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***Rent-Seeking Activities, Misallocation, and Innovation in  
Argentina***

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***“Rent-Seeking Activities, Misallocation, and Innovation in Argentina”***

Resumen

*¿Cuál es el costo en términos de eficiencia de hacer “rent-seeking” en Argentina? Este trabajo muestra cuantitativamente que rent-seeking en forma de sobornos tienen efectos agregados a través de dos canales. Primero, generan una mala asignación de recursos entre las empresas, porque evitan que los recursos fluyan hacia las más productivas, reasignándolos a aquellas empresas que tienen éxito en el rent-seeking. En segundo lugar, tales actividades afectan la asignación de recursos dentro de las empresas, porque alejan los recursos de las actividades de innovación. Estos dos canales pueden ayudar a explicar por qué Argentina tiene más misallocation entre las empresas y menos inversión en investigación y desarrollo que las economías desarrolladas, lo que explica una parte considerable de la baja productividad argentina.*

Palabras clave: crecimiento, misallocation, rent-seeking, innovación.

***“Rent-Seeking Activities, Misallocation, and Innovation in Argentina”***

Abstract

*What is the efficiency cost of rent-seeking activities in Argentina? In this paper, I quantitatively show that rent-seeking activities in the form of bribes have aggregate effects through two channels. First, they generate misallocation of resources across firms, because they prevent resources from flowing to the most productive ones, reallocating them instead to those that succeed at rent-seeking. Second, such activities affect the allocation of resources within firms, because they drive resources away from innovation activities. These two channels can help explain why Argentina has both more misallocation across firms and less investment in research and development than developed economies explaining a sizable portion of the Argentinian low productivity.*

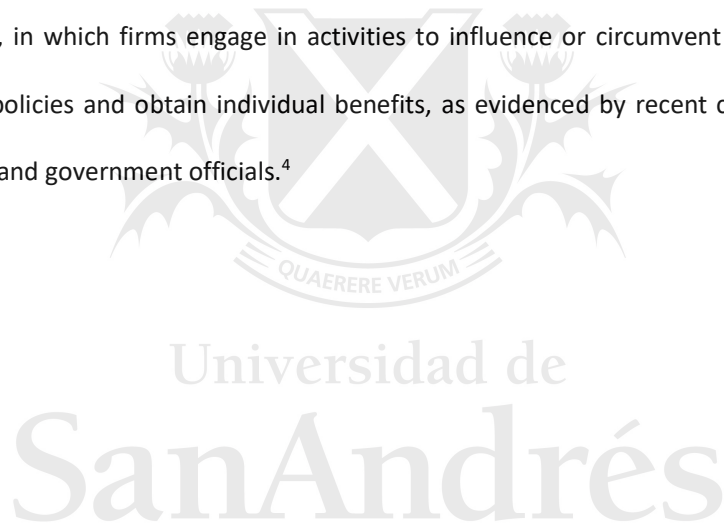
Keywords: growth, misallocation, rent-seeking, innovation.

Códigos JEL: E62, O11, O41.

## ***Rent-Seeking Activities, Misallocation, and Innovation in Argentina<sup>1</sup>***

### **1. Introduction**

In the past decade, the Argentinian government has imposed many discretionary restrictions that distort the allocation of resources. Such restrictions include import quotas and licenses, export permits, and unfair bidding practices for government contracts.<sup>2</sup> To gain a sense of the bureaucratic structure in Argentina, it is illustrative to look at various measures of the ease of doing business. Figure 1 shows several indicators from the World Bank's Doing Business dataset for Argentina and for Organization for Economic Co-operation and Development (OECD) countries. As expected, Argentina ranks very low in almost all the indicators, implying that the country requires long and cumbersome bureaucratic procedures in many areas.<sup>3</sup> The aforementioned restrictions create incentives for rent-seeking behavior, in which firms engage in activities to influence or circumvent these complicated regulations and policies and obtain individual benefits, as evidenced by recent corruption scandals connecting firms and government officials.<sup>4</sup>



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<sup>1</sup> The views expressed herein are my own and should not be attributed to the World Bank, its executive directors, or the countries they represent. All errors or omissions are my own.

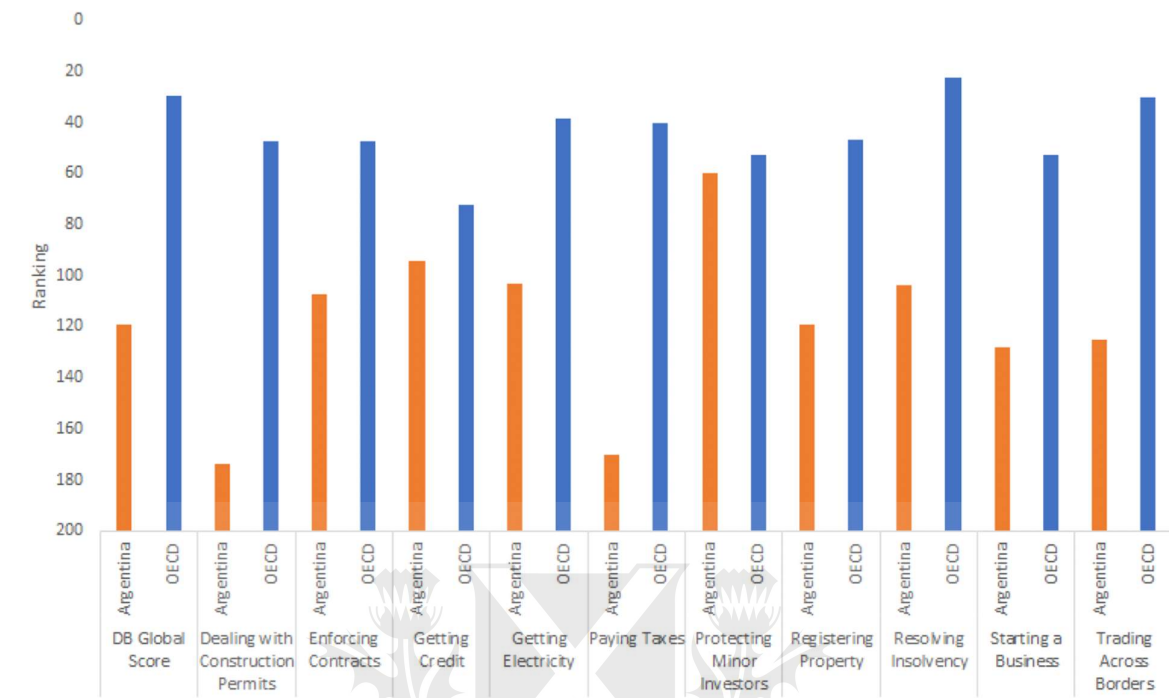
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<sup>2</sup> Other types of regulations suspected to distort resource allocation are selective enforcement of taxes and regulations, targeted subsidies, and the “cepo” cambiario (exchange rate), which enabled the government to reallocate U.S. dollars to certain firms. See Galiani, Gomez, and Scattolo (2019) for more evidence.

<sup>3</sup> For these indicators, a ranking of 1 means that a country has the best practices in the area in question and a ranking of 200 means that has the worst practices in that area. Argentina ranks in the lower half of the table for all but one indicator.

<sup>4</sup> These scandals drew the attention of [local](#) and [foreign](#) media and, more importantly, the public.

Figure 1. Measures of the ease of doing business in Argentina



Source: Doing Business dataset.

This behavior is not specific to Argentina; many studies and anecdotes detail how corruption, regulation, or direct government involvement distort the allocation of resources across firms, especially in developing countries. As described by Krueger (1974, page 2),

“These restrictions give rise to rents of variety of forms, and people often compete for the rents. Sometimes, such competition is perfectly legal. In other instances, rent seeking takes other forms, such as bribery, corruption, smuggling, and black markets”.

In this paper, I show quantitatively that rent-seeking decisions in the form of bribes affect long-run total factor productivity (TFP) by reducing investment in innovation and that this effect helps explain Argentinian underdevelopment. I focus on the interaction between bribes and innovation because there is a long tradition in development literature that stresses these channels (including Acemoglu 1995; Krueger 1974; Lopez 2013; and Murphy, Shleifer, and Vishny 1991, 1993).

This paper makes three contributions. First, I provide evidence that TFP is lower in countries

where bribes are pervasive and that two of the mechanisms lowering these countries' TFPs are misallocation of resources and reduction of incentives to innovate. Second, I contribute to the literature on cross-country differences in TFP and income by quantifying a new channel—rent-seeking in the form of bribes—that interacts with incentives to innovate and amplifies the effects of that source of misallocation. Third, I conduct counterfactual experiments to study the long-run implications for Argentina of rent-seeking in the form of bribes. To my knowledge, this paper is the first to try to quantify this channel of TFP reduction.

This paper emphasizes that rent-seeking activities in the form of bribes have aggregate effects through two channels. First, they generate misallocation of resources across firms, because they prevent resources from flowing to the most productive firms, reallocating them instead to those that succeed at rent-seeking. Second, rent-seeking activities affect the allocation of resources within firms, because they drive resources away from innovation activities. These two channels help explain why Argentina has both more misallocation across firms and less investment in research and development than developed economies, which explains a sizable portion of Argentinian underdevelopment. Compared to an economy without bribing, I find that the presence of bribing in an economy reduces output and TFP by 4.4 percent and 3 percent, respectively.

As the World Bank Enterprise Surveys (WBES) reveal, bribing and corruption occur frequently (though less commonly in the Western world), they are obstacles to doing business, and they carry a large cost for businesses. In Argentina, almost 9.5 percent of establishments in the economy participated reported bribing a government official, almost 1 percent more than the average in Latin America and the Caribbean but below the worldwide average. In addition, bribes in Argentina were sizable, averaging 6.5 percent of the establishments' annual sales.

Motivated by this evidence, this paper aims to quantify the efficiency cost of rent-seeking activities in the form of bribes in Argentina. To this end, I introduce bribing into a general equilibrium model of firm dynamics as in Atkeson and Bursteinn (2010). In this model, firms are heterogeneous

with respect to their levels of productivity and behave in an environment with imperfect competition.<sup>5</sup> Productivity in this model evolves stochastically, but the probability of increasing the level of productivity depends on research and development (R&D) expenditure. In the spirit of Restuccia and Rogerson (2008) and Hsieh and Klenow (2009), firms also face idiosyncratic subsidies and taxes that affect their size, which generate static misallocation in the model. However, unlike the static subsidies and taxes presented in those papers, these subsidies and taxes also evolve stochastically, conditional on the rent-seeking efforts (bribes) that each firm chooses to undertake. As a result of these choices, some firms will invest in rent-seeking activities and others will invest in improving the quality of their production process (by improving physical productivity, management practices, or intangible capital).<sup>6</sup> By diverting talent and resources away from production and innovation activities, rent-seeking activities can have sizable negative effects on aggregate efficiency.

For the quantitative analysis, I calibrate an undistorted version of the model to match key features related to the size distribution of firms in the U.S. economy, as it is usual in the literature. Next, to evaluate the quantitative implications of the model, I use data from the WBES, which is one of the few surveys that provide establishment-level evidence related to bribing. I use this micro-level evidence of bribing in Argentina to calibrate the distorted version of the model. In particular, I use the frequency of bribing, the average cost of bribing in terms of sales, bribing expenditures across the size distribution of firms, and statistics from the firm-level productivity distribution to pin down key parameters in the model.<sup>7</sup> In the distorted version of the model, aggregate output and TFP fall by 4.4 percent and 3 percent, respectively, compared to the undistorted economy. These effects are substantial, because bribes affect less than 10 percent of firms in the model. The model is consistent with the fact that R&D spending and average firm productivity are lower in economies where bribing

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<sup>5</sup> In the model, productivity captures physical productivity as well as management practices and intangible capital.

<sup>6</sup> In another background paper, Castro et al. (2019) find evidence supporting the fact that firms that pay bribes tend to have worse management outcomes, which would be reflected in productivity. This evidence supports the modeling strategy of this paper and the paper's general interpretation of productivity.

<sup>7</sup> This firm-level productivity distribution is stated in terms of the revenue productivity measure, TFPR.

is more pervasive. Finally, the model is used to explore the results of increasing the incentives for bribing by reducing the cost of this activity. As expected, TFP and output losses increase as bribing becomes easier.

Two channels misallocate resources across firms and generate these aggregate effects. First, as is well established in the literature, the idiosyncratic distortions that change the size of firms. However, in the model these distortions are partially endogenous when bribing is introduced to a model: each firm can choose to spend resources on bribes to affect the probability of the firm's revenue increasing. However, the final outcome is still stochastic, and therefore some firms are taxed (and thus contract) and others are subsidized (and thus expand). Second, bribing changes incentives to innovate, affecting the allocation of resources within firms. Firms respond to the presence of bribing by reducing innovation spending, which increases the share of unproductive firms in the economy and amplifies TFP losses from misallocation.

To understand how much the innovation channel contributes to the decline in TFP and output observed in the model, I study the effects of the increase in distortions coming only from rent-seeking. To do this, I allow bribing but keep firm-level innovation at the undistorted level (the first best) and I compare that model's results with those of a version in which innovation is affected by rent-seeking incentives. The quantitative results show that TFP losses are 9.6 percent larger than otherwise when the incentives to innovate are affected by bribing. The economy exhibits higher dispersion in revenue productivity, more unproductive firms, and a reduction in the average productivity of firms of 19.5 percent.

This paper relates to many strands of the development literature. First, it relates to the strand that studies the misallocation of resources as an important determinant of aggregate productivity. Restuccia and Rogerson (2008) and Hsieh and Klenow (2009), for example, focus on distortions in the form of wedges that act as implicit taxes or subsidies that distort the allocation of capital and labor across firms. Such papers, which take what is typically known as the "indirect" approach, are often silent about the underlying channels through which misallocation takes place and consider only the

overall effect of all potential sources of distortion on the economy.<sup>8</sup> In contrast, other papers take what is referred to as the “direct” approach, picking a particular policy or institution and using quantitative models to assess its contribution to the misallocation of resources and its impact on aggregate TFP.<sup>9</sup> This paper contributes to the latter line of research by focusing on the static and dynamic effects of one specific mechanism, bribing, that generates misallocation.

This paper is relevant to Argentina because the country’s recent corruption scandals have caused a loss of faith in institutions, which this paper shows to play a key role in enabling and perpetuating idiosyncratic distortions across establishments. More generally, because difficulties in doing business not only affect investment decisions but also generate incentives to obtain private rents, simplifying the regulations around starting and running businesses in order to reduce those incentives is of first-order importance.

In the following section, I present the facts on bribing and development that motivated this research. In section 3, I present the model that will try to account for these facts. In sections 4 and 5, respectively, I present the strategy for calibrating the models and the models’ quantitative results. Section 6 concludes and gives some policy recommendations.

## **2. Data**

The establishment-level data I use to calibrate this model is from the WBES. Their data was collected through interviews, typically with managers, aimed at understanding the major obstacles establishments face in their day-to-day operations. A convenient feature of the surveys is that they were administered in a similar form within continents, which allows for cross-country comparisons. The initial rollout of the survey was conducted in 2003, with subsequent and more complete rollouts conducted within a three-to-four-year span. For this paper, I use the dataset from 2006–2018 provided by the World Bank. This dataset contains firm-level observations for 135 countries, and it includes sections on corruption and regulations, among many other variables traditionally used in firm-level

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<sup>8</sup> The names of these approaches were first introduced by Restuccia and Rogerson (2013).

<sup>9</sup> For a more exhaustive description of the resource misallocation literature, see Hopenhayn (2014), Jones (2011), Restuccia and Rogerson (2013), and references therein.



analysis.<sup>10</sup> In particular, establishments are asked whether they have faced episodes of bribing in the past year (bribery incidence), the percentage of public transactions in which a gift or informal payment was requested of them (bribery depth), whether the firm was expected to give gifts to public officials "to get things done" what percentage of their sales was paid out in these bribes to "get things done" and the extent to which corruption is an obstacle to business operations (the potential responses are "not a problem," "a minor problem," "a moderate problem," and "a major problem" and are coded on a scale of 1 to 4).

Table 1 shows evidence of the incidence of bribes and corruption in selected countries.<sup>11</sup> There are three main facts to highlight: bribing and corruption occur frequently, they are obstacles to doing business in an economy, and bribing in particular carries a large cost for businesses.<sup>12</sup> In Argentina, almost 9.5 percent of establishments experienced a situation of bribing, almost 1 percent more than the average in Latin America and the Caribbean but below the worldwide average.

Table 1. Bribes in selected countries

|                           | Faced bribery (% of firms) | Reported corruption as a major constraint (% of firms) | Bribery depth (% of firms) | Firms expected to give bribes "to get things done" (%) | Bribes as a share of sales (%) | CPI |
|---------------------------|----------------------------|--|----------------------------|--|--------------------------------|-----|
| Sweden                    | 1.9                        | 2.7  | 1.5                        | -  | -                              | 84  |
| Poland                    | 5.1                        | 18.6   | 4.5                        | 14.5   | -                              | 60  |
| Guatemala                 | 7.3                        | 64.6   | 4.2                        | 12.9   | 12.4                           | 28  |
| Argentina                 | 9.3                        | 50.0   | 6.2                        | 14.7   | 6.5                            | 39  |
| Brazil                    | 11.7                       | 68.8   | 8.4                        | 12.5   | 6.6                            | 37  |
| Peru                      | 16.5                       | 51.2   | 15.9                       | 15.5   | 7.2                            | 37  |
| Germany                   | -                          | 3.8  | -                          | -  | 1.1                            | 81  |
| All countries             | 18.0                       | 32.7   | 14.1                       | 22.5   | -                              | 43  |
| Latin America & Caribbean | 8.7                        | 36.3   | 6.3                        | 10.0   | -                              | 43  |

Source: WBES and BEEPS 2005.

<sup>10</sup> The WBES data on corruption and bribery has reliability problems, but it is the only source of such data available, to my knowledge. Due to their illegal nature, corruption and bribery are hard to obtain data on. Data on lobbying activity (a "legal source of bribes") has been used recently to study various areas in the case of the United States. See Richter, Samphantharak, and Timmons (2009); Zaourak (2018); and references therein. Unfortunately, this kind of data is not available for Argentina.

<sup>11</sup> These patterns also emerge in other countries, it is not specific to the countries selected.

<sup>12</sup> In addition, there is evidence of a large heterogeneity in the amount of bribes businesses have to pay for a given firm size

*Note:* The CPI is measured from 0 to 100, and a higher number means a lower perception of corruption. BEEPS =The Business Environment and Enterprise Performance Survey; CPI = Corruption Perception Index; WBES = World Bank Enterprise Surveys.

Though bribing is undoubtedly present in many countries, how much of a constraint is it to doing business? The third column in table 1 provides proxy evidence by reporting the percentage of establishments that indicate that corruption is a major obstacle to the operation of their business. In Argentina, 50 percent of establishments report that this is the case. To put this figure in context, only 3 percent of establishments in Sweden say the same.

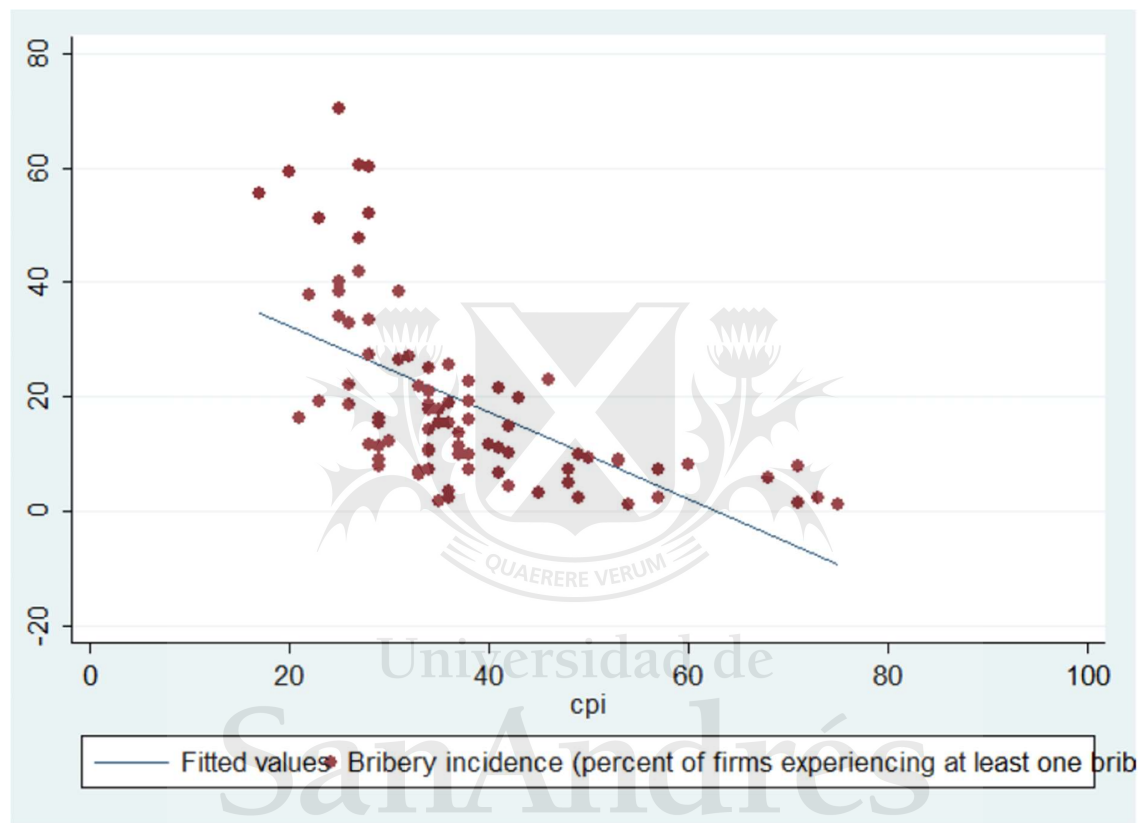
The fifth column in table 1 reports the average bribe payment as a percentage of sales by country, conditional on a business having faced a situation in which an informal payment was requested. The evidence shows that Argentina is close to Brazil and Peru in terms of the size of the bribes requested, and these bribes are 6 times larger than those requested in Germany, indicating a large deviation of resources to unproductive activities.

An additional measure to consider is Transparency International's Corruption Perception Index (CPI). This index ranks 176 countries on a scale from 0 ("highly corrupt") to 100 ("very clean") as determined by expert assessments and opinion surveys. In 2017, Denmark and New Zealand were perceived as the least corrupt countries in the world, while the country perceived as the most corrupt in the world was Somalia. The last column of table 1 displays the index values for the selected countries. We can see that Argentina ranks slightly below the Latin American and Caribbean average, and it ranks more than 40 points below developed economies like Sweden and Germany. Using this alternative measure, we can also conclude that corruption is an important problem for developing economies.

Figure 2 shows the correlation between the CPI and bribery incidence. As we can see, countries with a low CPI (high perceived corruption) tend to have a high percentage of firms facing bribery. The figure also shows that Argentina is below the linear predicted relationship between these two

variables. This implies that the incidence of bribery in Argentina is lower than what a linear model would predict, given the country's level of perceived corruption. In appendix A, I present additional bribery measures and their correlations.

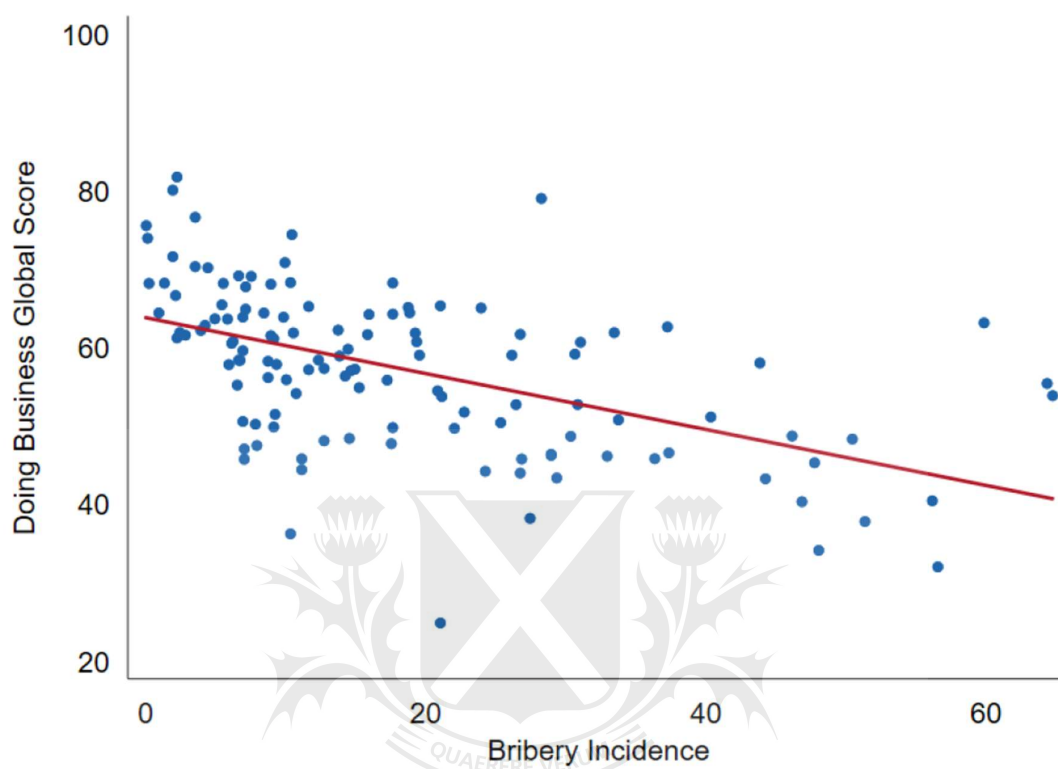
Figure 2. Bribery incidence vs. Corruption Perception Index



Source: World Bank Enterprise Surveys and Corruption Perception Index.

It is well established in the development literature that complex bureaucratic and regulatory frameworks leave room for rent-seeking behavior (see, for example, Krueger 1974). The evidence across countries seems to confirm this theory. Figure 3 shows the relationship between the country-level Doing Business indicator and bribery incidence. There is a clear negative relationship, indicating that in countries where doing business is complex and costly (those with lower index scores), bribery incentives are larger.

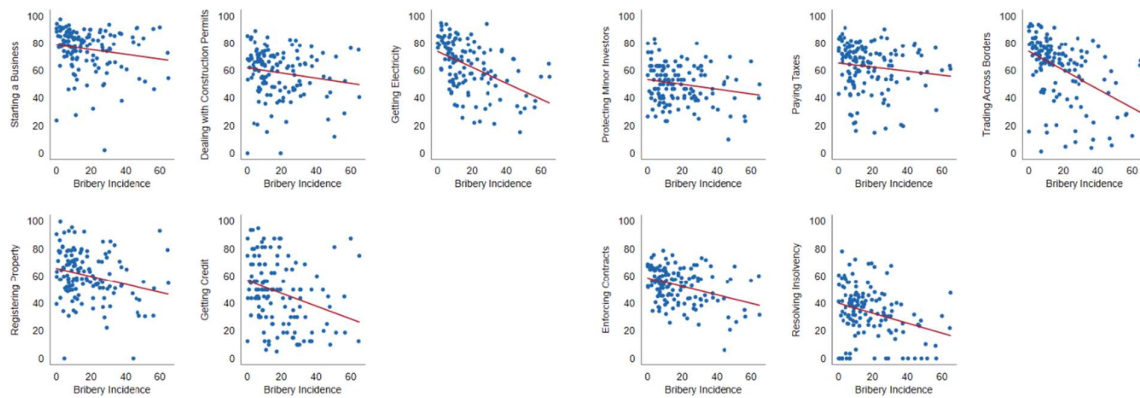
Figure 3. Bribery and Doing Business indicator



Source: Doing Business dataset and World Bank Enterprise Surveys.

Figure 4 displays similar graphs for all the measures in the Doing Business dataset versus bribery incidence. This evidence, using the individual indicators that make up the overall Doing Business score, provides additional support for the theory.

Figure 4. Individual Doing Business indicators and bribery



Source: Doing Business dataset and World Bank Enterprise Surveys.

To examine the link between bribery and aggregate development, it is useful to first examine the relationship between output per effective worker (relative to the United States) and TFP. Figure 5 displays the well-known fact that richer countries tend to have higher aggregate productivity, as measured by TFP.

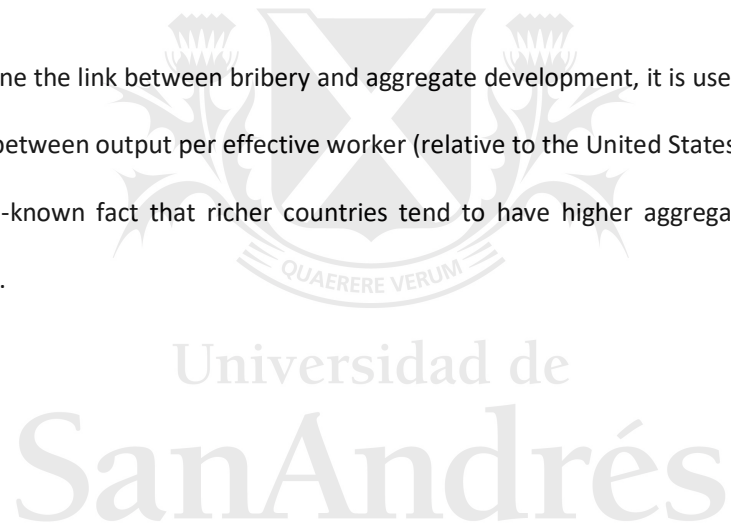
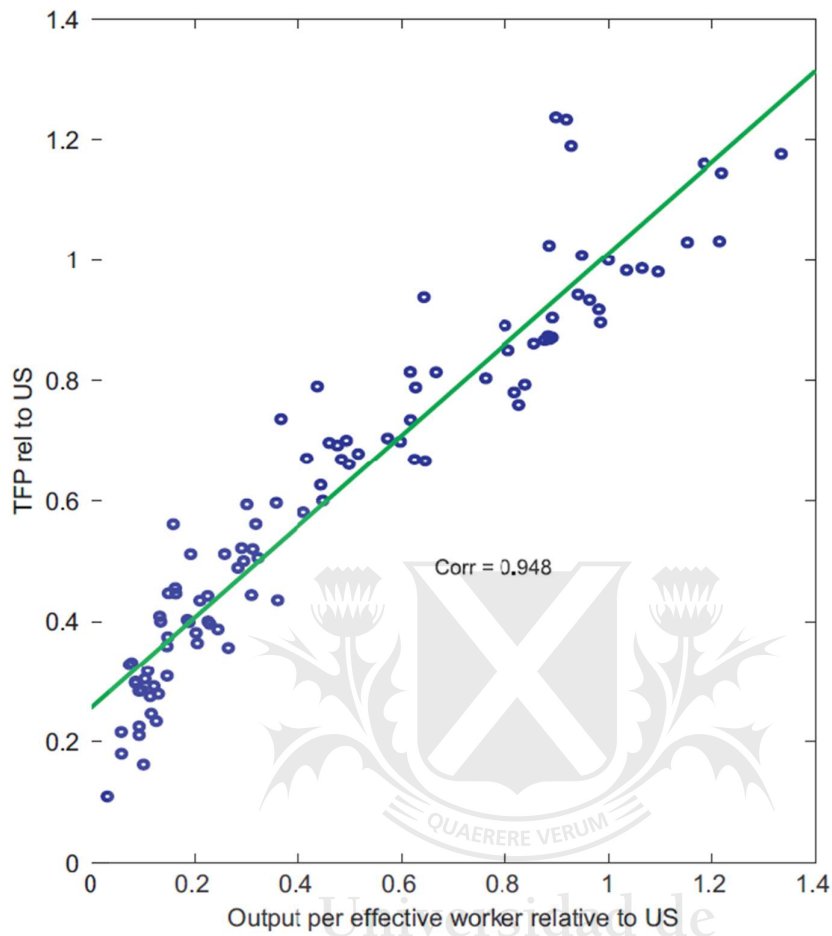


Figure 5. Output per worker and TFP

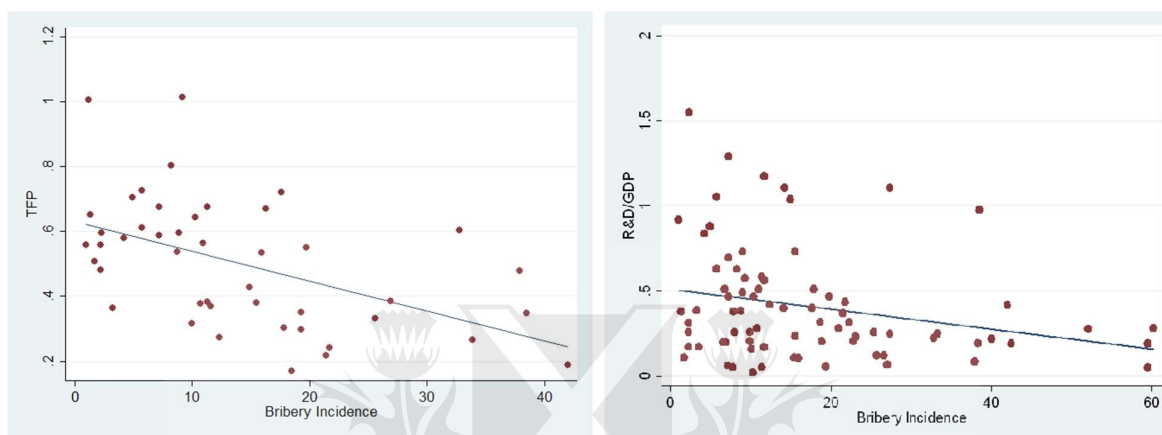


Why do we observe lower TFP in poor countries? The left panel of figure 6 shows one possible partial explanation: the relationship between TFP and bribery incidence. Not surprisingly, in countries where bribery incidence is higher, TFP is lower. A natural question is then the following: What mechanism could be driving down TFP? In other words, through what channel does bribery affects those countries? One channel stressed in the literature is innovation.<sup>13</sup> According to the literature, rent-seeking tends to reduce incentives to innovate. To test this hypothesis in the data, figure 6 displays the relationship between bribery incidence and R&D spending as a share of GDP. It is clear

<sup>13</sup> See Krueger (1974); Murphy, Shleifer, and Vishny (1991, 1993); and references therein.

from this figure that countries with higher bribery incidence tend to have lower R&D expenditure, which hints that innovation could be an important channel in understanding the aggregate effects of rent-seeking in the form of bribes.

Figure 6. TFP and R&D vs. bribery



Note: R&D = research and development; TFP = total factor productivity.

To summarize, bribing is fairly common in developing countries, it is an obstacle to production for businesses, and it is negatively correlated with measures of economic development and R&D. In the next section, I present a model to account for these patterns and evaluate their effects on the Argentinian economy. The model features firm-specific revenue taxes and subsidies that can be endogenously affected by rent-seeking. These distortions are the main source of misallocation across firms. In addition, because firms have the option to engage in costly innovation in order to grow, the potential to obtain rents through bribes will modify the incentives to innovate.

### **3. The Model**

The model is a variant of Atkeson and Bursteinn's (2010), which follows the tradition of Hopenhayn (1992) and Luttmer (2007). Although in the two earlier models the stationary size distribution of firms emerges as a result of idiosyncratic shocks to productivity, Atkeson and Bursteinn (2010) allow endogenous investment in innovation to affect the stochastic process for productivity. I depart from

this model by introducing firm-specific revenue taxes and subsidies that can be endogenously affected by rent-seeking behavior characterized by bribing, in the spirit of Krueger (1974). As discussed in that paper, *“people do not perceive themselves to be rent-seekers, and, generally speaking, individuals and firms do not specialize in rent-seeking. Rather, rent-seeking is one part of an economic activity, such as distribution or production, and part of the firm’s resources are devoted to rent-seeking.”* ( Krueger 1974, page 2).

### 3.1. Environment

In this model, time is discrete:  $t = 0, 1, 2, \dots, \infty$ . Households in the economy consume the final good  $C_t$ , provide inelastically one unit of labor  $L_t$ , and have preferences of the form

$$E_t \left[ \sum_{s=t}^{\infty} \beta^{s-t} \frac{C_s^{1-\gamma}}{1-\gamma} \right], \quad (1)$$

where  $\beta \in [0, 1]$  and  $\gamma > 0$  is the inverse of the intertemporal elasticity of substitution. In addition to working and consuming, households own a capital stock in the economy and make investment decisions.

### 3.2. Intermediate and Final Goods Producers

The final good is produced by a representative competitive firm using a constant elasticity of substitution technology,

$$Y_t = \left[ \int \int q_t(z, \tau) \frac{\rho-1}{\rho} M_t(z, \tau) dz d\tau \right]^{\frac{\rho}{\rho-1}},$$

where  $M_t(z, \tau)$  is the distribution of producing firms with state  $(z, \tau)$ ,  $q_t(z, \tau)$  is the production of one of the continuum of intermediate goods in the economy, and  $\rho$  denotes the elasticity of substitution. In this economy, the pair  $(z, \tau)$  represents the productivity level of the intermediate producer and the firm-specific revenue tax or subsidy (details to be provided below). Given the competitive market assumption, the firm solves the following problem,

$$\pi_t = P_t Y_t - \int p_t(z, \tau) q_t(z, \tau) M_t(z, \tau) dz d\tau,$$

subject to the production function. Solving a standard constant elasticity of substitution problem, the



demand for intermediates is given by

$$q_t(z, \tau) = \left( \frac{p_t(z, \tau)}{P_t} \right)^{-\rho} Y_t,$$

where all prices are expressed in terms of the wage (which is the numeraire of the economy), and the price index  $P_t$  is given by

$$P_t = \left[ \int \int p_t(z, \tau)^{1-\rho} M_t(z, \tau) dz d\tau \right]^{\frac{1}{1-\rho}}.$$

As mentioned, there is a continuum of measure 1 of intermediate products that are produced in a monopolistically competitive market. In this market, each firm produces using a constant-return-to-scale technology that combines capital and labor,

$$y_t = \exp(z_t)^{\frac{1}{\rho-1}} k_t^\alpha l_t^{1-\alpha} = q_t,$$

where  $q_t$  is the demand of intermediate inputs. At each point in time, the state of an intermediate firm is given by  $(z, \tau)$ , where  $z$  is the productivity index of the firm and  $\tau$  is the firm-specific revenue tax or subsidy. In particular, we assume that  $\tau \in [\tau_{min}, \tau_{max}]$ , and  $\tau_{min}$  and  $\tau_{max}$  are non-negative.

The problem of each intermediate producer, given demand, wages, and interest rates, can be written as

$$\Pi(z, r) = \max_p \tau^{\frac{1}{\rho}} p_t q_t - \widetilde{m} \widetilde{c}_t q$$

such that

$$q_t = \frac{p_t(z, \tau)^{-\rho}}{P_t} Y_t$$

where

$$\widetilde{m} \widetilde{c}_t = \frac{m c_t}{\exp(z)^{\frac{1}{\rho-1}}} = \frac{1}{\exp(z)^{\frac{1}{\rho-1}}} \left( \frac{w}{(1-\alpha)} \right)^{(1-\alpha)} \left( \frac{r}{\alpha} \right)^\alpha$$

(see appendix B.1-B3). After solving the problem, the price that maximizes profits  $\Pi(z, \tau)$  is given by

$$p_t = \frac{\rho}{\rho-1} \frac{m c_t}{\exp(z)^{\frac{1}{\rho-1}} \tau}, \quad (2)$$

and profit is expressed as

$$\Pi_t = \tau_t^\rho \Pi^d \exp(z_t), \quad (3)$$

where

$$\Pi^d = \frac{mc_t^{1-\rho} Y_t P_t^\rho}{(\rho - 1)^{1-\rho} \rho^\rho}$$

depends on parameters and aggregate variables and is common to all firms.

From equation 3, there are important aspects of this model to keep in mind. First, at any given point in time,  $\tau^\rho \exp(z)$  is a summary statistic of the size of a firm. This observation will help solve for the general equilibrium. Second, that expression makes clear the role of the firm-specific wedge  $\tau$ : for values of  $\tau > 1$  (a subsidy), the firm will be making profits higher than for the frictionless benchmark  $\tau = 1$ , while for values of  $\tau < 1$  (a tax), the firm will generate lower profits than for the benchmark. In addition, conditional on their levels of productivity, firms with subsidies will be relatively larger than firms with firm-specific taxes.

### 3.3. Entry, Exit, and Dynamics

In this model's economy, there are exogenous and endogenous sources of firm exit. At the beginning of each period, every firm is exposed to an exogenous death shock with probability  $\delta$  and survives with probability  $1 - \delta$ . Surviving firms can either choose to exit or continue to operate and pay a fixed cost of production  $f$ . The size of a firm over time depends on idiosyncratic shocks and on two endogenous mechanisms: innovation and bribing. A firm that decides to keep operating can choose to spend resources (innovate) to improve its productivity or to engage in rent-seeking behavior through bribes to try to improve its firm-specific revenue tax or subsidy. In the following subsections, I describe these mechanisms individually.

#### 3.3.1. Innovation

Productivity in this model evolves as in Atkeson and Bursteinn (2010). The productivity of a firm evolves depending on the firm's investment in R&D and on firm-specific shocks. A firm with state  $(z, \tau)$  that

decides to keep producing in period  $t$  can invest  $\exp(z)c_\varphi(\varphi)$  (in labor units) in R&D in order to increase the likelihood of improving its productivity in period  $t + 1$ . In particular, if a firm spends  $\exp(z)c_\varphi(\varphi)$ , it has a probability  $\varphi$  of increasing its productivity to  $z + \Delta_z$  and a probability  $1 - \varphi$  of decreasing its productivity to  $z - \Delta_z$ , where  $\Delta_z$  is the step size of the productivity support. I assume that the function  $c_\varphi(\varphi)$  is convex in  $\varphi$ .

### 3.3.2. Rent-seeking

The evolution of firm-specific taxes or subsidies is partially determined by bribing, as discussed in Krueger (1974). According to her, competition for rents (in her case, import licenses) can occur through firms allocating resources to influence their probability of obtaining the rents. On the basis of this interpretation, each firm can choose to spend resources on bribes that will affect the probability of increasing the firm's revenue. However, whether or not there is an opportunity in the firm's specific tax or subsidy is exogenous.<sup>14</sup> With probability  $\psi$ , the firm keeps its level of idiosyncratic distortion, and with probability  $(1 - \psi)$ , the firm gets a draw from a probability distribution that depends on the bribe  $\mu$ . The higher the firm's bribe, the higher the probability of getting an improvement in its specific tax or subsidy.<sup>15</sup> In particular, I assume that the probability distribution follows a bounded Pareto distribution,

$$F\left(\frac{\tau}{\mu}\right) = \frac{1 - \left(\frac{\tau}{\tau_{min}}\right)^{\frac{1}{\mu}}}{1 - \left(\frac{\tau_{min}}{\tau_{max}}\right)^{\frac{1}{\mu}}}, \quad (4)$$

where  $\tau_{max} > \tau_{min} > 0$ .

By choosing  $\mu$ , firms can alter the distribution of their future firm-specific tax or subsidy. Figure 7 shows the distributions for two different values of  $\mu$ . The way to determine  $\mu$  will be described below.

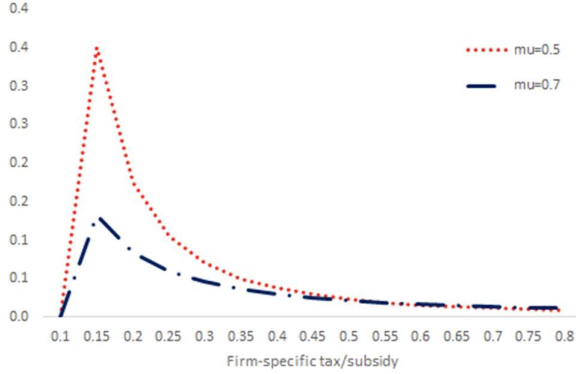
When taking the model to the data, I discretize the support of the distribution of  $\tau$  with linear spacing

<sup>14</sup> This aspect of the model reflects the fact that even if a firm bribes a government official, it will not always be successful in obtaining rents. There are "windows of opportunity" that cannot be influenced at the firm level.

<sup>15</sup> A high  $\mu$  means that the distribution dominates in first order the distributions with low  $\mu$ ; that is, a firm with higher bribes will on average draw a better firm-specific tax or subsidy.

given by  $\Delta_r$ .

Figure 7. Conditional firm-specific tax or subsidy probability distribution function



Bribes can improve the profitability of a firm, but they are costly. In particular, I assume that the cost of bribing, given by  $\exp(z)c_\mu(\mu)$ , is convex and increasing.

### 3.3.3. Value functions

Given the evolution of productivity and firm-specific revenue taxes or subsidies over time, the expected discounted value of profits for a firm with state  $(z, \tau)$  satisfies the following problem:

$$V(z, \tau) = \max_{x_t} [V_t^P(z, \tau), 0],$$

$$V_t^P(z, \tau) = \max_{\omega_t} \Pi_t - f + \max[V_f^R(z, \tau), V_t^I(z, \tau)],$$

$$V_t^R(z, \tau) = \max_{\mu} (1 - \delta) \frac{1}{R_t} E_{\tau'} [V_{t+1}(z, \tau') / (z, \tau)] - \exp(z) C_\mu(\mu),$$

$$V_t^I(z, \tau) = \max_{\varphi} (1 - \delta) \frac{1}{R_t} E_{z'} [V_{t+1}(z', \tau) / (z, \tau)] - \exp(z) C_\varphi(\varphi),$$

where  $\Pi_t$  is given by equation (3),  $R_t$  is the market discount factor,  $\varphi$  is the choice variable governing the probability of increasing productivity,  $\mu$  governs the probability of getting a reduction or increase in the firm's specific tax or subsidy, and  $f$  is the per-period fixed cost of producing.  $V_t^P(z, \tau)$  is the value of production given the state;  $V_t^R(z, \tau)$  is the value of a firm that decides to engage in bribing;  $V_t^I(z, \tau)$  is the value of a firm that decides to innovate;  $x_t$  is an indicator function that takes the value of one if a

firm keeps operating and zero otherwise; and  $\omega_t$  is an indicator function that takes the value of one if a firm engages in bribing and zero otherwise. Using the information previously described, conditional expectations are given by

$$E_{z'}[V_{t+1}(z', \tau)/(z, \tau)] = [\varphi V_{t+1}(z + \Delta_z, \tau) + (1 - \varphi)V_{t+1}(z - \Delta_z, \tau)],$$

$$E_{t'}[V_{t+1}(z, \tau')/(z, \tau)] = \psi V_{t+1}(z, \tau) + (1 - \psi) \int V_{t+1}(z, \tau) f(t/\mu) d\tau,$$

where  $f(\tau/\mu)$  follows a bounded Pareto distribution from equation (4).

Firms in this economy need to pay a one-time entry cost  $f_e$  (in units of labor) prior to entering. After that, firms receive their productivity and distortion drawn from a joint distribution  $G(z, \tau)$  and decide whether to start producing or to exit the market. Given that there are an infinite number of potential entrants, the following free entry condition holds in equilibrium,

$$\frac{1}{R_t} \int \int V_{t+1}(z, \tau) G(z, \tau) dz d\tau = f_e,$$

where  $G(z, \tau)$  is the stationary joint distribution of  $(z, \tau)$ .

Let  $M_t(z, \tau)$  denote the distribution of operating firms at time  $t$ , which over time will evolve based on the exogenous probability of exit  $\delta$ , the innovation effort to improve the firms' productivity, and the endogenous bribing behavior. Let  $M_{et}$  be the measure of firms that enter at period  $t$  and that will start producing (if profitable) in period  $t + 1$ . To complete the description of this economy, we need market clearing conditions for labor, capital, the final good, and the intermediate goods.

The market clearing condition for labor is given by

$$L_{It} + L_{rt} + f_e M_{et} + \int \int f M_t(z, \tau) dz d\tau + \int \int l_t(z, \tau) M_t(z, \tau) dz d\tau = L,$$

where

$$L_{It} = \int \int \exp(z) C_\varphi[\varphi_t(z, \tau)] M_t(z, \tau) dz d\tau$$

is the labor used to produce innovation and

$$L_{rt} = \int \int \exp(z) C_\mu[\mu_t(z, \tau)] M_t(z, \tau) dz d\tau$$

is the labor used to generate rent-seeking. We can write the labor market clearing condition as

$$f_e M_{et} + \int \int \{f + \exp(z) [c_\varphi(\varphi_t(z, \tau)) + c_\mu(\mu_t(z, \tau))] + l_t(z, \tau)\} M_t(z, \tau) dz d\tau = L. \quad (5)$$

For capital, we have that

$$\int \int k_t(z, \tau) M_t(z, \tau) dz d\tau = K_t.$$

For the final good, we have that

$$C_t + I_t = Y_t.$$

Assuming without loss of generality that  $L = 1$ , we can then write the labor market clearing condition as

$$M_e \left[ f_e + (L_p)/(M_e) + \int \int \{f + \exp(z) [c_\varphi(\varphi_t(z, \tau)) + c_\mu(\mu_t(z, \tau))]\} \bar{M}_t(z, \tau) dz d\tau \right] = 1.$$

Finally, the labor demand (see appendix B.3) is given by

$$l = \frac{(1 - \alpha)}{w} \tau_t^\rho \exp(z_t) \Pi^d (\rho - 1).$$

### 3.4. Consumers

Given preferences determined as in equation (1), in each period households have to choose consumption and tomorrow's stock of capital subject to the budget constraint

$$C_t + K_{t+1} - (1 - \Omega)K_t \leq w_t L_t + r_t K_t + \Pi_t^* - T_t,$$

where  $\Omega$  is the depreciation rate,  $T_t$  represents a lump-sum transfer from the government,  $r_t$  is the rental rate, and  $\Pi_t^*$  represents the aggregate profits earned by all firms in the economy:

$$\Pi_t^* = \int_{z \in Z} \int_{\tau_{max}}^{\tau_{min}} \Pi_t(z, \tau) M_t(z, \tau) dz d\tau.$$

The first-order conditions from this problem imply that

$$\left( \frac{C_{t+1}}{C_t} \right)^\gamma = \beta(1 + r_t - \Omega), \quad (6)$$

which in steady state implies that the interest rate is given by

$$\frac{1}{\beta} = (1 + r - \Omega).$$

### 3.5. Government

The government in this model is passive, and the total amount of taxes and subsidies given to all firms has to equal the transfer  $T_t$  that is returned to consumers as a lump sum,

$$\int_{z \in Z} \int_{\tau_{max}}^{\tau_{min}} \tau p(z, \tau) q(z, \tau) M_t(z, \tau) dz d\tau = T_t. \quad (7)$$

### 3.6. Competitive Equilibrium

An equilibrium in this economy is as follows:

- a collection of sequences of aggregate prices, wages, capital rental rates and prices for intermediate goods;
- a collection of sequences of intermediate firms' value functions, profits, exit rules, and innovation and rent-seeking decisions; and
- distributions of operating firms and measures of entering firms such that
  - households maximize utility subject to the budget constraint,
  - intermediate firms and final-good producers maximize profits, and
  - feasibility constraints (such as market clearing for all markets) are satisfied and the distribution of operating firms evolves endogenously.

#### 4. Calibration

In this section, I calibrate the model to the data. First, I need to provide a functional form for the costs of innovation,  $c_z(\varphi)$ . I assume that the costs are given by

$$c_z(\varphi) = h_z \exp(b_z \varphi),$$

which is strictly convex in  $\varphi$ , with  $h_z > 0$  and  $b_z > 0$ . For the cost of bribing,  $c_t(\varphi)$ , I assume the same functional form, given by

$$c_t(\mu) = h_t \exp(b_t \mu),$$

which is strictly convex in  $\mu$ , with  $h_t > 0$  and  $b_t > 0$ .

For the sake of clarity, I will classify the model's parameters into four groups: (a)  $\{\gamma, \rho, \alpha, \Omega\}$  are the standard parameters, (b)  $\{\delta, f_e, f\}$  are technological parameters, (c)  $\{\Delta_z, h_z, b_z\}$  are parameters related to innovation, and (d)  $\{\Delta_t, \psi, \tau_{min}, \tau_{max}, h_t, b_t\}$  are parameters related to rent-seeking in the form

of bribing.

The strategy I used to calibrate the parameters in the steady state has three parts. First, I set some of the parameters according to existing microeconomic and macroeconomic evidence in the literature. Second, I calibrated the technological parameters to an undistorted economy where  $\tau = 0$  for all firms. In order to map this economy to the data, I followed the literature and used the U.S. economy as a benchmark, given that the United States has a relatively low intensity of bribing.<sup>16</sup> Third, to evaluate the quantitative effects of rent-seeking in the form of bribes, I calibrated the rest of the parameters to match relevant features of bribing in Argentina. All data moments and targets are based on the WBES, unless otherwise stated. One year in the model is equivalent to one year in the data.

#### 4.1. Moment Selection and Calibration

**Standard parameters.** Values for the model's standard parameters can be found in table 2. The discount factor  $\beta$  is calibrated to match a real interest rate  $r$  of 4 percent. This rate implies a calibrated impatience rate of 0.05. The depreciation rate  $\Omega$  is set to imply an average investment to capital ratio of approximately 6 percent, which corresponds to the average value for the private capital stock in the United States. Following the literature, I set the share of capital in value added at  $\alpha = 1/3$ . Finally, I set the elasticity of substitution at  $\rho = 3$ , as in Hsieh and Klenow (2014).<sup>17</sup>

Table 2. Standard parameters

| Parameter                  | Value           | Target/source              |
|----------------------------|-----------------|----------------------------|
| Share of income to capital | $\alpha = 0.33$ | Literature                 |
| Elasticity of substitution | $\rho = 3$      | Broda and Weinstein (2006) |
| Depreciation rate          | $\Omega = 0.06$ | Literature                 |
| Discount factor            | $\beta = 0.96$  | Interest rate of 4%        |

**Technological and innovation parameters.** Six parameters need to be jointly calibrated to match six

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<sup>16</sup> What matters for this analysis is that the U.S. economy is relatively undistorted by bribing behavior. There could be other ways by which firms in the United States try to influence their profits, like lobbying, but those ways are outside the scope of this paper, which focuses on illegal activities.

<sup>17</sup> This number is consistent with estimates found in the trade and industrial organization literature. See, for example, Broda and Weinstein (2006), which provides estimations of elasticity of substitution for U.S. imports at a disaggregated level.



relevant moments for the U.S. economy. For technical details of the computational procedure used to calibrate them, see appendix B.4. The moments and parameters are described in table 3.

Table 3. Technological parameters and innovation

| Parameter                              | Value            | Target/source   |
|--|------------------|---|
| Cost of entry                          | $f_e = 1$        |   |
| Fixed cost of production               | $f = 0.2$        | Exit rate of 6%   |
| Exogenous exit rate                    | $\delta = 0.02$  | Exit rate of large firms of 0.55%   |
| Step size of productivity              | $\Delta_z = 0.2$ | Standard deviation of employment growth of large firms                                  |
| Scale parameter of innovation cost     | $h_z = 0.001$    | R&D / GDP = 2.7%  |
| Curvature parameter of innovation cost | $b_z = 13.54$    | $\varphi_{500 \leq l \leq 1000}^{avg} / \varphi_{1000 \leq l \leq 5000}^{avg} = 38.1\%$ |

Note: GDP = gross domestic product; R&D = research and development.

I chose  $\Delta_z$  so that the standard deviation of the growth rate of employment of large firms in the model would be 25 percent (annualized), following Atkeson and Bursteinn (2010), which is based on data in line with estimates from Davis et al. (2007).

I chose the exogenous exit rate  $\delta$  so that the model's annual employment-weighted exit rate of large firms would be 0.55 percent, which is consistent with the exit rate for large firms in the United States, according to the Statistics of U.S. Businesses database.<sup>18</sup> Note that in the model, large firms do not exit because of lack of profitability; they exit because of this exogenous shock. Hence,  $\delta$  directly determines the annual exit rate of these firms. Next, I parameterize the distribution  $G$  of productivity draws so that all firms enter with the same level of productivity,  $z = 0$ . In the full model, firms will also enter with  $\tau = 0$ .

Using data from the Business Dynamics Statistics, Atkeson and Bursteinn (2010) find that the size of the median firm in the U.S. employment-based firm size distribution is 500 employees. In the model, firm size in terms of number of employees is a normalization. I set the level of employment  $L$  so that entering firms' employment will be 6 percent of the median employment in the economy, as

<sup>18</sup> These statistics can be found at [www.sba.gov](http://www.sba.gov).

reported by Luttmer (2007). Finally, I normalize  $f_e = 1$  and set  $f = 0.2$ , which implies an exit rate of 6 percent.<sup>19</sup>

To calibrate  $h_z$  and  $b_z$ , I use firm-specific R&D data as a proxy for the innovation effort. As documented in Aw, Roberts, and Xu (2011), firms that invest in R&D on average increase their productivity over time. Boothby, Lau, and Songsakul (2008) and Ranasinghe (2014) documented the patterns of R&D expenditure for U.S. firms based on a dataset provided by the National Science Foundation, and they found that R&D (when measured as employment) is increasing. Following Ranasinghe's (2014) strategy, I calibrate the curvature parameter  $b_z$  of the innovation cost to target average R&D spending by firms that have between 500 and 1000 employees relative to average R&D spending by firms that have between 1000 and 5000 employees. The scale parameter  $h_z$  of the cost of R&D is closely related to the total spending on innovation. Following the literature, I target the ratio of R&D to GDP in the United States, which for 2016 was equal to 2.7 percent.

**Bribing parameters.** Based on the data provided by the WBES, total bribes increase with firm size (measured as employment), with large differences across firms. For example, the average total bribe paid by firms with 50 to 100 employees is 40 percent of the average total bribe paid by those with 100 to 500 employees.<sup>20</sup> In contrast, firms with 100 to 500 employees spend on average 80 percent as much on bribes as do firms with 500 to 1000 employees. Based on these features of the data, I calibrate the curvature parameter  $b_z$  of the cost of rent-seeking to target average bribes for firms that have between 500 and 1000 employees relative to average bribes for firms that have between 1000 and 5000 employees. I calibrate the probability of keeping a firm's distortion,  $\psi$ , on the basis of the percentage of firms that have faced bribes in Argentina. Intuitively, the higher the value of  $\psi$ , the lower the incentives to engage in bribing in the model. A list of parameters and targets is given in table 4.

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<sup>19</sup> Notice that the exit rate is determined by the fixed cost of producing  $f$ , the entry cost  $f_e$  that determines the minimum productivity required to stay in the market, and the stochastic process. In a model with rent-seeking, the stochastic process for the firm-specific revenue tax or subsidy will also play a key role in determining survival. In that case, firms with low productivity could stay in the market if they had subsidies large enough.

<sup>20</sup> See figure in appendix A

Table 4. Bribing parameters

| Parameter                              | Value               | Target/source   |
|--|---------------------|---|
| Step size of firm-specific tax/subsidy | $\Delta\tau = 0.15$ | $Avg[\ln(TFPR_i)] = 0$  |
| Probability of keeping firm distortion | $\psi = 0.43$       | Percentage of firms bribing = 9.3%  |
| Lower-bound wedge distribution         | $\tau_{min} = 0.01$ | $Min[\ln(TFPR_i)] = 0.1$  |
| Upper-bound wedge distribution         | $\tau_{max} = 2$    | $max[\ln(TFPR_i)] = 2$  |
| Scale parameter of bribing cost        | $h_\tau = 0.002$    | $avg\left(\frac{bribe}{sales}\right) = 6.9\%$                                   |
| Curvature parameter of bribing cost    | $b_\tau = 5$        | $\mu_{500 \leq l \leq 1000}^{avg} / \mu_{1000 \leq l \leq 5000}^{avg} = 64.9\%$ |

Note: TFPR = total factor revenue productivity.

Table 5 reports target moments from the model and the data. Despite solving a rather complicated multidimensional mapping, the model targets all moments quite closely. The only two moments that the model finds difficult to match are the employment-weighted exit rate for large firms and the percentage of firms engaging in bribery, but the differences between the model and these moments are not dramatic.

Table 5. Calibration: data and model targets

| Moment targeted   | Data   | Model  |
|---|--------|--------|
| <b>U.S.-based targets</b>   |        |        |
| Exit rate   | 0.006  | 0.006  |
| Employment-weighted exit rate for large firms   | 0.0055 | 0.0045 |
| Standard deviation of employment growth of large firms                                  | 0.25   | 0.245  |
| R&D as share of GDP   | 0.027  | 0.028  |
| $\varphi_{500 \leq l \leq 1000}^{avg} / \varphi_{1000 \leq l \leq 5000}^{avg} = 38.1\%$ | 0.38   | 0.37   |
| <b>Argentina-based targets</b>  |        |        |
| $Avg[\ln(TFPR_i)] = 0$  | 0      | 0.05   |
| Percentage of firms bribing   | 0.093  | 0.097  |
| $Min[\ln(TFPR_i)]$  | 0.1    | 0.1    |
| $max[\ln(TFPR_i)]$  | 2      | 2      |
| $avg\left(\frac{bribe}{sales}\right)$   | 0.069  | 0.067  |
| $\mu_{500 \leq l \leq 1000}^{avg} / \mu_{1000 \leq l \leq 5000}^{avg} = 64.9\%$         | 0.649  | 0.641  |

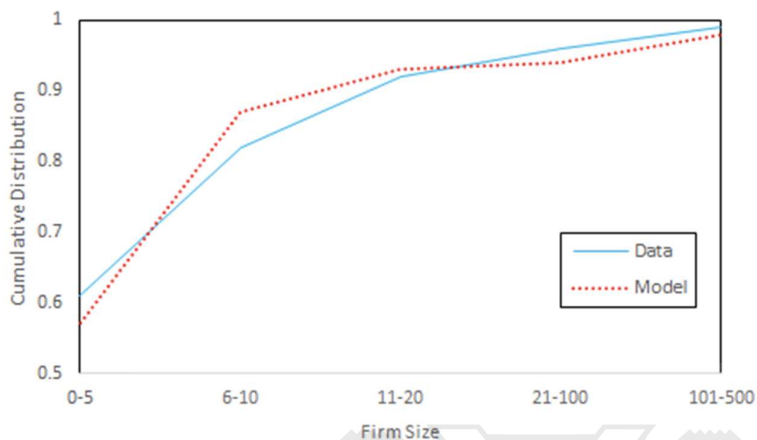
Note: GDP = gross domestic product; R&D = research and development; TFPR = total factor productivity revenue.

## 4.2. Model Testing

In this section, I test the model against some observables. First, I compare the undistorted model with the firm size distribution in the United States. Figure 8 plots the distribution of employment in the U.S alongside the model's distribution of employment. The model does a fairly good job of matching the distribution of employment, which demonstrates the effectiveness of the calibration strategy for the

undistorted model.

Figure 8. Firm size distribution



Furthermore, the model is able to capture additional, untargeted moments related to innovation and rent-seeking (see the ratios  $\varphi_{i \leq l \leq j}^{avg}$  and  $\mu_{i \leq l \leq j}^{avg}$  in table 6). In particular, the model captures the ratios of R&D expenditure and of bribery for micro firms (those with fewer than 50 employees), small firms (those with 50 to 100 employees), and medium firms (those with 100 to 500 employees).

Table 6. Moments not targeted in calibration

| Moments not targeted  | Data  | Model |
|---|-------|-------|
| $\varphi_{5 \leq l \leq 50}^{avg} / \varphi_{50 \leq l \leq 100}^{avg}$     | 0.285 | 0.301 |
| $\varphi_{50 \leq l \leq 100}^{avg} / \varphi_{100 \leq l \leq 1000}^{avg}$ | 0.365 | 0.418 |
| $\mu_{5 \leq l \leq 50}^{avg} / \mu_{50 \leq l \leq 100}^{avg}$             | 0.051 | 0.113 |
| $\mu_{50 \leq l \leq 100}^{avg} / \mu_{100 \leq l \leq 1000}^{avg}$         | 0.404 | 0.431 |
| $std[\ln(TFPR_i)]$  | 1.868 | 1.71  |

### 4.3. Innovation with and Without Rent-Seeking

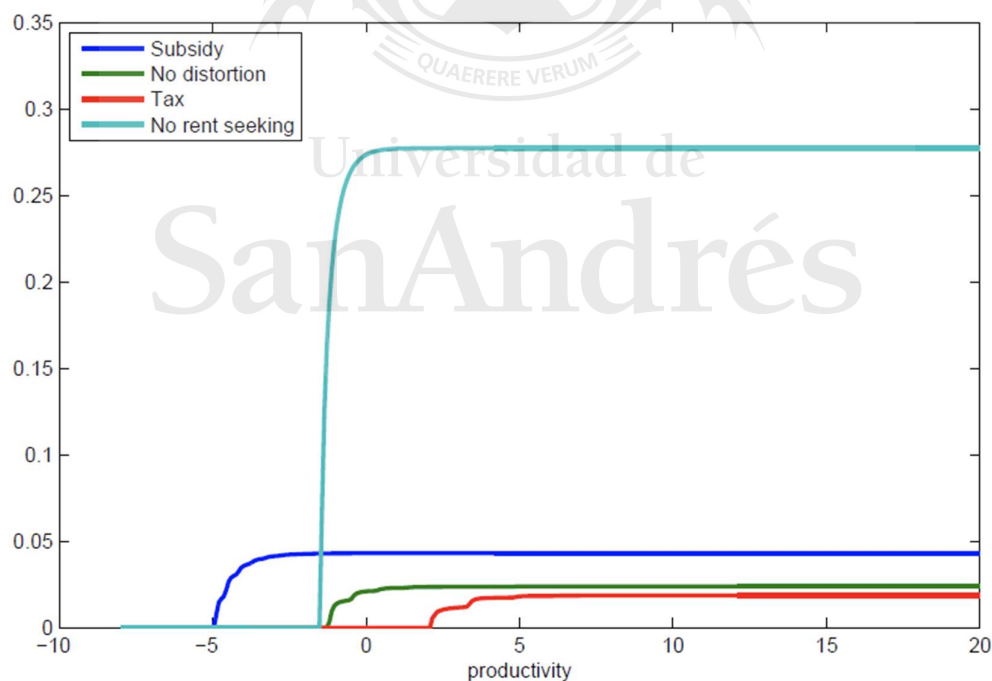
Having described the model's equilibrium, I now focus on the key channel emphasized in the model:

the role that rent-seeking in the form of bribes plays in innovation and how it thereby shapes the productivity distribution in the long run, and on how rent-seeking generates misallocation of resources

in a static sense. I begin by considering a rent-seeking free environment in which all firm-specific distortions are set to 0 to highlight the effects of innovation on future productivity.

In figure 9, we see how the policy function for innovation behaves when there is no rent-seeking in the form of bribes (the light blue line). Because the only way that firms can increase profits in the future is by improving their level of productivity, firms optimally decide to spend a considerable amount of resources on R&D. However, when rent-seeking is introduced, we see that a firm with a given level of productivity on average spends less resources on innovation. As hypothesized, this change affects the aggregate TFP of the economy in steady state. In the following section, distortions are introduced into the model to explore their consequences on aggregate outcomes and on firm-level characteristics.

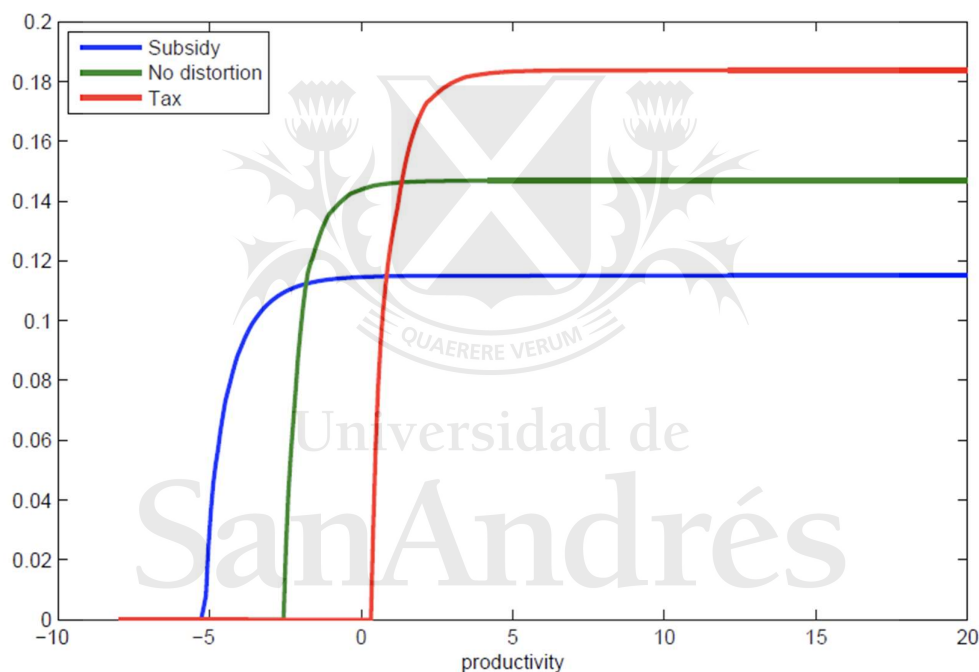
Figure 9. Innovation policy function with and without rent-seeking



Note: The figure displays a firm's probability of increasing its productivity in the future for a given level of productivity.

What happens to bribing behavior when a firm receives a subsidy? The results of the calibrated model show that for a given level of productivity, firms that receive subsidies ( $\tau > 1$ ) tend to invest less in rent-seeking than firms that face a firm-specific tax ( $\tau < 1$ ). Intuitively, firms that on average pay more taxes want to increase their profitability in the future, and they devote more resources than subsidized or less heavily taxed firms to reaching that goal.

Figure 10. Rent-seeking policy function



*Note:* The figure displays the value of  $\mu$  (a parameter of the model's Pareto distribution) for a given level of productivity.

### **5. Aggregate Effects of Bribing**

This section compares the effects of rent-seeking in the form of bribes relative to an economy without bribing (the benchmark economy). Table 7 shows selected statistics on aggregate variables (such as aggregate output, TFP, and aggregate innovation), firms (such as average productivity per firm and output per firm), and bribing behavior. All variables, except for those in the last two rows, are displayed

relative to the benchmark economy, in which  $\tau = 0$  for all firms.

Table 7. Quantitative effects of bribing

|  | Bribing economy<br>( $h_\tau = 0.002$ ) | Bribing economy<br>( $h_\tau = 0.001$ ) | Bribing economy<br>( $h_\tau = 0.005$ ) |
|--|---|---|---|
| <i>Aggregate statistics</i>                            |   |   |   |
| Output   | 95.60                                   | 90.42                                   | 97.41                                   |
| TFP  | 96.99                                   | 91.34                                   | 98.89                                   |
| Consumption  | 94.05                                   | 88.78                                   | 96.03                                   |
| Aggregate innovation                                   | 71.3                                    | 65.21                                   | 80.28                                   |
| <i>Firm-level statistics</i>                           |   |   |   |
| Average productivity                                   | 97.28                                   | 93.14                                   | 98.25                                   |
| Average size   | 98.12                                   | 92.59                                   | 98.93                                   |
| Output per firm  | 88.81                                   | 84.71                                   | 93.21                                   |
| Number of firms  | 111.43                                  | 119.21                                  | 104.72                                  |
| Std (TFPR)   | 104.13                                  | 108.36                                  | 102.77                                  |
| <i>Bribing statistics</i>                              |   |   |   |
| Percentage of firms bribing                            | 10                                      | 22                                      | 6                                       |
| $avg \left( \frac{\text{bribe}}{\text{sales}} \right)$ | 0.07                                    | 0.13                                    | 0.02                                    |

Note: All results are relative to the benchmark economy in which there is no bribing. TFP = total factor productivity; TFPR = total factor revenue productivity.

When bribing is introduced (column 2), output and TFP decrease by 4.4 percent and 3 percent, respectively (both relative to the benchmark economy with no bribing). This decrease is due to three related effects. First, resources are reallocated from “taxed” firms to “subsidized” firms, that is, from productive firms to unproductive firms. In other words, bribing prevents resources from flowing to the most productive firms, diverting them instead to the firms that succeed in their rent-seeking efforts. Second, rent-seeking activities affect the allocation of resources within firms, because they drive resources away from innovation activities. This shift translates into a reduction in firm-level and aggregate innovation, implying that firms will on average have lower productivity, which also reduces aggregate TFP. Third, the existence of firm-specific subsidies reduces the minimum level of productivity required to operate in the economy. Therefore, firms that in an economy without bribing would have

exited the market instead stay in it (the exit rate decreases).<sup>21</sup> Also, due to this “lack of selection” effect, the number of firms increases (entry is now easier), and firms’ average size, output, and productivity decrease.

As discussed, the quantitative effects of bribing on economies with high incentives to bribe are sizable. What are the quantitative effects in economies with higher incentives to bribe? To assess this, I decrease the cost of bribing (decreasing  $h_t$ ) while keeping the rest of the parameters in the economy unchanged. The results of this exercise are shown in column 3 of table 7. A pattern emerges: as the cost of bribing falls, the losses to TFP, output, consumption, and innovation grow. In addition, as we increase the incentives to bribe by lowering the cost of doing so, the model also delivers features related to underdevelopment, namely lower average firm productivity, a higher number of small business with low scale, and larger TFPR dispersion. Finally, as the cost of bribing increases, the economy gets closer to the undistorted economy (see column 4).

Next, I evaluate how much of the effects of bribery comes from the misallocation channel (effects one and three) and how much comes from the endogenous response of innovation to bribing (effect two). In order to perform this comparison, I keep firm-level innovation fixed at the “undistorted economy” steady state and recompute the aggregate statistics. The difference between the results obtained in this exercise and the results obtained when firms can adjust innovation “optimally” is the aggregate effect of bribing on innovation and long-run TFP. Table 8 compares the economy in which the firm-specific tax or subsidy evolves endogenously while firms adjust innovation (column 2) and the economy in which innovation is fixed at the undistorted level but endogenous bribing is allowed (column 3).

The main result obtained from this counterfactual simulation is that TFP losses are 9.6 percent larger when innovation is allowed to adjust optimally to the introduction of bribing. The economy exhibits higher dispersion in revenue productivity, more firms that are less productive, and a reduction

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<sup>21</sup> In other words, in this scenario there is a larger concentration of firms in the left tail of the productivity distribution.



in average productivity of 19.5 percent. On the basis of these results, I conclude that the dynamic effect of bribing on innovation amplifies the misallocation that comes from bribing.

Table 8. Decomposition of effects

|                              | Bribing economy | Bribing, keeping innovation constant |
|------------------------------|-----------------|--------------------------------------|
| <i>Aggregate statistics</i>  |                 |                                      |
| Output                       | 95.60           | 96.53                                |
| TFP                          | 96.99           | 97.28                                |
| Consumption                  | 94.05           | 95.01                                |
| <i>Firm-level statistics</i> |                 |                                      |
| Average size                 | 98.12           | 98.98                                |
| Output per firm              | 88.81           | 95.2                                 |
| Average productivity         | 97.28           | 97.81                                |
| Number of firms              | 111.43          | 102.21                               |

*Note:* All results are relative to the benchmark economy in which there is no bribing. TFP = total factor productivity.

### **6. Conclusions and Policy Recommendations**

Since Bils, Klenow, and Ruane (2018); Hsieh and Klenow (2009); and Restuccia and Rogerson (2008), the misallocation of resources across firms has been given a major role in the macro development agenda while keeping the distribution of productivity given exogenously. In Hsieh and Klenow (2014), the authors tried to understand why average productivity is lower in poor countries, using a framework similar to that of Hsieh and Klenow (2009) but in a dynamic environment, and therefore making the distribution of productivity endogenous. This paper contributes to this strand of the literature by presenting a general equilibrium model of bribing to highlight bribing's effects on the economy through misallocation (a static effect) and on the distribution of firm-level productivity through reductions in innovation (a dynamic effect). The paper's quantitative model is guided by establishment-level data on bribing and captures reasonably well the cross-country features from the data, namely that countries with higher bribery incidence have lower TFP and lower R&D spending.

The model's results show that rent-seeking and corruption not only are very detrimental to governance—as demonstrated in the “cuadernos” scandal—but also have a large impact on productivity. A clear policy implication of this paper is that it is important to increase the cost of

engaging in bribes both for firms and for government officials. In principle, this could be done by increasing legal punishments if firms or government officials are caught in bribing schemes. However, a second important policy implication of this paper is that bribery incidence tends to be higher in countries where the costs of doing business are high. This result suggests that simplifying and increasing the predictability of the regulatory and bureaucratic frameworks for businesses could have a dual positive impact, increasing investment by reducing the cost of doing business and increasing productivity by reducing rent-seeking behavior. The potential gains from minimizing rent-seeking are large.

In terms of a data agenda, it would be important to generate data on prices and quantities produced at the firm level in order to estimate the distribution of TFPQ (physical productivity). This data would allow researchers to compare the distribution of physical productivity that comes endogenously from the model to its data counterpart.

Future research could also consider the model's sectoral implications, for example, whether some sectors tend to engage more in bribing than others because they face more extensive regulation. According to the model, one should observe more variability in subsidies and taxes across firms in sectors that face more complex regulation. In order to test this implication, more data is needed on the ease of doing business in various sectors and on lobbying and bribing at the firm level in those sectors. Finally, it would be interesting to extend this model to allow firms to lobby or bribe to produce differential entry costs. By blocking potential competition, firms could generate additional rents.

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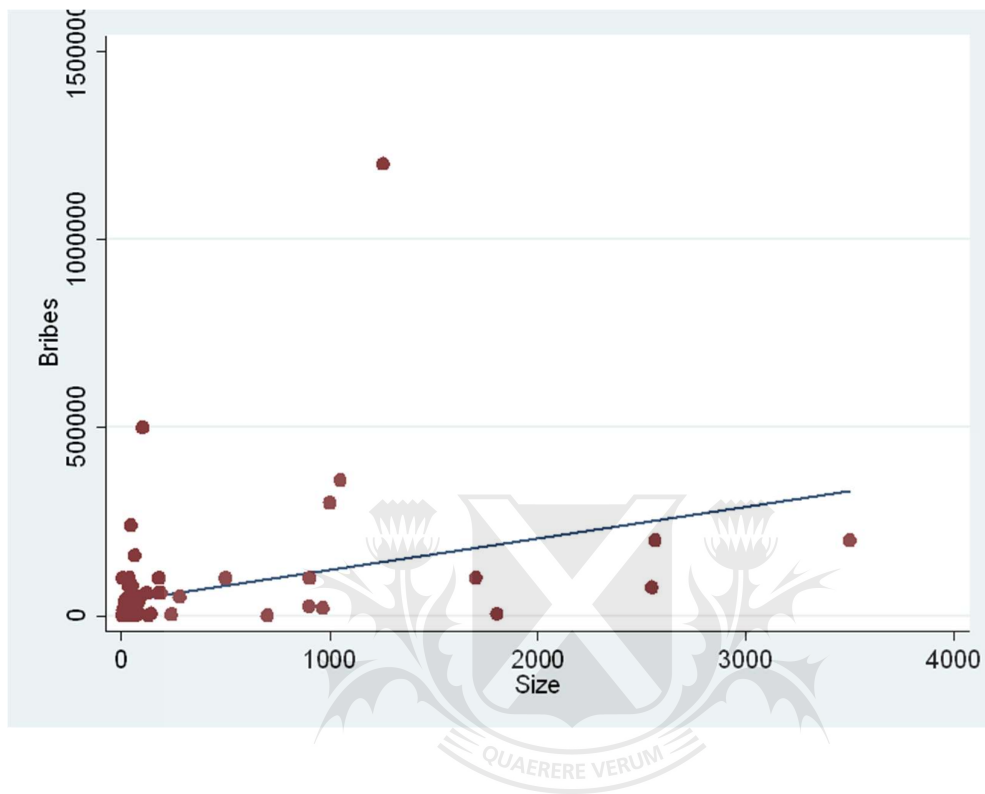


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**Appendix A**

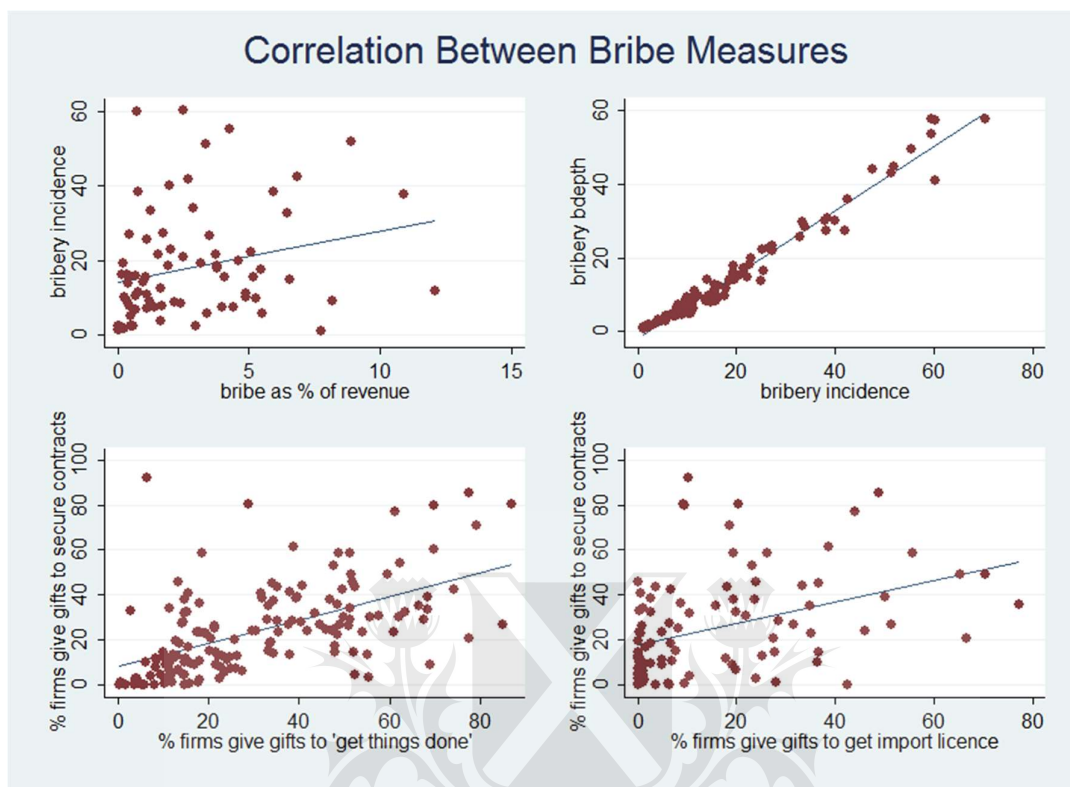
**Additional Figures**

Figure 11. Bribes and size of firms



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Figure 12. Correlations across measures of bribing



## Appendix B

### B.1. Cost Minimization

Marginal cost is obtained from the cost minimization problem of the intermediate firm:

$$\min wl + rk$$

such that

$$y = \exp(z)^{\frac{1}{\rho-1}} k_t^\alpha l_t^{1-\alpha}.$$

The first order conditions are given by

$$(1 - \alpha) \frac{\lambda y}{l} = w,$$

$$\alpha \frac{\lambda y}{k} = r.$$

Then

$$\frac{rk}{\alpha y} = \lambda = \frac{wl}{(1 - \alpha)y} = \frac{wl + rk}{y} = \frac{TC}{y}.$$

(TC stands for total cost.)

$$TC = y\lambda.$$

Solving for  $l$  and  $k$  as a function of  $y$  and  $\lambda$  and plugging the result into the production function,

$$y = \exp(z)^{\frac{1}{\rho-1}} \left( \alpha \frac{y\lambda}{r} \right)^\alpha \left( (1-\alpha) \frac{y\lambda}{w} \right)^{1-\alpha},$$

$$1 = \exp(z)^{\frac{1}{\rho-1}} \left( \alpha \frac{\lambda}{r} \right)^\alpha \left( (1-\alpha) \frac{\lambda}{w} \right)^{1-\alpha},$$

$$\lambda = \frac{1}{\exp(z)^{\frac{1}{\rho-1}}} \left( \frac{r}{\alpha} \right)^\alpha \left( \frac{w}{1-\alpha} \right)^{1-\alpha} = \frac{mc}{\exp(z)^{\frac{1}{\rho-1}}} = \widetilde{mc}.$$

## B.2. The Problem of the Intermediate Firm

$$\Pi_t = \max_p \tau_t p_t q_t - \frac{mc_t}{\exp(z)^{\frac{1}{\rho-1}}} q_t,$$

subject to

$$q_t = Y_t \left( \frac{p_t}{P_t} \right)^{-\rho}.$$

We can write this as

$$\max_p \tau_t p_t Y_t \left( \frac{p_t}{P_t} \right)^{-\rho} - \frac{mc_t}{\exp(z)^{\frac{1}{\rho-1}}} Y_t \left( \frac{p_t}{P_t} \right)^{-\rho}.$$

The optimal pricing is

$$p_t = \frac{mc_t}{\tau_t \exp(z)^{\frac{1}{\rho-1}}} \frac{\rho}{\rho-1} = \frac{\rho}{\rho-1} \frac{\widetilde{mc}}{\tau_t}.$$

Replacing, we have

$$\Pi_t = Y_t \widetilde{mc}^{1-\rho} \tau_t^\rho P_t^\rho \left[ \left( \frac{\rho}{\rho-1} \right)^{1-\rho} - \left( \frac{\rho}{\rho-1} \right)^{-\rho} \right],$$

$$\Pi_t = \left[ \left( \frac{\rho}{\rho-1} \right)^{1-\rho} - \left( \frac{\rho}{\rho-1} \right)^{-\rho} \right] [mc_t^{1-\rho} Y_t P_t^\rho \exp(z) \tau_t^\rho],$$

$$\Pi_t = \frac{mc_t^{1-\rho} Y_t P_t^\rho}{(\rho-1)^{1-\rho} \rho^\rho} \exp(z) \tau_t^\rho = \Pi^d \exp(z) \tau_t^\rho.$$



### B.3. Factor Demand

To obtain factor demands, we first derive equilibrium quantities. Plugging the pricing rule into the demand function, we find that

$$q_t = \left( \frac{\rho}{\rho - 1} \frac{\widetilde{mc}_t}{\tau} \frac{1}{P_t} \right)^{-\rho} Y_t.$$

Plugging this result into the expression for labor in the cost minimization problem, we obtain the demand for labor:

$$\begin{aligned} l &= (1 - \alpha) \frac{y}{w} \widetilde{mc}_t, \\ l &= \frac{(1 - \alpha)}{w} \left( \frac{\rho}{\rho - 1} \frac{\widetilde{mc}_t}{\tau} \right)^{-\rho} P_t^\rho Y_t \widetilde{mc}_t, \\ l &= \frac{(1 - \alpha)}{w} \left( \frac{\rho}{\rho - 1} \frac{\widetilde{mc}_t}{\exp(z) \frac{1}{\rho-1}} \right)^{-\rho} \tau^\rho P_t^\rho Y_t \frac{mc}{\exp(z) \frac{1}{\rho-1}}, \\ l &= \frac{(1 - \alpha)}{w} \left( \frac{\rho - 1}{\rho} \right)^\rho mc^{1-\rho} P_t^\rho Y_t \exp(z_t). \end{aligned}$$

Recall that

$$\Pi^d = \frac{mc_t^{1-\rho} Y_t P_t^\rho}{(\rho - 1)^{1-\rho} \rho^\rho}.$$

Hence,

$$l = \frac{(1 - \alpha)}{w} \left( \frac{\rho - 1}{\rho} \right)^\rho \tau_t^\rho \exp(z_t) \Pi^d (\rho - 1)^{1-\rho} \rho^\rho,$$

$$l = \frac{(1 - \alpha)}{w} \tau_t^\rho \exp(z_t) \Pi^d (\rho - 1).$$

The demand for capital is given by

$$k = \alpha \frac{y}{r} \widetilde{mc}_t,$$

$$k = \frac{\alpha}{r} \left( \frac{\rho}{\rho - 1} \frac{\widetilde{mc}_t}{\tau} \right)^{-\rho} P_t^\rho Y_t \widetilde{mc}_t,$$

$$k = \frac{\alpha}{r} \left( \frac{\rho}{\rho - 1} \right)^{-\rho} mc^{1-\rho} P_t^\rho Y_t \exp(z) \tau_t^\rho.$$

#### B.4. Procedure for Calibration

For the parameters that are not taken from the literature or estimated using a reduced-form equation, I implement a simulated method of moments (SMM). Suppose we have a vector  $A^d$  of  $1 \times n$  moments from the data that correspond to moments from the steady-state distribution coming from the model.<sup>22</sup> Given a vector  $\Theta$  of parameters to estimate, the model produces a vector of  $n$  corresponding moments,  $A^m(\Theta)$ . The SMM estimator  $\hat{\Theta}$  minimizes the weighted-square sum of the distances between the model's simulated moments and their counterparts in the data. Explicitly, it solves

$$\hat{\Theta} = \underset{\Theta}{\operatorname{argmin}} [A^d - A^m(\Theta)]' W_d [A^d - A^m(\Theta)],$$

where  $W_d$  is a weighting matrix, which may be a function of the data. For now, the weighting matrix is going to be the identity matrix. As a result, the estimates are consistent but not efficient.<sup>23</sup>

The implementation of the estimation is as follows. For a given vector of parameters  $\Theta$ , I simulate the model, and as a first step to find the vector  $\hat{\Theta}$  that minimizes the objective function, I use an annealing algorithm. This algorithm is a global optimization routine that jumps randomly around the parameter space and decreases the probability of landing in non-optimal areas with each iteration. After a certain number of iterations, once the objective function seems to be reaching a global maximum, I use a local search method to obtain the calibrated parameters.<sup>24</sup> In section 4.1, I describe the selected moments and the data used for the calibration.

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<sup>22</sup> In particular, these  $n$  moments include the market clearing conditions and budget constraints from the model.

<sup>23</sup> If the model is overidentified, the weighting of each moment is extremely relevant, as in the standard generalized method of moments. In particular, it would be necessary to put more weight on better-identified moments. This weighting would be implemented by using the inverse of the variance-covariate matrix of the data moments.

<sup>24</sup> To be more specific, I use the MATLAB function *fminsearch* that comes with the optimization toolbox.