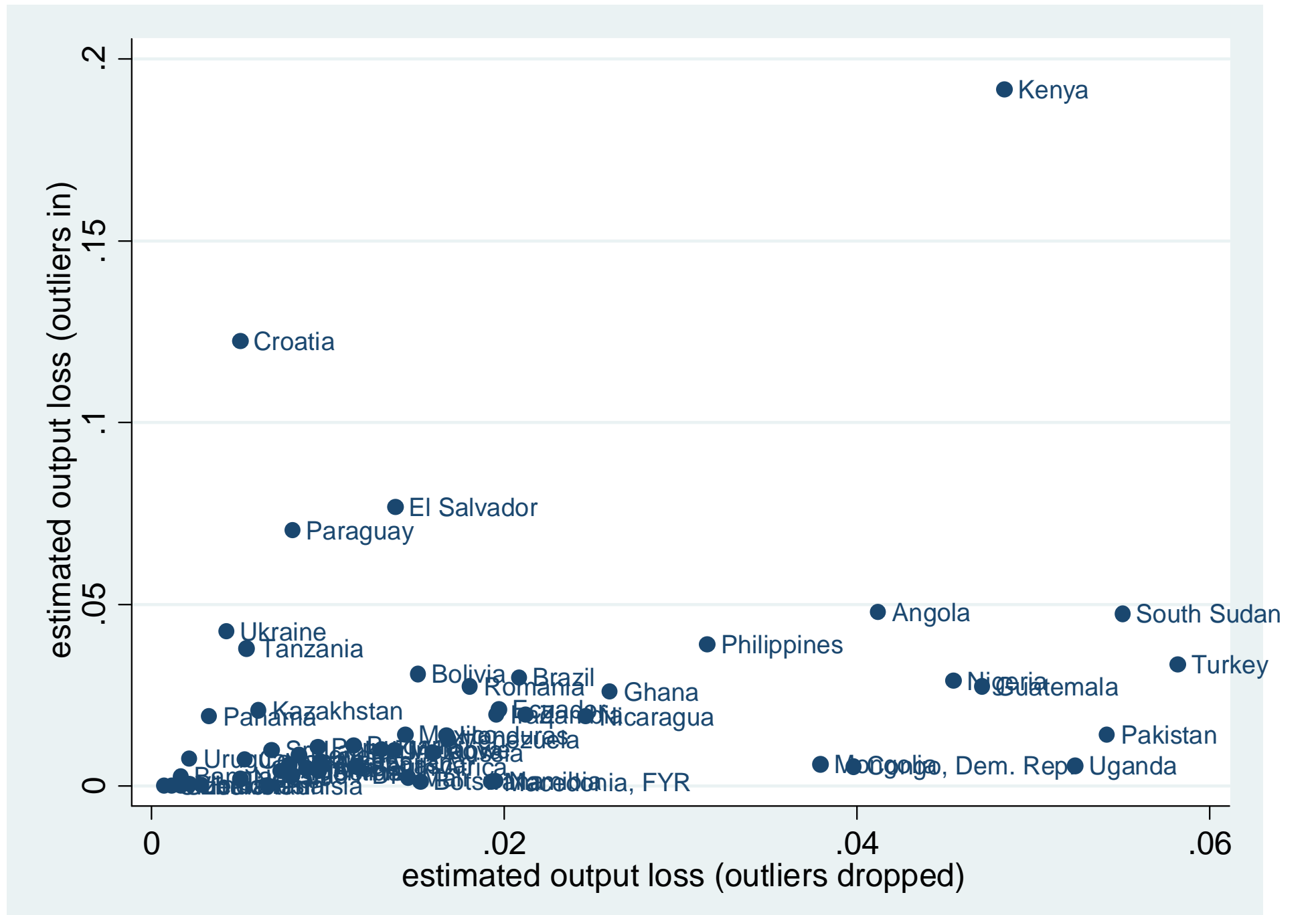


Figure A4: Non-Robustness to Dropping Outliers (manufacturing)

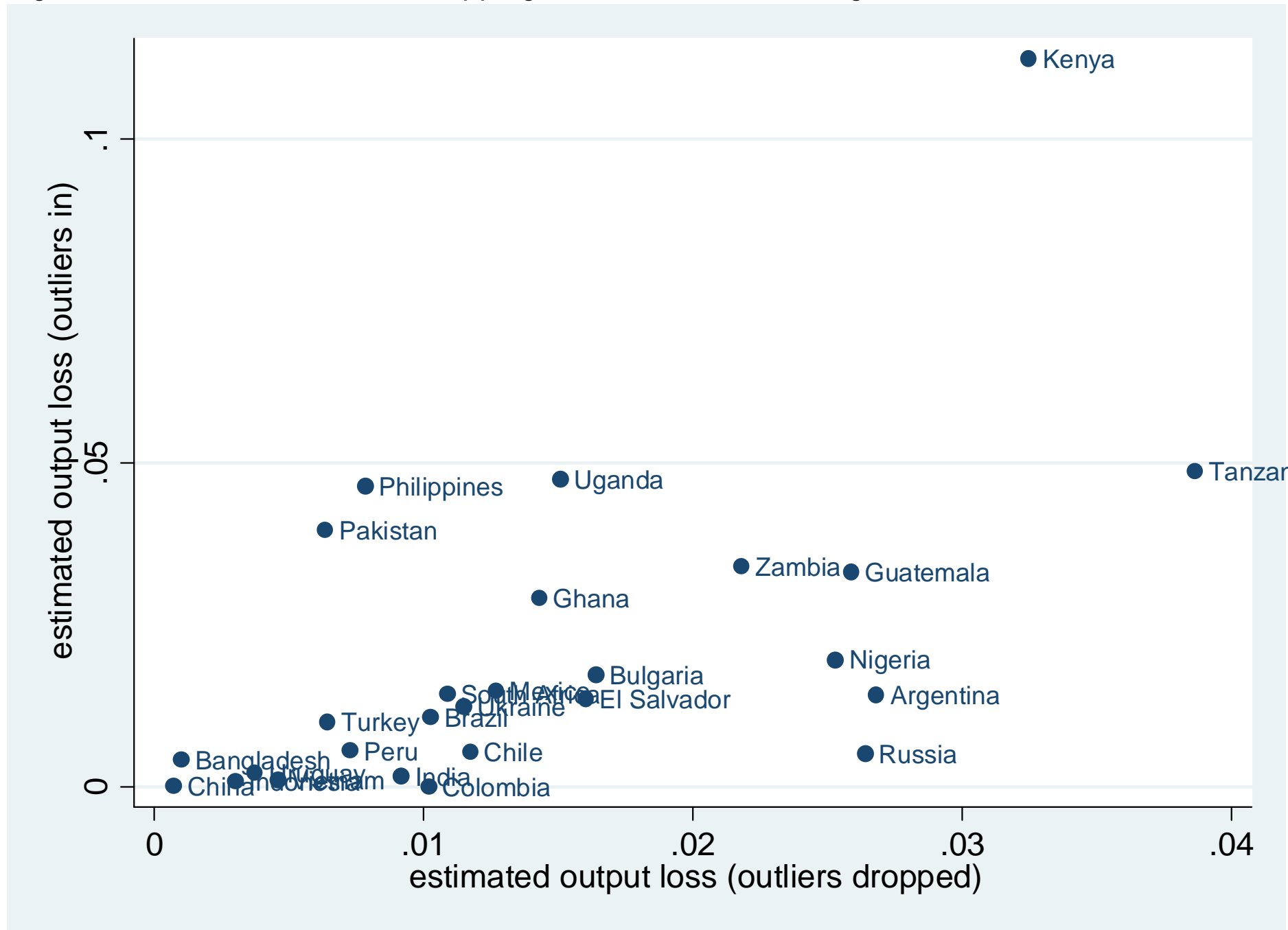


Figure A5: Comparison of Output Loss Estimates in Manufacturing

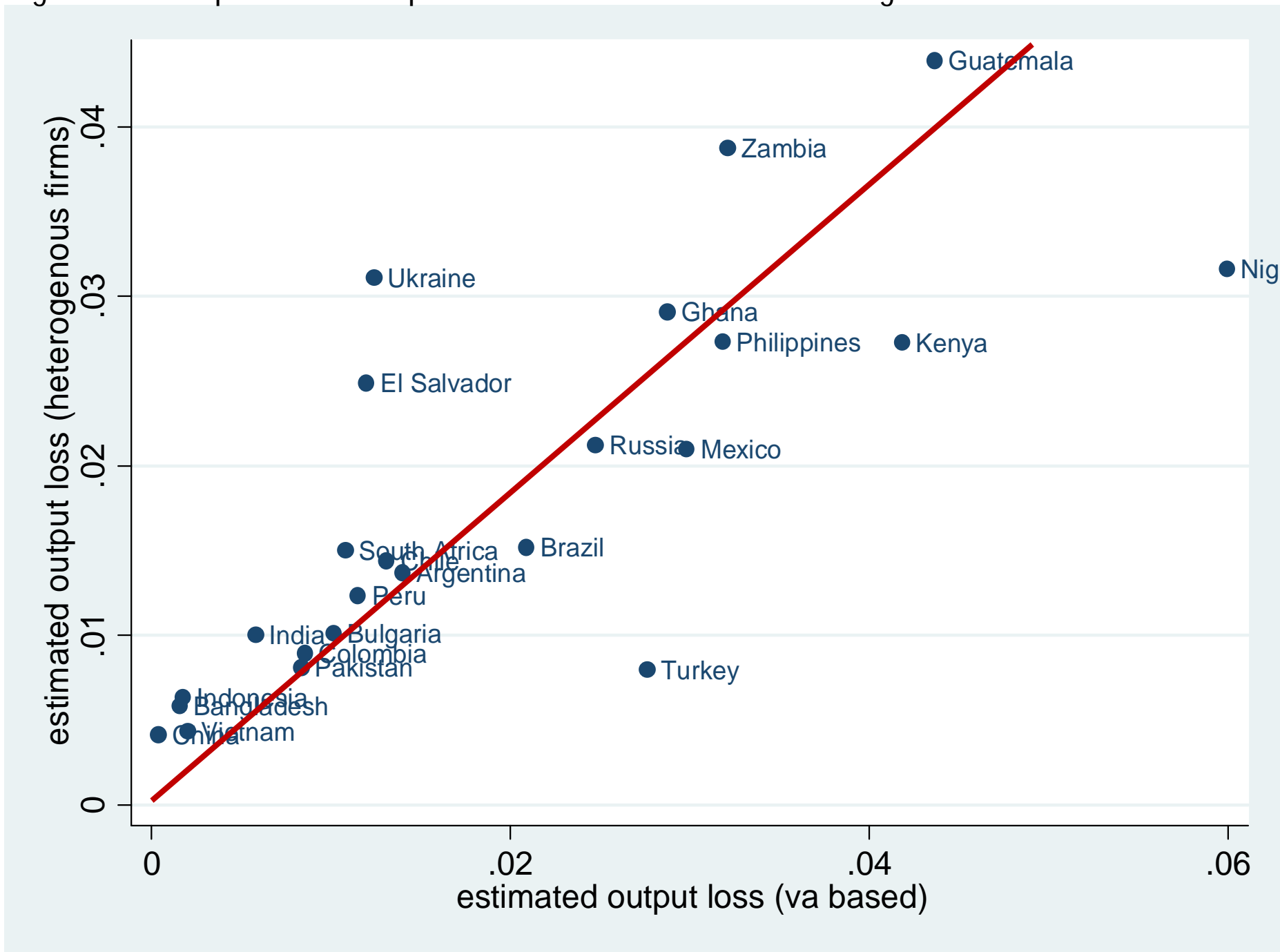


Figure A6: Re-Allocation Effect

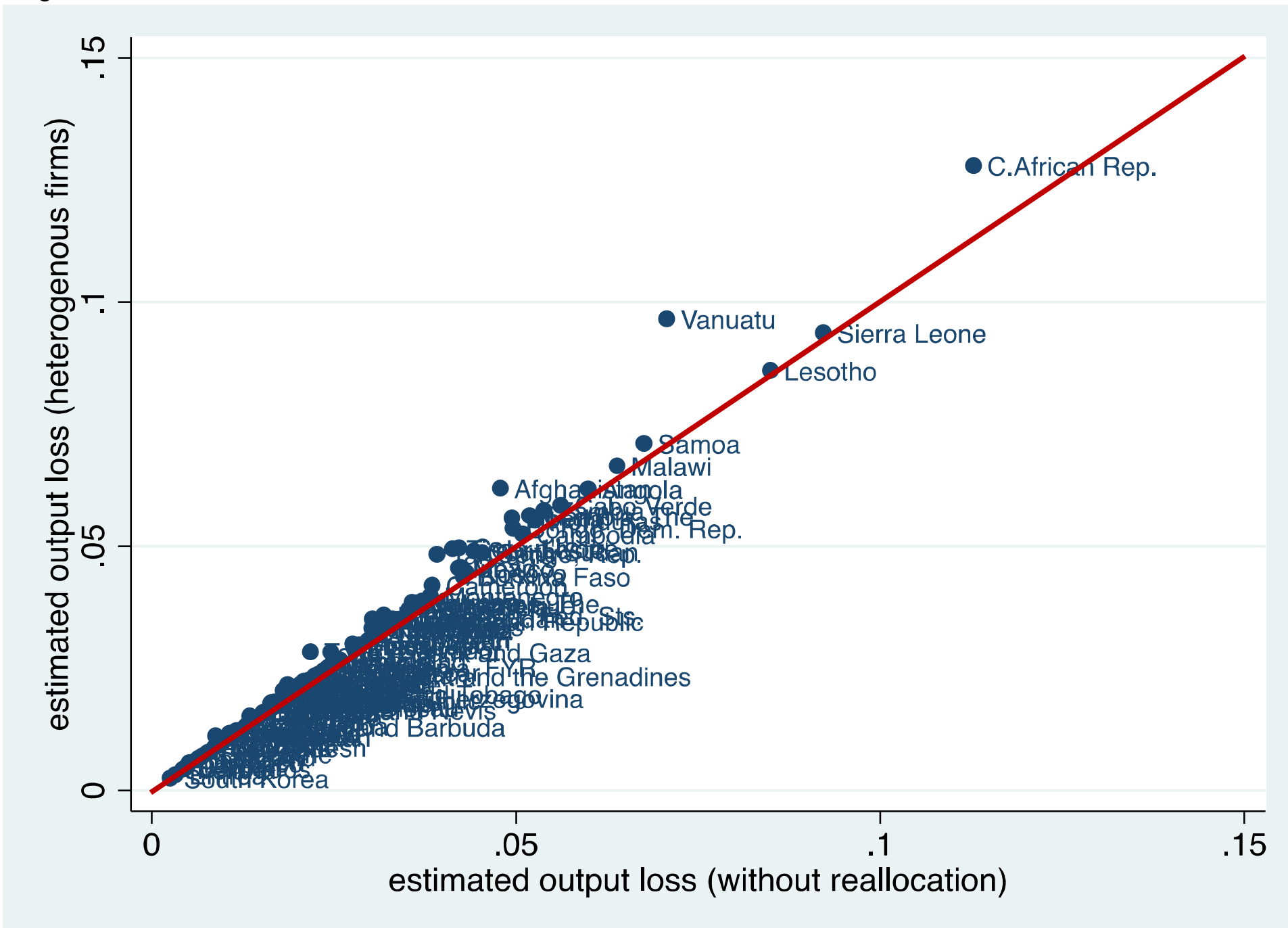


Figure A7: Protection Estimates by Firm Productivity

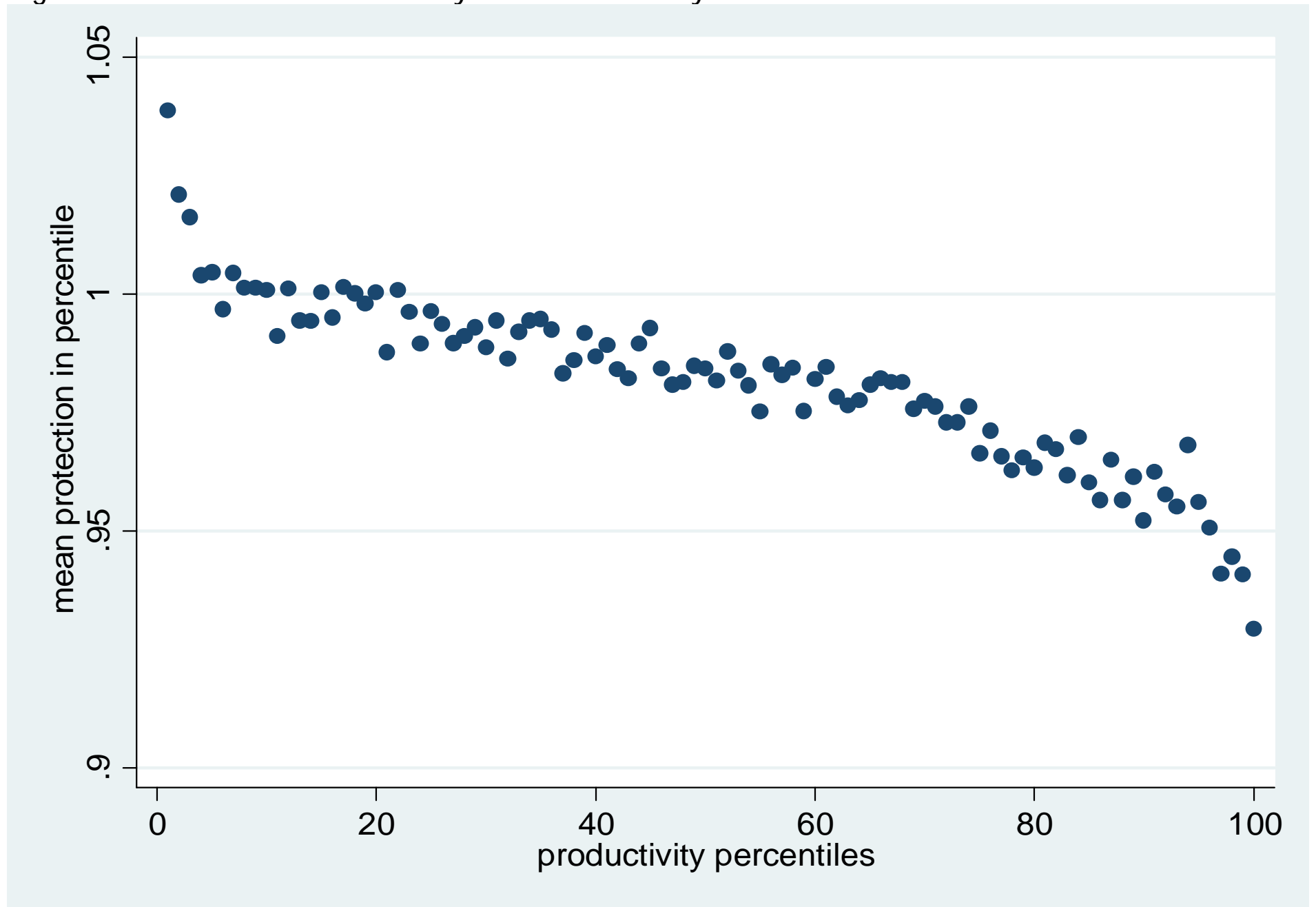




Figure A8: Output Loss by Sector



Figure A9: Spearman's Rank Correlation as a Proxy for Distortions

