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Entry Costs, Industry Structure, and Cross-Country Income and TFP Differences[1]

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Abstract

Entry costs vary dramatically across countries. To assess their impact we construct a model with endogenous entry and operation decisions by firms and calibrate it to match the U.S. distribution of firms by size. Higher entry costs lead to greater misallocation of productive factors and lower TFP and output. In the model, countries in the lowest decile of the entry costs distribution have 1.35 to 1.50 times higher TFP and 1.57 to 1.82 times higher output per worker than countries in the highest decile. As in the data, higher entry costs are associated with a larger informal sector and overall number of operating firms, a smaller number of legally registered firms, and a higher concentration of employment in the smallest and largest firms.

JEL: L16, O11, O17, O4.

Keywords: entry costs, TFP, industry structure, formal and informal sectors.

1 Introduction

Cross-country differences in legal barriers to entry provide one of the most striking examples of institutional failure. A key measure of these barriers are legal fees for registering a small domestically operating firm. They are negligible in most developed countries, but average 32 percent of output per worker and reach as high as 764 percent. We show that the variability in barriers to entry accounts for a substantial part of the cross-country differences in productivity and output per worker. We do so by constructing a model with heterogeneous firms in which a higher entry cost distorts the industry structure, allowing low-productivity firms to operate. We find that a 1 percent increase in entry costs is associated with a 0.14 percent decline in TFP, while the corresponding statistic in the data is 0.52 percent. Due to the enormous variation in entry costs this elasticity translates into large differences in economic outcomes: In the model, countries in the bottom decile of the entry cost distribution have, on average, 1.35 times higher TFP and 1.57 times higher output per worker than countries in the upper decile.

Our study of the effects of entry costs in a general equilibrium setting builds on the seminal contributions of Hopenhayn [1992] and Hopenhayn and Rogerson [1993]. In our model, firms are ex-ante identical and face a sunk cost of entry, consisting of regulatory/legal fees and a nonregulatory component (i.e., securing a physical location, initial capital investment, advertisement, etc.). Once the entry cost is paid, the firm receives an i.i.d. productivity draw. At the firm level, production is subject to decreasing returns to scale with a fixed operating cost (overhead labor)—only firms with relatively high productivity draws choose to operate. We show that the model aggregates into a variant of the neoclassical growth model with constant returns to scale and endogenous TFP. We establish a log-linear negative relation between TFP and the entry cost. The mechanism behind this result traces back to Hopenhayn [1992]: With free entry, a higher entry cost implies that fewer entrants pay the sunk cost and receive productivity draws. Wages decline since there is less competition for labor. Lower-productivity firms choose to operate, sullying the pool of producers; firms' average productivity and TFP fall.

We assume that nonregulatory entry costs, measured as a fraction of output per worker, are constant across countries.[1] Since the model predicts a log-linear relation between TFP and the overall entry cost—i.e., inclusive of the nonregulatory component—the magnitude of the nonregulatory costs is of key importance to our analysis: The smaller these costs are the larger the cross-country productivity differences caused by the variation in legal entry barriers. We rely on recent advances in the empirical IO literature to pin down the magnitude of the nonregulatory sunk costs in proportion to the fixed operating cost. In particular, as a benchmark we use the average estimated ratio of the sunk cost to the operating cost from Aguirregabiria and Mira [2007] and Dunne et al. [2009]. Although both studies cover different industries, the estimates are close and concentrated around 1. The first study covers restaurants, gas stations, bookstores, shoe shops, and fish shops, and the second deals with dentists and chiropractors in three different market settings. We also consider the estimates from Collard-Wexler [2008] and Suzuki [2009]. Collard-Wexler [2008] reports an average ratio of 5.94 for the ready-mix concrete industry, while Suzuki [2009] finds an average ratio of 4.31 for the hotel industry. In both of these industries, most of sunk entry costs explicitly arise from construction costs of business premises.

For a given entry-to-operating cost ratio, our model features two additional parameters beyond those in the standard neoclassical growth model: the dispersion of the firms' productivity draws and the magnitude of the fixed operating cost. We calibrate them to match the distributions of employment and firms by size in the U.S.

We derive our benchmark results by feeding the calibrated model the measure of entry costs constructed by adding to each country's legal fees the estimated nonregulatory cost. Implicit in this experiment is an assumption that the representative firm is a standardized firm, for which the cross-country measures of legal entry barriers are constructed. That is, it faces no additional legal entry barriers and, in particular, is not required to pay up front for building or setting up business premises. We assume that all economies in our dataset are

[1] We show in Section 3 that this assumption is conservative in terms of the model's ability to explain cross-country income and productivity differences.

identical except for the legal cost of entry. We compute TFP and the steady-state level of output for each country and compare them with their empirical counterparts. Our calibrated model accounts for 27 percent of the unconditional correlation between entry costs and TFP across countries observed in the data and 18 percent of the correlation between entry costs and output. In the model, countries in the lower decile of the entry cost distribution have, on average, 1.35 times higher TFP than countries in the upper decile.

We also consider alternative measures of entry costs. We add the costs of construction permits and related legal expenses for setting up business premises to our benchmark measure of entry barriers. We calibrate the nonregulatory entry cost to match the average entry-to-operating cost ratio from Collard-Wexler [2008]. Here the representative firm is one with a high nonregulatory entry cost due to large initial sunk investment into business premises. Such a firm, of course, faces the additional legal burden of obtaining construction permits and other relevant approvals. The model generates 50 percent productivity differences between countries in the lower decile and the upper decile of the entry cost distribution.

We extend our model to include the informal sector. We model the latter according to stylized facts documented in La Porta and Shleifer [2008]: Firms in the informal sector are smaller and less productive than small legally operating firms. They rarely grow or become formal firms. The purpose of this exercise is to show that the framework of Hopenhayn [1992], which we adopted here, naturally accounts for a number of "development facts". First, the size of the informal sector is positively correlated with entry barriers and is negatively correlated with productivity and output. Second, the number of legally operating firms is negatively correlated with entry costs and is positively correlated with income. Third, the evidence in Tybout [2000] implies that the number of all operating firms is positively correlated with entry costs and negatively correlated with income. Our model reproduces exactly these patterns: As the entry cost rises, fewer firms are willing to pay. Less competitive pressure allows firms that pay the cost—even those with low productivity—to operate. Average productivity of firms in the formal sector declines, pushing labor into the informal sector. The size of the shadow economy, as a percentage of official output, and the number of informal firms increases. A larger informal sector only partially offsets the output decline in the formal sector; as a result aggregate output falls. Quantitatively, the effects of entry costs on TFP and official output per worker are as large as in the benchmark model. The model's implications about the firms' size distribution in the formal sector depend on the assumed distribution of productivity draws. With a log-normal distribution, the model generates a positive relationship between entry costs and legal firms' average size, their log-size, and the variance of their log-size, consistent with the facts reported in Alfaro et al. [2009].[2] Finally, the model generates a pattern of a "missing middle" [Tybout, 2000, Buera et al., 2009]: In countries with a high entry cost, employment is concentrated in the smallest and the largest firms because entry costs lead to a high number of small informal firms and to a thick right tail of the legal firms' productivity distribution.

Overall, our results echo recent empirical findings on the nature of the productivity gap between rich and developing countries. The McKinsey Global Institute [2001] reports that "market regulations restrict competition and best practice" in India and that it is the prevalence of small, relatively unproductive units, operating alongside a few large productive firms, that leads to lower efficiency in many industries. The McKinsey Global Institute [2006] study of Brazil emphasizes the improper regulation and the large size of the informal sector as major contributors to slow productivity growth; it also stresses the prevalence of small unproductive firms in many Brazilian industries. Nicoletti and Scarpetta [2003] estimate that entry liberalization has a positive effect on productivity in a sample of OECD countries. Bastos and Nasir [2004] find that competitive pressure accounts for a significant part of the variation in firm-level productivity in five transition economies.

Several authors have argued that distortions to the allocation of resources across firms are a major determinant of cross-country income differences. Hsieh and Klenow [2009] ar-

[2] Consider, for example, legal firms' average size. As the entry costs increase, fewer firms pay the entry cost and receive the opportunity to produce. However, of those firms that do enter, lower-productivity firms also choose to operate. In addition, labor shifts to the informal sector. Thus, the overall effect of entry costs on the average size of legally operating firms is ambiguous and will depend largely on the properties of the underlying distribution of productivity draws.

gue that a significant share of the TFP gap between China (India) and the U.S. is due to a misallocation of productive factors across plants. They find that if capital and labor in China (India) were reallocated to mimic the distribution of marginal products in the U.S., it would generate productivity increases of 30 to 50 percent (40 to 60 percent). Restuccia and Rogerson [2008] analyze the potential impact of idiosyncratic tax schemes on resource allocation. They report that the resulting price heterogeneity faced by individual firms may lead to a 30 to 50 percent decline in productivity. Guner et al. [2008] analyze quantitatively the macroeconomic impact of policies that distort firms' size. Alfaro et al. [2008] perform a similar exercise in a model with differentiated products.[3] Buera et al. [2009] argue that an underdeveloped financial sector leads to a significant decline in productivity and output. Their model produces about 40 percent productivity differences between the most and the least financially developed countries. As opposed to most of these contributions, our analysis directly relies on observable measures of entry barriers available for a large number of countries. A recent paper by Moscoso Boedo and Mukoyama [2009] studies the impact of entry and firing costs on productivity and output. Though similar to our model, their model differs from ours in its calibration strategy, formulation of the operating cost, endogeneity of labor, and the absence of the informal sector. Most importantly, their modeling and calibration strategy implies that entry costs affect productivity almost entirely through firms' size: Poor countries have fewer but larger firms than rich countries. In our model, the main mechanism through which the entry cost affects TFP is the average productivity of producing firms; moreover, it is consitent with any (positive or negative) relationship between entry costs and firms' average size.

The rest of the paper is structured as follows. Section 2 briefly describes the data used in the paper. Section 3 describes our benchmark model and main results. Section 4 introduces the informal sector into the model. Section 5 assesses the robustness of our results. We conclude in Section 6. Data sources and definitions are given in the Appendix.

[3] See also Herrendorf and Teixeira [2005], Erosa and Hidalgo-Cabrillana [2008], Buera and Shin [2008], and Burstein and Monge-Naranjo [2009].

2 Data

In this section we describe the data used in our analysis. Data sources and definitions are provided in Appendix A. The two key measures of economic activity that we consider are output per worker and TFP. Output per worker is measured as real output per person in the workforce for year 2000 from the Penn World Table 6.1 [see Heston et al., 2002]. We construct TFP (in logs) following Klenow and Rodriguez-Clare [2005]: We subtract human capital per worker (based on educational attainment) and physical capital per worker from output per worker (all in logs). Both measures of capital are weighted by their share in national income, 2/3 and 1/3, respectively. When discussing the properties of the model with the informal sector, we also use total real per capita output: i.e., the sum of official output and output of the informal sector. Output of the informal sector is the product of real per capita output from Penn World Table 6.1 and the size of the informal sector as a fraction of output estimated by Schneider [2007].

The regulatory component of the cost of entry is given by the legal fees that domestically owned firms that do not require special licensing must pay before they can legally operate (see the World Bank's *Doing Business* surveys 2004-2009). Legal fees range from 0 to 764 percent of output per worker, with an average value of 32 percent of output per worker and a standard deviation of 78 percent (Table 1). The regulatory entry costs are negatively correlated with TFP and output. Countries in the first decile (quartile) of the entry cost distribution have, on average, 3.25 (2.54) times higher TFP than countries in the last decile (quartile).

Legal entry fees are negatively correlated with business density—i.e., the number of legally operating firms per 100 working age persons—and are positively related to the mean and the variance of the log-size of legally operating firms. These correlations are in contrast with the standard development theory view that in poor countries most firms are small [see Tybout, 2000]. Cross-country variation in the size of the informal economy is responsible for this seemingly contradictory empirical evidence. Most of the evidence in Tybout [2000] includes the informal sector [see Liedholm and Mead, 1987], which is populated by firms that are smaller than those in the formal sector [see La Porta and Shleifer, 2008]. The data reported in Table 1 pertain only to firms operating in the formal sector [see Alfaro et al., 2009].[4] The size of the shadow economy, as a percentage of official GDP, is on average large and quite variable. It is positively correlated with legal entry costs and is negatively correlated with measures of economic activity.[5]

Our alternative measures of entry barriers include the legal fees of construction permits, utility connections, and inspections associated with building a physical location in which to operate a firm or establishment, also surveyed by the World Bank. These fees, recorded for a "standardized" warehouse, are about 10 times higher than the legal fees for registering a firm on average and their standard deviation is 840 percent of output per worker. Costs of setting up a physical location are positively correlated with our benchmark measure of entry barriers and are negatively correlated with productivity and output.

From the same Word Bank's sources, we construct the opportunity costs of an entrepreneur's time for registering a firm and obtaining construction permits (see Table 1). These measures translate the number of days required to complete the legal entry procedures into a monetary cost. These costs are positively correlated with the direct costs of entry and negatively correlated with measures of economic activity.

Finally, we consider the World Bank's measures of the minimum capital requirement—the amount firms must deposit in a bank before they can legally start a business. This requirement may represent additional costs for starting a business (see Table 1), especially in economies with tight credit constraints. Minimum capital requirements are positively correlated with entry costs and negatively correlated with productivity and output. However, only the correlation with TFP is statistically significant.

[4] Also, as Alfaro et al. [2009] acknowledge, this data is likely to underrepresent small plants.

[5] This finding dates back to Djankov et al. [2002]. More recently, the World Bank [2008] reports that "... lower barriers to start-up are associated with a smaller informal sector."

3 The Benchmark Model

In this section we present our benchmark model and calibration strategy. We then study the link between entry costs and output, productivity, and other variables of interest.

3.1 The Model

Our benchmark model is a variant of the standard one-sector neoclassical growth model with heterogeneous firms à la Hopenhayn [1992]. It is close to the model developed in Atkeson and Kehoe [2005]. The model economy is populated by infinitely lived households, one-period lived firms, and the government.

3.1.1 Households

There is a continuum of measure 1 of households that inelastically supply N units of labor (workers), consume, invest, and own all firms in the economy. The problem of the representative household is given by

$$\max_{\{C_t, K_{t+1}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t U(C_t),\ \ \beta \in (0,1) \tag{3.1}$$

$$\text{s.t. } C_t + K_{t+1} - (1-\delta) K_t = r_t K_t + w_t N + \Pi_t + TR_t,$$

where C_t denotes consumption, K_t is household capital, r_t is the rental rate on capital, and w_t is the wage. The variable Π_t denotes the firms' profits, and TR_t is a lump-sum transfer from the government; β and $\delta \in (0,1)$ are the discount rate and depreciation rate, respectively.

3.1.2 Firms

Firms are ex-ante identical and maximize profits. There is a strictly positive sunk entry cost, κ_t, which consists of a nonregulatory component, κ_t^{NR}, and a legal entry fee, κ_t^R. We assume that both types of entry costs are a constant fraction of GDP per worker (i.e., that the ratios $\tilde{\kappa}_t = \kappa_t N/Y_t$, $\tilde{\kappa}^R = \tilde{\kappa}_t^R N/Y_t$ and $\tilde{\kappa}_t^R = \kappa_t^R N/Y_t$ are constant over time). After the fixed entry cost is paid, each firm receives a productivity draw a from the distribution F. The production function for a firm with productivity a is given by $y = a^{1-\gamma}\left(k^{\alpha}n^{1-\alpha}\right)^{\gamma}$, where k and n denote capital and labor, respectively. The parameter $\gamma \in (0,1)$ determines the degree of returns to scale in variable inputs.[6] The parameter $\alpha \in (0,1)$ pins down the capital share of output.

If a firm decides to produce, it incurs an operating cost in terms of wages paid to ϕ units of overhead labor. For a firm with productivity a, profits are

$$\pi_t^p(a) = \max_{k_t,n_t} a^{1-\gamma}\left(k_t^{\alpha}n_t^{1-\alpha}\right)^{\gamma} - r_t k_t - w_t\left(n_t + \phi\right). \tag{3.2}$$

A firm will produce only if it can generate non-negative profits: $\pi_t\left(a\right) = \max(\pi_t^p(a), 0)$. Free entry implies that the expected value of a firm (i.e., expected profits) are equal to the entry cost:

$$\kappa_t = \int_0^{\infty} \pi_t\left(a\right) dF(a). \tag{3.3}$$

3.1.3 Aggregation

The existence of economy-wide competitive factor markets implies that in equilibrium, the output, capital, and labor ratios of any two firms are equal to their relative productivities:

$$\frac{y(a)}{y(b)} = \frac{k(a)}{k(b)} = \frac{n(a)}{n(b)} = \frac{a}{b},\ \forall a, b, \tag{3.4}$$

which, in turn, implies that the economy's aggregate output can be written as

$$Y_t = \left(\nu_t \bar{a}_t\right)^{1-\gamma} K_t^{\alpha\gamma}\left(N_t\right)^{(1-\alpha)\gamma},$$

where ν_t is the measure of operating firms, $\bar{a}_t$ is the firms' average productivity, and K_t and N_t are aggregate capital and labor, respectively. Let u_t denote the fraction of labor used directly in production. Notice that each operating firm employs ϕ units of overhead labor. By definition, the number of operating firms (times ϕ) is equal to the amount of labor used

[6] This is the managers' "span of control," as in Lucas [1978, p. 511].

as overhead: $(1-u_t)N_t = \nu_t \phi$. Using this expression we can rewrite aggregate output in a standard Cobb-Douglas form:

$$Y_t = TFP_t K_t^{\alpha\gamma} N_t^{1-\alpha\gamma}, \tag{3.5}$$

where the economy's TFP is defined as follows:

$$TFP_t \equiv \left(\frac{\bar{a}_t}{\phi}\right)^{1-\gamma} \left[u_t^{(1-\alpha)\gamma} (1-u_t)^{1-\gamma}\right]. \tag{3.6}$$

There are two variable components of TFP: One is firms' average productivity, $\bar{a}_t$, and the other, the term in brackets, depends on the allocation of labor between productive and overhead use.

The relations between firm-level variables and aggregate variables (capital, labor, and profits), as well as average productivity, are expressed as follows:

$$K_t = e_t \int_{\underline{a}_t}^{\infty} k_t(a) dF(a), \tag{3.7}$$

$$N = N_t = e_t \int_{\underline{a}_t}^{\infty} (n_t(a) + \phi) \, dF(a), \tag{3.8}$$

$$\Pi_t = e_t \int_0^{\infty} \pi_t(a) \, dF(a) - e_t \kappa_t, \tag{3.9}$$

$$\bar{a}_t = \frac{\int_{\underline{a}_t}^{\infty} a dF(a)}{1 - F(\underline{a}_t)}, \tag{3.10}$$

where e_t denotes the measure of firms entering the market in period t. The rental rate on capital and the wage rate are

$$r_t = \alpha\gamma \frac{Y_t}{K_t}, \tag{3.11}$$

$$w_t = (1-\alpha)\gamma \frac{Y_t}{u_t N_t}. \tag{3.12}$$

3.1.4 Government Budget Constraint and Resource Constraint

The government collects the entry fees from firms and rebates them to the households in a lump-sum fashion:

$$TR_t = e_t \kappa_t^R. \tag{3.13}$$

The resource constraint is

$$C_t + e_t \kappa_t^{NR} + K_{t+1} - (1-\delta) K_t = Y_t. \tag{3.14}$$

3.1.5 Competitive Equilibrium

An equilibrium is a sequence of prices, $\{r_t, w_t\}_{t=0}^{\infty}$; factor demands, $\{n_t(a), k_t(a)\}_{t=0}^{\infty}$; firms' operating decisions, measures of entry and operation, $\{e_t, \nu_t\}_{t=0}^{\infty}$; consumption and capital, $\{C_t, K_{t+1}\}_{t=0}^{\infty}$; and government transfers,$\{TR_t\}_{t=0}^{\infty}$, such that

- (i) consumers choose C and K optimally by solving problem (3.1);
- (ii) firms optimize: the factor demand functions, k and n, solve problem (3.2); the operation decision is optimal, i.e., only firms generating non-negative profits choose to operate;
- (iii) the free entry condition, eq. (3.3), is satisfied;
- (iv) markets clear, i.e., eqs. (3.7), (3.8), and (3.14) are satisfied;
- (v) the government's budget constraint, eq. (3.13), is satisfied.

3.2 Properties of the Model

The first-order conditions of problem (3.2) imply that profits from producing are equal to the firm's share of the gross profits $(1-\gamma)$ minus the operating cost:

$$\pi_t^p(a) = (1-\gamma)a^{1-\gamma}\left(k_t^{\alpha} n_t^{1-\alpha}\right)^{\gamma} - \phi w_t.$$

Profits are increasing in a firm's productivity. Therefore, as long as $a = 0$ is in the support of F, there exists a cutoff level of productivity, $\underline{a}_t$, which makes the marginal firm indifferent to producing or not: i.e., $\pi_t^p\left(\underline{a}_t\right) = 0$. Firms with productivity above the cutoff will produce, and those with lower productivity will not. Thus, since firms' gross profits are proportional to their productivity, the free-entry condition can be written as[7]

$$\kappa_t = \phi w_t \int_{\underline{a}_t}^{\infty} \left(\frac{a}{\underline{a}_t} - 1 \right) dF(a). \tag{3.15}$$

The cutoff condition, $\pi^p(\underline{a}_t) = 0$, and eq. (3.12) imply that the fraction of labor used in production can be expressed as follows:

$$u_t = \frac{\frac{(1-\alpha)\gamma}{1-\gamma}\overline{a}_t}{\frac{(1-\alpha)\gamma}{1-\gamma}\overline{a}_t + \underline{a}_t}.$$

Substituting for w_t from eq. (3.12) and then for u_t from the expression above in the free-entry condition, we obtain an equation relating the entry cost (relative to output) to the productivity cutoff $\underline{a}_t$:

$$\frac{\tilde{\kappa}_t}{(1-\alpha)\gamma\phi} = \left[1 + \frac{1-\gamma}{(1-\alpha)\gamma}\frac{\underline{a}_t}{\overline{a}_t}\right]\left(\frac{\overline{a}_t}{\underline{a}_t} - 1\right)(1 - F(\underline{a}_t)), \tag{3.16}$$

where average productivity is only a function of the cutoff (eq. 3.10). TFP can be expressed as:

$$TFP_t = \phi^{\gamma-1}\left(\frac{(1-\alpha)\gamma}{1-\gamma}\right)^{(1-\alpha)\gamma}\left(\frac{\overline{a}_t}{\underline{a}_t}\right)^{1-\alpha\gamma}\left(1 + \frac{(1-\alpha)\gamma}{1-\gamma}\frac{\overline{a}_t}{\underline{a}_t}\right)^{1-\alpha\gamma}\underline{a}_t^{1-\gamma}. \tag{3.17}$$

Differentiating the right-hand side of eqs. (3.16) and (3.17) we obtain that the cutoff, $\underline{a}(\tilde{\kappa}_t)$, is a decreasing function of the entry cost, $\tilde{\kappa}_t$, and that TFP is an increasing function of the cutoff. Therefore, $TFP(\tilde{\kappa}_t)$ is decreasing in the entry cost. The intuition behind this result traces back to Hopenhayn [1992]. With free entry, a higher entry cost discourages entry. Fewer entrants pay the sunk cost and receive productivity draws. Wages and the productivity cutoff decline since there is less competition for labor. Thus, lower-productivity firms choose to operate, sullying the pool of producers; firms' average productivity and TFP fall.

[7] If F has support over $[x, \infty)$, where x is strictly positive, then the free-entry condition can be written as in eq. (3.15) as long as $(1-\gamma)(1-\frac{x}{\bar{a}}) \geq 1 - \alpha\gamma - \frac{(1-\alpha)\gamma}{u^x}$, where $\bar{a}$ is the expected value of F and u^x is the solution to the following equation: $\tilde{\kappa} = \frac{(1-\alpha\gamma)u^x - (1-\alpha)\gamma}{(1-u^x)u^x}$. If the inequality is not satisfied, then the productivity cutoff is x and u^x is the amount of labor engaged directly in production.

Notice that if $\tilde{\kappa}_t = \tilde{\kappa}\ \forall t$ as we assumed, then the productivity cutoff is time invariant as well: i.e., $\underline{a}_t = \underline{a}\ \forall t$. This implies that average productivity and TFP are constant over time. Thus, as long as the entry cost is a constant fraction of output, the model is a standard neoclassical model with constant TFP and all the standard results (i.e., existence and uniqueness of the equilibrium, features of the transition dynamics, steady-state properties, etc.) apply.

As expressions (3.16) and (3.17) show, the elasticity of TFP to the entry cost depends on the properties of the underlying distribution of productivity draws. We consider two distributions commonly used in the literature [see Axtell, 2001, Atkeson and Kehoe, 2005]: Pareto and log-normal. Suppose firms draw their productivity from a Pareto distribution: i.e., $F(a;\theta) = 1 - a^{-\theta}$, $a \in [1,\infty)$, $\theta > 1$. In this case, average productivity is a linear function of the productivity level of the marginal firm, $\frac{\overline{a}}{\underline{a}} = \frac{\theta}{\theta-1}$, implying that the free-entry condition (3.16) describes a log-linear relationship between the entry cost and marginal productivity:

$$\ln \underline{a} = \frac{\ln\left[\phi\left(\frac{1-\gamma}{\theta} + \frac{(1-\alpha)\gamma}{\theta-1}\right)\right]}{\theta} - \frac{1}{\theta}\ln\tilde{\kappa}. \tag{3.18}$$

It follows that TFP is a linear function of the entry cost (both in logs) and that the elasticity of TFP to the entry cost is fully determined by the managerial span of control, γ, and by the Pareto parameter, θ[8]:

$$\ln TFP = \text{constant} - \frac{1-\gamma}{\theta}\ln\tilde{\kappa}. \tag{3.19}$$

In the case of a log-normal distribution it is not possible to derive a closed-form relationship between the entry cost and TFP. However, our computations show a close-to-linear relationship. The elasticity of TFP to the entry cost is determined by the span of control parameter and the variance of the firms' productivity draws.

In anticipation of our main results, we note that eq. (3.19) is the key expression of the paper since, for a given ratio $\frac{1-\gamma}{\theta}$, it maps the cross-country differences in the entry cost into the cross-country differences in productivity and output. This expression also illustrates

[8] We are grateful to an anonymous referee and to Alex Monge for pointing this out.

that the mapping from legal entry costs to economic outcomes depends significantly on the magnitude of other nonregulatory components of the entry cost, such as initial sunk capital purchases, market research, and advertising. Throughout the paper we assume that the nonregulatory component of the entry cost, $\tilde{\kappa}^{NR}$, as a fraction of output per worker, is invariant across countries. Thus, for each country i the overall entry cost is the sum of the nonregulatory cost of entry and of the legal, or regulatory, cost, denoted $\tilde{\kappa}_i^R$:

$$\tilde{\kappa}_i = \tilde{\kappa}^{NR} + \tilde{\kappa}_i^R,$$

and the variation in the second term is the sole cause of cross-country productivity differences in the model.

In terms of the model's ability to explain the cross-country productivity and income variation, we emphasize that this assumption is conservative vis-à-vis the following two alternatives. First, empirical evidence suggests that nonregulatory entry costs are mostly in terms of sunk capital purchases [see Lambson and Jensen, 1998, Gschwandtner and Lambson, 2002, 2006, Collard-Wexler, 2008, Suzuki, 2009]. Thus, one could model $\tilde{\kappa}^{NR}$ in units of capital. However, the price of investment goods varies systematically with income [Restuccia and Urrutia, 2001] and is strongly positively correlated with legal entry costs. Thus, we would end up having a higher nonregulatory entry cost in countries with higher legal entry fees. Second, one could assume that the nonregulatory component of the entry cost is constant across countries in dollars, rather than a fraction of output per worker. However, recall the free-entry condition in eq. (3.16): The productivity cutoff $\underline{a}$ and TFP are decreasing functions of $\tilde{\kappa}$, which is the entry cost expressed as a fraction of output per worker. By assuming that the nonregulatory component is constant across countries in levels, one de facto assumes higher $\tilde{\kappa}$ in poorer countries, where legal entry costs are higher.[9]

[9] Put differently, the observed ratio κ/Y determines TFP in the model, for each country. If κ is constant across countries, than countries with lower output per worker have higher entry barriers. Consequently, a larger fraction of TFP differences is attributed to entry costs.

3.3 Calibration

We set the neoclassical parameters of our model to standard values and, conditional on the legal entry fees in the U.S., we choose the parameters determining firms' productivity levels to match key features of the distribution of U.S. firms.

We assume that one period in the model represents one year. We choose β so that the steady-state interest rate is $R = 1.041$, as in McGrattan and Prescott [2005]. The depreciation rate, δ, is set to 0.08. This is the value employed by Klenow and Rodriguez-Clare [2005] to construct the cross-country TFP measures used in our analysis. The parameter γ determines the degree of the diminishing returns to scale in variable inputs at the firm level. As a benchmark, we set γ to 0.85. This value is commonly used in the literature [see Atkeson and Kehoe, 2005, Restuccia and Rogerson, 2008] and is very close to the estimated value of 0.84 in Basu [1996]. The choice of the parameter α depends on the capital share in national income, $s_k = \alpha\gamma$. We set s_k to 1/3, which is the value used by Klenow and Rodriguez-Clare [2005]. This implies that when γ is set to 0.85, α is equal to 0.392.

We consider two productivity distributions: a log-normal distribution, $F(a; \mu, \sigma)$,[10] and a Pareto distribution, $F(a; \theta)$. We let the data dictate the value of θ (or σ) as well as the amount of overhead labor, ϕ.

The remaining unknown parameter is $\tilde{\kappa}^{NR}$. The free entry condition in eq. (3.15) implies that it is not the magnitude of the entry cost, but the ratio of the entry to operating cost, that is relevant for assessing the impact of entry costs on the productivity cutoff $\underline{a}$ and TFP. We rely on recent studies by Aguirregabiria and Mira [2007] and Dunne et al. [2009] to pin down this ratio.[11] The ratios of the entry cost to the fixed operating cost for different industries

[10]It can be shown that μ is a scale parameter—its value has no bearing on our results. We set μ to -10.

[11]We note that even though many papers have identified entry costs as an important element in understanding industry dynamics, there are few studies that quantify the actual magnitude of sunk entry costs. Exceptions are the two studies above and Collard-Wexler [2008] and Suzuki [2009]. The estimates in the last two papers are constructed for industries that require a building to start operation. We discuss these estimates in Section 5.

are summarized in Table 2.[12] Remarkably the estimated ratios are close, even though the first study covers restaurants, gas stations, bookstores, shoe shops, and fish shops in Chile, while the second deals with dentists and chiropractors (in three different market settings) for the U.S. The highest ratio is for dentists, who likely require large initial investments into equipment, and the lowest is for bookstores.[13] We use the average ratio, equal to 0.82, to express $\tilde{\kappa}^{NR}$ as a function of ϕ (and other parameters of the model): We set it so that $\frac{\tilde{\kappa}_{USA} Y_{USA}}{\phi w_{USA}} = \frac{\left(\tilde{\kappa}^{NR} + \tilde{\kappa}^{R}_{USA}\right) Y_{USA}}{\phi w_{USA}} = 0.82$. The value of legal entry fees for the U.S. as a fraction of output per worker is 0.0038.

In sum, our model requires two more parameters than the standard neoclassical model, $[\phi, \sigma]$ for log-normal productivity and $[\phi, \theta]$ for Pareto productivity. In the model, productivity is roughly proportional to employment; therefore, we calibrate the productivity distribution to match the distribution of firms and employment by size classes. Overall, to calibrate our two parameters we use 18 moments from the data depicted as dark gray bars in Figure 1.

The calibration routine determines parameter values that minimize the Euclidean distance between the moments generated by the model and their empirical counterparts. Figure 1 compares the moments generated by the calibrated model (Pareto productivity, cream colored; log-normal productivity, light gray) with their data counterparts. The estimated parameters are reported in Table 3. The estimated value of σ is sizable: In the model, productivity and employment are proportional and a substantial productivity variance is required to generate the high dispersion of employment shares across class sizes observed in the data. The value of the parameter ϕ implies that the smallest firm size in the model is 1.9 employees. This value is close to the minimum firm size in the data: i.e., one employee.

[12] Estimates of the entry cost and of the operating cost are in different units in the various sources we use (Tables 2 and 5). We refer the reader to the original sources, given that the ratio is all we need to calibrate our model.

[13] Bookstores and shoe shops (which have the second-lowest ratio) presumably do not require special licensing. Thus, they are the closest to the standardized firms for which the World Bank surveys legal entry fees.

The implied value of the nonregulatory component of the sunk entry cost is 18.38 percent of output per worker, and the entry cost in the U.S., inclusive of legal fees, $\tilde{\kappa}_{USA}Y_{USA}$, is $\$12,112$. The latter is comparable to $\$20,000$, which Ellickson [2007] considers as an upper bound of the entry cost for small businesses in the U.S.

The estimated Pareto parameter, θ, is close to unity, implying a large dispersion of productivity draws across firms. The smallest firm size in this case is 2.8 employees. The implied value of the nonregulatory component of the sunk entry cost is 27.57 percent of output per worker, and the value of the overall entry cost in the U.S. is $\$18,040$.

Finally, we note that the case with log-normal distribution provides a better fit to the data: The residual sum of squares is 15.8, while for the Pareto distribution it is 137. Except for the following section, we report only the results implied by the log-normal distribution of productivity draws.

3.4 Empirical Results

We now assess the quantitative effect of the entry cost on TFP and output. We assume that all economies in our dataset are identical except for the cost of entry. We normalize the number of workers, $N = 1$. For each country, we input into the model the calibrated cost for the U.S. net of legal fees—i.e., $(18.38 - 0.38) = 18$ percent—plus the observed legal entry free for that country. We compute TFP, the steady-state level of output per worker, and other statistics of interest.

The first panel of Figure 2 plots the relationship between TFP and the overall entry cost (both in logs) in the model and in the data when the distribution of productivity draws is log-normal. The slope of the linear relation in our model is -0.14, while in the data it is -0.52, implying that the model accounts for 27 percent of the (average) relation between the entry cost and TFP observed in the data. We also compare TFP differences across countries exhibiting the highest and lowest entry costs. In the model, countries in the first decile (quartile) of the entry cost distribution have, on average, 1.35 (1.25) times higher TFP than countries in the last decile (quartile). In the data the corresponding value is 3.25 (2.54).

As noted earlier, TFP in our model depends not only on firms' average productivity, but also on the allocation of labor between productive and overhead use. On one hand, more firms—i.e., a higher $(1-u)$—increase aggregate productivity because firms face diminishing returns to scale. On the other hand, more operating firms imply that fewer workers are engaged directly in production—i.e., a smaller u—and this reduces TFP.[14] Since u is a function of $\bar{a}/\underline{a}$, the properties of the latter determine the elasticity of the labor allocation component of TFP to the entry cost. For the log-normal distribution the average-to-marginal productivity ratio is decreasing: An increase in the entry cost leads to a decline in the number of operating firms and a decline in the labor allocation component of TFP. For the Pareto distribution $\bar{a}/\underline{a}$ is constant and so are the number of operating firms and the labor allocation component of TFP.[15] Yet, the elasticity of TFP to the entry cost is close to the log-normal case because with the estimated Pareto distribution average productivity has a higher elasticity to $\tilde{\kappa}$: the slope of the relation between TFP and the entry cost is -0.13.[16]

The second panel of Figure 2 plots the log of output per worker.[17] In the model, the relation between the entry cost and output is linear, with a slope of -0.21: The model captures 18 percent of the observed relation between entry costs and output per worker. It is expected that the model accounts for a higher fraction of the correlation between the entry cost and TFP than that between the entry cost and output. In our framework, the entry cost affects output only through TFP and not through the capital-to-output ratio.

[14] As long as $u > (1-\gamma)/(1-\alpha\gamma)$, the first effect always dominates: the overall effect of an increase in the number of operating firms on labor allocation component of TFP is positive.

[15] In Appendix B we show that in the model the relation between the entry cost and the number of operating firms can be reversed while preserving the quantitative impact of entry costs on productivity and output.

[16] However, in the Pareto case the estimated value of the nonregulatory component of the entry cost is higher, which implies smaller cross-country differences in productivity: Countries in the first decile (quartile) of the entry cost distribution have, on average, 1.26 (1.19) times higher TFP than countries in the last decile (quartile).

[17] For ease of comparison, we plot and compute statistics for output only for the countries for which we also have TFP data available. Including in the analysis the countries for which entry cost and output data are available, but TFP data are not, does not change our results.

The latter is determined by the steady-state interest rate, assumed to be identical across countries. Barseghyan [2008] finds these exact patterns in the data. Moreover, he estimates that the effect of entry costs on output is about 1.5 times larger than the effect on TFP, coinciding with the ratio generated by our model.[18] Barseghyan [2008] also finds that entry costs are correlated with property rights, which affect output through the capital-to-output ratio. Hence, the model captures a larger part of the (unconditional) correlation between the entry cost and TFP than between the entry cost and output.

4 The Informal Sector

Djankov et al. [2002] find that greater regulation is associated with a larger informal economy. We introduce the informal sector into the model along the lines of La Porta and Shleifer [2008] and Jones [2008]. We show that the effects of entry barriers in this model are as large as in our benchmark model. In addition, we show that the relationship between the entry cost and (i) the size of the informal sector, (ii) the number of legally operating firms, (iii) the mean and the variance of log-size of legally operating firms, and (iv) the overall number of operating firms is consistent with empirical evidence. Finally, both in the model and in the data very small and very large firms have higher employment shares in countries with high entry costs than in countries with low entry costs.

We model the informal economy as a separate sector. Informal firms are identical and have access to a low-productivity technology without paying either the regulatory or the nonregulatory entry costs. These assumptions are consistent with the facts about the informal sector documented by La Porta and Shleifer [2008]: Unofficial firms are much smaller and less productive than official firms. In particular, their productivity is lower than that of small formal firms. Finally, there is no tendency for informal firms to become formal or to grow.

[18] Recall that in the steady state of the neoclassical growth model, $\ln(Y) = \text{constant} + 1/(1-s_k) \cdot \ln(TFP)$. When the share of capital is 1/3, $1/(1-s_k) = 1.5$.

Households are unchanged with respect to our benchmark analysis except that the final good they consume, Y, is produced by perfectly competitive producers combining formal and informal sector goods, F-good and I-good, respectively. Investment requires only the F-good. Producers of both F- and I-good are price takers in all markets. There is free entry in both the formal and informal sectors. The formal sector is modeled as in the benchmark analysis in Section 3: Firms gain access to the formal sector by paying the entry cost, κ_t, which is constant over time as a fraction of the formal sector's output per worker. Firms operating in the informal sector all have the same productivity b: They share the same technology, $b^{1-\gamma}(k^{\alpha}n^{1-\alpha})^{\gamma}$. Operating in the informal economy does not entail the payment of an entry cost but requires the same overhead labor cost as in the formal sector. Formal and informal goods are imperfect substitutes. The final good is produced according to

$$Y_t = \left[z_F^{1-\psi} F_t^{\psi} + z_I^{1-\psi} I_t^{\psi} \right]^{\frac{1}{\psi}},$$

where $\psi \leq 1$; z_F and z_I are constants, $0 < z_F, z_I \leq 1$ and $(z_F + z_I) = 1$. The households' optimality conditions imply that

$$\frac{F_t}{I_t} = \frac{z_F}{z_I} \left(\frac{1}{p_{I,t}} \right)^{-\frac{1}{1-\psi}},$$

where $p_{I,t}$ denotes the relative price of I-good in terms of F-good, which is the numéraire. The price of the final consumption good is

$$P_t \equiv \left[z_F + z_I p_{I,t}^{\frac{\psi}{\psi-1}} \right]^{\frac{\psi-1}{\psi}}.$$

Producing firms in the F-sector have the following profit function,

$$\pi_t^p(a) = \max_{k_t, n_t} a^{1-\gamma} \left(k_t^{\alpha} n_t^{1-\alpha} \right)^{\gamma} - r_t k_t - w_t \left(n_t + \phi \right),$$

and the following free-entry condition,

$$\kappa_t = \int_0^{\infty} \max(\pi_t^p(a), 0) dF(a).$$

The F-sector's aggregate output and productivity can be expressed as

$$F_t = TFP_t K_{F,t}^{\alpha\gamma} \left(N_{F,t} \right)^{1-\alpha\gamma},$$

$$TFP_{F,t} = \left(\frac{\bar{a}_t}{\phi} \right)^{1-\gamma} u_{F,t}^{(1-\alpha)\gamma} \left(1 - u_{F,t} \right)^{1-\gamma},$$

where $K_{F,t}, N_{F,t}$, $\bar{a}_t$ and $u_{F,t}$ refer to the formal sector's aggregate capital and labor, firms' average productivity, and the share of labor used in production, respectively. The expressions for the rental rate on capital, the wage rate, and the cutoff condition are as in the benchmark analysis:

$$r_t = \alpha\gamma \frac{F_t}{K_{F,t}},\ w_t = (1-\alpha)\gamma \frac{F_t}{u_{F,t}N_{F,t}},\ w_t = (1-\gamma)\frac{F_t}{(1-u_{F,t})N_{F,t}}\frac{\underline{a}_t}{\overline{a}_t}.$$

Using the expressions for the wage rate and the cutoff condition we can express the fraction of labor used in production as

$$u_{F,t} = \frac{\frac{(1-\alpha)\gamma}{1-\gamma}\overline{a}_t}{\frac{(1-\alpha)\gamma}{1-\gamma}\overline{a}_t + \underline{a}_t},$$

and we can write the firms' entry condition into the formal sector as

$$\frac{\tilde{\kappa}_t}{(1-\alpha)\gamma\phi} = \left[1 + \frac{1-\gamma}{(1-\alpha)\gamma}\frac{\underline{a}_t}{\overline{a}_t}\right]\left(\frac{\overline{a}_t}{\underline{a}_t} - 1\right)\left(1 - F\left(\underline{a}_t\right)\right).$$

The latter is identical to the free entry condition (3.16) in the benchmark model. Thus, the effect of the entry cost on (the formal sector's) TFP and output per worker is identical in both models. Moreover, the effect of the entry cost on formal sector's productivity and output per worker does not depend on the value of the informal sector parameters: i.e., ψ, b, and z_I.

The informal firms' maximization problem is

$$\pi_t(b) = \max_{k_t,n_t} p_{I,t} b^{1-\gamma}\left(k_t^{\alpha} n_t^{1-\alpha}\right)^{\gamma} - r_t k_t - w_t\left(n_t + \phi\right).$$

Using the firms' optimality conditions we can express output and TFP as

$$\begin{aligned} I_t &= TFP_{I,t} K_{I,t}^{\alpha\gamma}\left(N_{I,t}\right)^{1-\alpha\gamma}, \\ TFP_{I,t} &= \left(\frac{b}{\phi}\right)^{1-\gamma} u_{I,t}^{(1-\alpha)\gamma}\left(1-u_{I,t}\right)^{1-\gamma}, \end{aligned}$$

where $K_{I,t}, N_{I,t}$, and $u_{I,t}$ refer to the informal sector's aggregate capital and labor, and the share of labor used in production, respectively. The rental rate on capital, the wage rate, and the free-entry condition into the I-sector can be written, respectively, as

$$\frac{r_t}{p_{I,t}} = \frac{\alpha\gamma I_t}{K_{I,t}},\ \frac{w_t}{p_{I,t}} = \frac{(1-\alpha)\gamma I_t}{u_{I,t}N_{I,t}},\ \frac{w_t}{p_{I,t}} = \frac{(1-\gamma)I_t}{(1-u_{I,t})N_{I,t}}.$$

From the last two equations it follows that $u_{I,t}$ and the size of informal firms are constant over time. Finally, it can be shown that the size of firms in the informal sector always coincides with the size of the smallest legally operating firm. Both variables are invariant to the entry cost. That is, the smallest firms are of the same size in all economies.

4.1 Calibration

As in the benchmark case, we calibrate our model to the U.S. economy. We do not need to recalibrate the parameters governing the distribution of productivity draws in the formal sector, the fixed operating cost, and the nonregulatory component of the entry cost since the structure of the formal sector is identical to that in the benchmark model.[19] The additional parameters to be calibrated are ψ, z_I, and b. The key parameter here is the elasticity of substitution between formal and informal goods. Empirical estimates of the elasticity of substitution between goods produced in the same industry range from 3 to 10 [see La Porta and Shleifer, 2008, Hsieh and Klenow, 2009]. These values correspond to $\psi \in [0.66, 0.90]$, because the elasticity of substitution between formal and informal goods in the model is $(1-\psi)^{-1}$. In what follows we report results for $\psi = 0.78$: i.e., the mid-point of the empirically plausible interval. We assess the robustness of our results for $\psi = 0.66$ and $\psi = 0.90$ in Section 5. The remaining two parameters, z_I and b, are calibrated to match the size of the informal sector in the U.S. (8.3 percent of official output) and to equate the lowest productivity used in the U.S. formal sector to that of the informal sector.[20]

[19] In particular, the firms' size distribution in the formal sector is identical to that in the benchmark model.

[20] The assumption that the lowest productivity of the U.S. formal sector coincides with that of the informal sector is, we recognize, somewhat arbitrary. However, our findings are not sensitive to this assumption: Requiring that $\underline{a} = 0.5b, 2b$, or $4b$ has virtually no effect on the results of our analysis. When $\underline{a} = b$, the informal sector may produce even when the F- and I-good are perfect substitutes, i.e., when $\phi \to 1$.

4.2 Results

As in the benchmark analysis, we assume that all economies are identical except for the cost of entry and we normalize N to 1. For each country, we input the observed value of the entry cost into the calibrated model and compute TFP, the steady-state level of output, and other statistics of interest.

As derived above, the effects of the entry cost on output per worker and productivity of the formal sector, F/N_F and TFP_F, are identical to those on output per worker and TFP in the benchmark model. As in the benchmark model, ouptut per woker in the formal sector in a high-entry-cost country is low because low-productivity firms sully the pool of producers. However, the level of formal sector output (Figure 3, top panel) is low for two reasons: Low-productivity firms operate and fewer workers are employed. A 1 percent increase in the entry cost leads, on average, to a 0.30 percent decline in formal sector output. Countries in the bottom decile (quartile) of the entry cost distribution have, on average, 1.85 (1.56) times higher formal sector output than countries in the top decile (quartile). The difference between formal output per worker and formal output is due to the "flight" to the informal sector. As the entry cost rises, fewer firms are willing to enter the formal sector causing the number of legally operating firms to decrease and the size of the informal sector to rise, subtracting labor away from the formal sector.

We emphasize that there is a certain ambiguity relating the predictions of our model to the data stemming from the measurement of output per worker. In the Penn World Table output per worker is constructed by dividing real output of the formal sector by the size of the workforce.[21] It is not clear whether the workers in the informal sector are included in the workforce. We consider two opposite cases. First, suppose the informal sector workers are not part of the workforce in the data. Then, model-generated output per worker and TFP in the formal sector are directly comparable to output per worker from the Penn World Table

[21] The Penn World Table acknowledges that the definitions of the workforce, which come from the International Labor Organization, may vary from country to country. See http://pwt.econ.upenn.edu/Documentation/PWT_63webac_final.doc.

and the corresponding TFP measure. It follows that the model's ability to explain cross-country productivity and income differences is identical to that of the benchmark model. Second, suppose informal sector employees are accounted for in the workforce. Then, for each country the proper counterpart to the empirical measure of output per worker is not F/N_F but $F/N = F$.[22]

One way to avoid the ambiguity in the composition of the workforce is to assume that the ratio of total labor force to population is constant across countries and compare the model-generated measures of total per capita output to their empirical counterparts (Figure 3, bottom panel). In the model, a 1 percent increase in the entry cost leads to, on average, a 0.23 percent decline in per capita output, which is 28 percent of the corresponding figure in the data, 0.82 percent. Countries in the bottom decile (quartile) of the entry cost distribution have, on average, 1.62 (1.43) times higher per capita output than countries in the top decile (quartile). The effect of the entry cost on per capita output is slightly larger than on per worker output in the formal sector, because in the model per capita output is the average of output in the formal and informal sectors. As the entry cost rises, labor is reallocated to the less-productive informal sector. In addition, the relative price of output in the informal sector falls, magnifying the effect of the entry cost on overall output.

We next describe the relation between the entry cost and various features of industry structure. The top panel of Figure 4 compares the measures of business density with their empirical counterparts. Both in the model and in the data a higher entry cost is associated with a smaller number of legally operating firms.[23] At the same time, the average size of the legally operating firms is increasing with the entry cost, which is consistent with the data

[22] That is, if in the data the informal sector workers (or work hours they provide) are attributed to the employment in the formal sector, then the empirical measure of output per worker underestimates the actual output per worker by a factor of (N/N_F).

[23] Notice that our model is calibrated to match the firms' average size or, equivalently, the business density in the U.S. Since the best linear fit to the data implies a business density twice as large as the one observed for the U.S., our model is constrained to generate a weaker relation between entry cost and business density. In fact, the slope of the best linear fit to the data is twice the slope generated by the model. Nevertheless, both the data and the model show a precipitous decline in the number of operating firms as entry costs rise.

(Figure 4, bottom panel). That is, as the entry cost increases, the decrease in the number of legally operating firms more than offsets the decline in labor employed by the formal sector.

In the top panel of Figure 5 we plot the size of the informal sector. The model predicts roughly the same relation between the entry cost and the size of the informal sector as in the data. Also, since firms operating in the informal sector are smaller than firms in the formal sector, a higher entry cost leads to a greater overall number of operating firms, consistent with the evidence in Tybout [2000] (Figure 5, bottom panel).[24]

The model also reproduces the features of the distribution of firms by size: The average log-size of legally operating firms increases and so does the variance of their log-size (Figure 6). Since in the model employment and productivity are proportional, the relation between the entry cost and the variance of the formal sector firms' log-size distribution is determined by the underlying distribution of productivity draws. In particular, it can be shown that

$$\text{Var}(\ln(N)) = \text{Var}(\ln(c_0(\underline{a})\, a + \phi)) \approx \text{Var}(\ln(a)),$$

where $c_0(\underline{a})$ is a function of the productivity cutoff $\underline{a}$ and the approximate equality holds because ϕ is small. In turn, this implies that the relation between the entry cost and $\text{Var}(\ln(N))$ is fully described by the properties of the underlying distribution of the productivity draws. If the variance of the distribution of productivity of producing firms is decreasing in the cutoff, as is the case with the log-normal distribution, then $\text{Var}(\ln(N))$ is increasing in the entry cost.

Finally, in Figure 7 we plot the distributions of employment and firms by size in the top and bottom decile of entry costs. The employment shares in high-entry-cost countries exhibit the pattern of the missing middle discussed in Tybout [2000]: The smallest and the largest

[24] Gollin [2008] introduces in a model à la Lucas [1978] heterogeneity in entrepreneurial skills. The most able individuals operate large firms as full-time managers; people of intermediate ability split their time between self-employment and working for full-time entrepreneurs; the least-able people are workers. Gollin [2008] shows that, consistent with the data, poorer countries have a larger share of small firms (self-employment). In his model, small firms are more productive than large ones: This is at odds with the evidence in La Porta and Shleifer [2008].

firms in these countries have much higher employment shares than the corresponding firms in low-entry-cost countries. The positive relation between the entry cost and the employment share of the smallest firms arises naturally because of the positive relationship between the entry cost and the size of the informal sector. The positive relationship between the entry cost and the employment share of the largest firms occurs via changes in the distribution of legally operating firms, $\frac{F(a)}{1-F(\underline{a})}$, $a \geq \underline{a}$. As the entry cost increases, the productivity cutoff $\underline{a}$ declines and the dispersion of the productivity distribution of formal firms increases, implying a larger employment share of the firms at the right tail of the productivity draws.

We conclude this section by emphasizing that some of the relationships described above are not driven by log-normality of firms' productivity draws. In particular, a higher entry cost reduces business density and increases the size of the informal sector and the overall number of operating firms with the Pareto distribution as well. However, with the Pareto distribution, the formal sector firms' average size, average log-size, and variance of their log-size do not depend on the entry cost.[25]

5 Robustness Analysis and Discussion

In this section we assess the robustness of our findings along several dimensions and provide additional discussion. The results of the experiments below are collected in Tables 4 and 6. In particular, each row corresponds to a single experiment and reports average income and productivity differences in the benchmark model and the model with the informal sector between countries in the bottom and top decile (by entry cost).

5.1 Calibration

Returns to scale in variable inputs and capital share of output. In the benchmark calibration we set the returns to scale in variable inputs to $\gamma = 0.85$. There is evidence,

[25] We note that many distributions, including exponential and uniform, lead to the same relations as in the case of log-normal distribution.

however, in favor of lower values of this parameter. Calibration in Guner et al. [2008] yields a value of $\gamma = 0.802$. Chang [2000] argues for $\gamma = 0.80$. Veracierto [2001]'s calibration yields a value of $\gamma = 0.83$. Recalibrating our model with $\gamma = 0.80$ allows us to explain an even larger part of the observed relationship between the entry cost and macroeconomic outcomes (see Table 4, Row 2).

Parente and Prescott [2000, 2005] argue for a higher capital share of output. With $s_k = 0.65$, the model generates productivity differences similar to those generated by the benchmark model, but output differences are higher (Table 4, Row 3).

Elasticity of substitution. A higher elasticity of substitution between the formal and informal sector leads to a stronger "flight to informality" caused by increases in the entry cost. Thus, the higher the elasticity of substitution, the stronger the effect of the entry cost on the formal sector and total output (Table 4, Rows 4 and 5).

Measures of economic performance. In our benchmark analysis we rely on output per worker and TFP data for the year 2000 as measures of economic performance. Using data for 1996 or 2003 for output (1996 for TFP)[26] does not significantly change any of the statistics reported in the paper or the quantitative success of our model.

5.2 Entry Costs: Broader Measures and Correlated Distortions

Broader measures of the cost of entry. The elasticity of TFP to the entry cost derived in our model does not depend on the entry cost measures.[27] The relationship is linear for Pareto productivity and close to linear for log-normal productivity. Clearly, the cross-country differences in productivity and output generated by the model depend on the cross-country variability of entry costs. A broad measure of the cost of entry implies larger (smaller) cross-country productivity and income differences if the broad measure is more (less) volatile than

[26] As discussed in Appendix A, TFP data for 2003 are not available.

[27] Using different measures of the U.S. entry cost has no effect on the calibrated value of the Pareto parameter θ. The effect on the calibrated variance of the log-normal distribution is tiny. Consequently, the elasticity of TFP to the entry cost is practically invariant to changes in the U.S. entry cost measure used for calibration.

the narrow measure.

In our first experiment, we add to our benchmark measures of legal entry barriers the time cost of registering the firm and recalibrate the model. The results do not significantly differ from those in the benchmark case and are reported in Table 6 (Row 1).

In our second, third, and fourth experiments, we aim to assess the robustness of our results with respect to the calibration of the nonregulatory component of the entry costs. In these experiments, we set the ratio of entry cost to the operating cost in the U.S. to 5.94, which is the average ratio for ready-mix concrete plants from Collard-Wexler [2008] (see Table 5). His entry cost estimates consist in large part of the cost of building the premises.[28] As discussed in Section 2, the World Bank provides data on the regulatory costs for building and setting up business premises. We add those to our benchmark measures of legal entry barriers and recalibrate the model. The resulting cross-country TFP differences are larger than in the benchmark model, even though the nonregulatory component of the entry cost reaches 95 percent of output per worker, which is $61,383 in the U.S. This is because the costs of building and setting up premises are higher and more variable than the costs of registering a firm. In the benchmark model, countries in the bottom decile have, on average, 1.50 times higher productivity and 1.82 times higher output per worker then the countries in the top decile (Table 6, Row 2). The corresponding numbers for formal sector and total output in the model with the informal sector are 2.33 and 1.96, respectively. The third experiment adds the time costs of (i) building and setting up premises and (ii) registering the firm to the measure of legal entry barriers used in the second experiment. The resulting productivity differences are similar to those in the second experiment (Table 6, Row 3).

[28] Suzuki [2009] provides another example of an industry that requires initial investment into a building. He finds that the ratio of the sunk entry cost to the operating cost in the Texas hotel industry is 4.31. Most of the sunk entry costs in the hotel industry also arise from the expenses associated with building the hotel. Finally, Aguirregabiria and Ho [2009], study the airline industry and find the ratio of entry to operating cost of 2.10. We do not use the latter estimate to calibrate our model because we do not observe regulatory entry barriers into the airline industry across countries. Presumably, operating an airline entails complying with many more regulations than other industries we are considering.

In the fourth experiment, we set the fixed-to-operating cost to an extreme value: five times the average estimate in Collard-Wexler [2008]. The measure legal entry costs is the same as in the second experiment. The estimated value of the nonregulatory sunk entry cost is now 317.3 percent of output per worker, which is $204,796 in the U.S. Yet, even in the presence of such an extreme nonregulatory sunk cost, the regulatory burden lowers productivity and output from the top to the bottom decile by 30 and 48 percent, respectively (Table 6, Row 4).

Finally, we consider minimum capital requirements. In many countries, an entrepreneur must deposit an initial amount of funds into a bank or other depository institution before it can operate legally. While we recognize that some of these funds might be recoverable, we note that in many high-entry-cost countries entrepreneurs face severe credit constraints and high interest rates [see Banerjee and Duflo, 2005], effectively making the minimum capital requirement an additional entry cost. In row 5 of Table 6 we report the results of an experiment in which the overall entry cost is the sum of our benchmark measure and 50 percent of the minimum capital requirement. The resulting differences in productivity and output are higher than in the benchmark case.

Borrowing constraints. If entrepreneurs must borrow to finance entry, then the effective cost will be higher. As noted above, since entrepreneurs typically face higher borrowing costs in poorer countries, it follows that borrowing constraints would magnify the effect of entry costs on economic activity and lead to even higher cross-country productivity differences than implied by our model.

Corruption. Levels of corruption and entry costs are strongly correlated in the data [see Barseghyan, 2008]. One can think of corruption as either a tax on firms' profits, τ^{π}, and/or a markup on measured entry costs, τ^{κ}. Corruption acts as a multiplier, $(1+\tau^{\kappa})/(1-\tau^{\pi}) > 1$, on entry cost. Countries with higher entry costs tend to have higher rates of corruption. Hence, corruption magnifies the negative effect of higher entry costs on economic activity.

Output net of entry costs. Up to this point we have treated the entry cost payments as part of a country's income. An alternative assumption is that entry costs represent a deadweight loss akin to unproductive government spending. To check whether this can affect our results, we compute output net of the entry costs. Net output is almost perfectly correlated with gross output and these two measures of output have essentially identical elasticities with respect to the entry cost. In countries with higher entry costs, fewer firms pay the costs of entry and the net-to-gross output ratio is nearly constant across countries.

5.3 Long-Lived Firms

In our benchmark analysis in Section 3, we argued that the sizable effects of entry costs on TFP are related to the volatility of the underlying productivity draws. However, in a model where firms are one-period lived we might be overstating the variance of productivity by attributing all of the heterogeneity in firms' size to productivity and none to age effects.[29] In reality, the evidence suggests [see Klette and Kortum, 2004] that entrants are much smaller then incumbents and, conditional on survival, they grow as they age. Eventually firms become obsolete and exit. In what follows we assess the robustness of our results to the assumption of long-lived firms.

After the fixed entry cost is paid, each firm receives a productivity draw a_0 from a log-normal distribution $F(a; \mu, \sigma)$.[30] In subsequent periods, each firm's productivity evolves according to

$$a_s = \begin{cases} \lambda_s a_{s-1} & \text{with probability } p_s \\ 0 & \text{with probability } (1-p_s) \end{cases}, \tag{5.1}$$

where the parameters governing the dynamics of firms' productivity, $\{\lambda_\tau\}_{\tau=1}^{\infty}$, and the probability of surviving, $\{p_\tau\}_{\tau=1}^{\infty}$, are exogenous.

Productivity of an age-t firm, relative to its initial productivity draw (i.e., $\bar{\lambda}_0 = 1$), is denoted by $\bar{\lambda}_t = \Pi_{j=1}^{t} \lambda_j$. We assume that the function $\bar{\lambda}$ is (weakly) increasing and then (weakly) decreasing, which is consistent with the notion that, conditional on survival, the

[29] See an earlier draft of this paper [Barseghyan and DiCecio, 2009] for a detailed description of the model, as well as the robustness of the relevant results to various modeling assumptions.

[30] As in the benchmark model, it can be shown that μ_a is a scale parameter—its value has no bearing on our results.

firms' productivity grows but eventually declines. We also assume that a firm's productivity eventually declines back to the level of the initial draw, i.e., $\lim_{t\to\infty} \bar{\lambda}_t \to 1$. The exogenous component of the survival function is given by $\bar{p}_t = \Pi_{j=1}^{t} p_j$ and it is decreasing. We assume that firms have a maximum life span $\bar{N} < \infty$, i.e., $p_{\bar{N}+1} = 0$. Notice that $\bar{p}_t$ is the upper bound on the survival function: In equilibrium a firm exits because either it receives a zero productivity draw or its productivity, while still positive, falls below an endogenously determined productivity threshold.

The value function[31] for a firm of vintage s with productivity a and the free-entry condition are given by

$$V_t(a,s) = \max\left[\pi_t(a) + \frac{p_{s+1}}{R_{t+1}} V_{t+1}(\lambda_{s+1}a, s+1), 0\right], \tag{5.2}$$

$$\kappa_t = \int_0^\infty V_t(a,0)\, dF(a). \tag{5.3}$$

We parametrize firms' productivity evolution and the exogenous component of the survival function as follows:

$$\bar{p}_s = \begin{cases} (1+s)^{-\eta_0} & 0 \le s \le \bar{N} \\ 0 & s > \bar{N} \end{cases},$$

$$\bar{\lambda}_s = 1 + \text{Beta}(\frac{s}{\bar{N}}; \eta_1, \eta_2),\ 0 \le s \le \bar{N},$$

where s is a firm's age, $\bar{N} = 400$ is the upper bound on firms' life span, and Beta denotes the p.d.f. of the beta distribution. The parameters $\eta_0 \ge 0$, $\eta_1 \ge 1$, $\eta_2 \ge 1$ are to be calibrated.

We assume that the economy in a steady-state equilibrium: prices, quantities, and the measures of entry and operation are all constant over time. This version of the model requires five more parameters than the standard neoclassical model: $[\sigma, \phi, \eta_0, \eta_1, \eta_2]$. As in the benchmark, the model's empirical properties are determined mostly by the distribution of productivity across firms. This distribution is a function of productivity draws at birth but also depends on how firms' productivity evolves as they age. As in the benchmark

[31] To economize on notation, we index V_t by the time subscript and suppress state variables as arguments in the firms' value function.

model, productivity is proportional to employment. Therefore, we calibrate the productivity distribution to match the distribution of firms and employment by size classes, as in Section 3.3. In addition, we use data on the distribution of firms by age (i.e., seven additional moments) to capture how productivity changes over time. Overall, we use 25 moments to calibrate five parameters.

The vector of calibrated parameters is [3.65, 0.45, 0.59, 2.58, 27.60] and fit of the model to the data is shown in Figure 8. The calibrated parameters imply a high exit rate at early ages and, conditional on survival, an initial rapid growth, a productivity peak at around age 20, and a decline afterward. These patterns are consistent with the stylized facts about firms' evolution over time, summarized in Klette and Kortum [2004]. The model matches well a number of available statistics that have not been used in the calibration. The smallest firm size in the model is 0.78 employees. The entry rate in the model is 6.1, which is close to its empirical counterpart of 8.1 percent. The job creation (destruction) in the model is 4.5 percent of total, which is more than half of the 8.38 (8.43) percent observed in the data. It is expected that job creation and destruction are smaller than in the data, since in the model there are no idiosyncratic productivity shocks. The sum of all firms' one-period profits, net of the operating and sunk entry costs [i.e., the payments to organization capital in the language of Atkeson and Kehoe, 2005] are 8.94 percent in the model, while for the U.S. manufacturing they are about 8 percent.

The slope of the relationship between TFP and entry costs (both in logs) generated by the model is -0.14, which coincides with that in the benchmark model. The estimated value of the entry cost is 19.04 percent of output per worker, which nearly coincides with that in the benchmark model. Consequently, the resulting impact of entry barriers on economic activity is the same as in the benchmark model.

5.4 Open Economy Considerations

In our model, the interest rate is the same for every country: The model is consistent with unrestricted capital flows.[32] In addition, allowing firms' equity shares to be traded within or across borders would not change our results—each firm would be valued at the present discounted value of its expected profits. Moreover, since we assume that the productivity distribution is the same across countries, the nationality of entering firms is immaterial. The only restriction needed for our results to hold is that a firm with a given productivity level cannot replicate itself within a country or across countries.

6 Conclusions

Differences in industry structure due to distorting policies are often seen as a reason for cross-country variation in productivity and output. However, theoretical constructs must be confronted with the data if they are to identify which policies are important and how much they affect economic outcomes. In this paper, we have shown that the observed variation in regulatory entry costs leads to substantial cross-country differences in TFP and output. Entry barriers allow unproductive firms to operate, changing the industry composition and lowering its average productivity. This mechanism is complementary to the misallocation of capital and labor among a given set of operating firms emphasized by Restuccia and Rogerson [2008] and Hsieh and Klenow [2009]. The quantitative effect of lower entry costs is similar to that of the marginal product equalization found by Hsieh and Klenow [2009]. The latter implies a 1.30-1.50 (1.40-1.60) ratio of U.S. TFP to that of China (India), while the corresponding empirically observed TFP ratio is 2.53 (3.12). We find that entry costs lead to a 1.37 to 1.50 TFP ratio between countries with the lowest and the highest costs. The corresponding ratio in the data is 3.25.

Consistent with empirical evidence, in our model entry costs affect economic activity

[32] Models with heterogeneous firms and endogenous TFP have been successful in the trade literature. See Melitz [2008] and the references therein.

via firms' average productivity and not their size. In fact, our benchmark model has no implications about the relation between the entry cost and firms' average size. The model incorporating the informal sector accounts for both the negative relationship between the entry cost and the overall number of operating firms [Tybout, 2000] and the positive relationship between the entry cost and the formal business density [Alfaro et al., 2009]. The reconciliation of this seemingly contradictory empirical evidence is achieved by our model's ability to account for a larger size of the informal economy in countries where it is more costly to operate a firm legally.

The model developed here can be extended further to study the combined effect of entry barriers and other sources of misallocation analyzed in the literature. For example, we leave for further research the study of the interaction of entry costs with borrowing constraints [see Buera and Shin, 2008, Buera et al., 2009] and an analysis of various distortionary policies of the kind analyzed by Restuccia and Rogerson [2008] and Guner et al. [2008] in conjunction with costly entry.

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Variable	**Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Corr. with entry costs**	**Corr. with log output p.w.**	**Corr. with log TFP**
Entry costs (% of GDP p.w.)	128	32.45	78.30	0.00	764	1.00 [–]	−0.37 [0.000]	−0.39 [0.000]
Entry time	128	6.82	5.17	0.38	37.88	0.38 [0.000]	−0.33 [0.000]	−0.42 [0.000]
Constr. permits costs	128	351	840	1.82	6,867	0.58 [0.000]	−0.49 [0.000]	−0.57 [0.000]
Constr. permits time	128	37.27	21.86	6.75	138.4	0.34 [0.000]	−0.26 [0.003]	−0.39 [0.000]
Min. capital requirement	128	61.88	148.72	0	1,207	0.12 [0.173]	−0.28 [0.001]	−0.14 [0.191]
Output per worker (logs)	128	9.35	1.10	6.90	11.54	−0.37 [0.000]	1.00 [–]	0.94 [0.000]
TFP (logs)	86	5.87	0.54	4.30	6.77	−0.39 [0.000]	0.94 [0.000]	1.00 [–]
Business density	76	5.01	4.01	0.00	15.80	−0.42 [0.000]	0.57 [0.000]	0.58 [0.000]
Average log firm size	75	3.04	1.39	0.24	6.12	0.24 [0.041]	−0.75 [0.000]	−0.66 [0.000]
Variance log firm size	75	2.48	1.19	0.53	7.23	0.21 [0.065]	−0.64 [0.000]	−0.54 [0.000]
Shadow economy (% of GDP)	110	34.92	14.21	8.38	67.74	0.31 [0.001]	−0.66 [0.000]	−0.65 [0.000]
Total output per capita (logs)	110	8.78	1.07	6.57	10.50	−0.32 [0.001]	0.98 [0.000]	0.90 [0.000]

Table 1: Summary statistics: significance level of correlation reported in brackets.

	Aguirregabiria and Mira [2007]					**Dunne et al. [2009]**					
						Chiropractors (market profitability)			Dentists (market profitability)		
	Bookstores	Shoe shops	Restaurants	Fish shops	Gas stations	low	medium	high	low	medium	high
Entry cost	5.62	5.84	5.76	4.59	10.44	0.06	0.11	0.21	0.13	0.23	0.36
Fixed operating cost	16.00	14.50	9.52	6.27	12.77	0.07	0.12	0.19	0.15	0.22	0.27
Ratio	0.35	0.40	0.60	0.73	0.82	0.84	0.92	1.10	0.88	1.05	1.33

Table 2: Entry costs and fixed operating costs in different industries.

Fixed parameters			**Estimated parameters**			
Symbol	Description	Value	Symbol	Description	Value: Log-normal	Value: Pareto
R	Interest rate	1.041	ϕ	Overhead labor	0.44	0.64
δ	Depreciation rate	0.08	σ	Log-normal parameter	3.26	-
γ	Managerial span of control	0.85	μ	Log-normal parameter	-10^{*}	-
α	Elasticity of output to capital	s.t. $s_K \equiv \alpha\gamma = 1/3$	θ	Pareto parameter	-	1.15
			$\tilde{\kappa}^{NR}$	nonregulatory entry cost	0.36	0.53

*normalization

Table 3: Parameters values

Parameters values	**TFP**	**Output per worker**	**Output**	
	Benchmark model, Formal Sector	Benchmark model, Formal sector	Formal sector	Total
Benchmark	1.35	1.56	1.83	1.64
$\gamma = 0.8$	1.43	1.70	2.12	1.84
$s_k = 0.65$	1.37	2.41	2.67	2.29
$\psi = 0.66$	1.35	1.56	1.68	1.61
$\psi = 0.9$	1.35	1.56	2.93	1.76
Data	3.26	16.00		13.54

Notes: Each cell reports the ratio of the average of the corresponding measure of economic activity in the bottom decile of countries to the average in the top decile, by the entry cost. In the benchmark model all measures of output coincide.

Table 4: Robustness analysis: parameter values (log-normal productivity).

	Collard-Wexler [2008]			**Suzuki [2009]**
	Ready-mix concrete plants			Hotels
	Small	Medium	Large	
Entry cost	1,648	2,000	3,321	3041.8
Fixed operating cost	355	397	408	706.4
Ratio	4.64	5.04	8.14	4.31

Table 5: Entry costs and fixed operating costs for ready-mix concrete and hotel industries.

Measure of entry costs	**TFP**	**Output per worker**	**Output**	
	Benchmark model, Formal Sector	Benchmark model, Formal sector	Formal sector	Total
Benchmark	1.35	1.56	1.83	1.64
(1)	1.35	1.57	1.85	1.65
(2)	1.50	1.82	2.33	1.96
(3)	1.51	1.83	2.34	1.97
(4)	1.30	1.48	1.68	1.55
(5)	1.48	1.80	2.30	1.93
Data	3.26	16.00		13.54

Notes: Each cell reports the ratio of the average of the corresponding measure of economic activity in the bottom decile of countries to the average in the top decile, by the entry cost. In the benchmark model all measures of output coincide.

Table 6: Robustness analysis: various measures of entry costs (log-normal productivity).

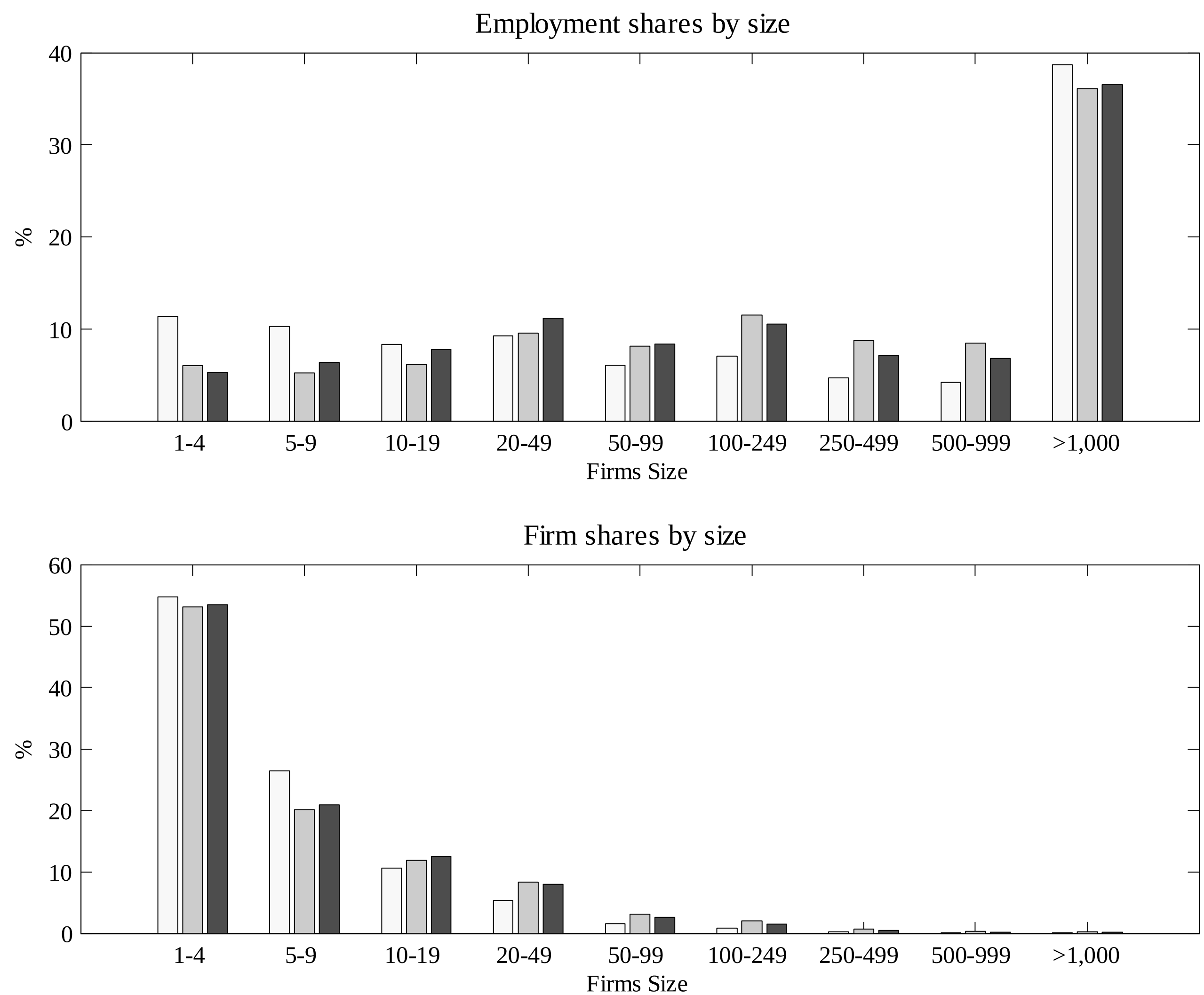

Figure 1: Distribution of employment and firms by size in the U.S.: model (Pareto productivity, cream; log-Normal productivity, light gray) and data (dark gray).

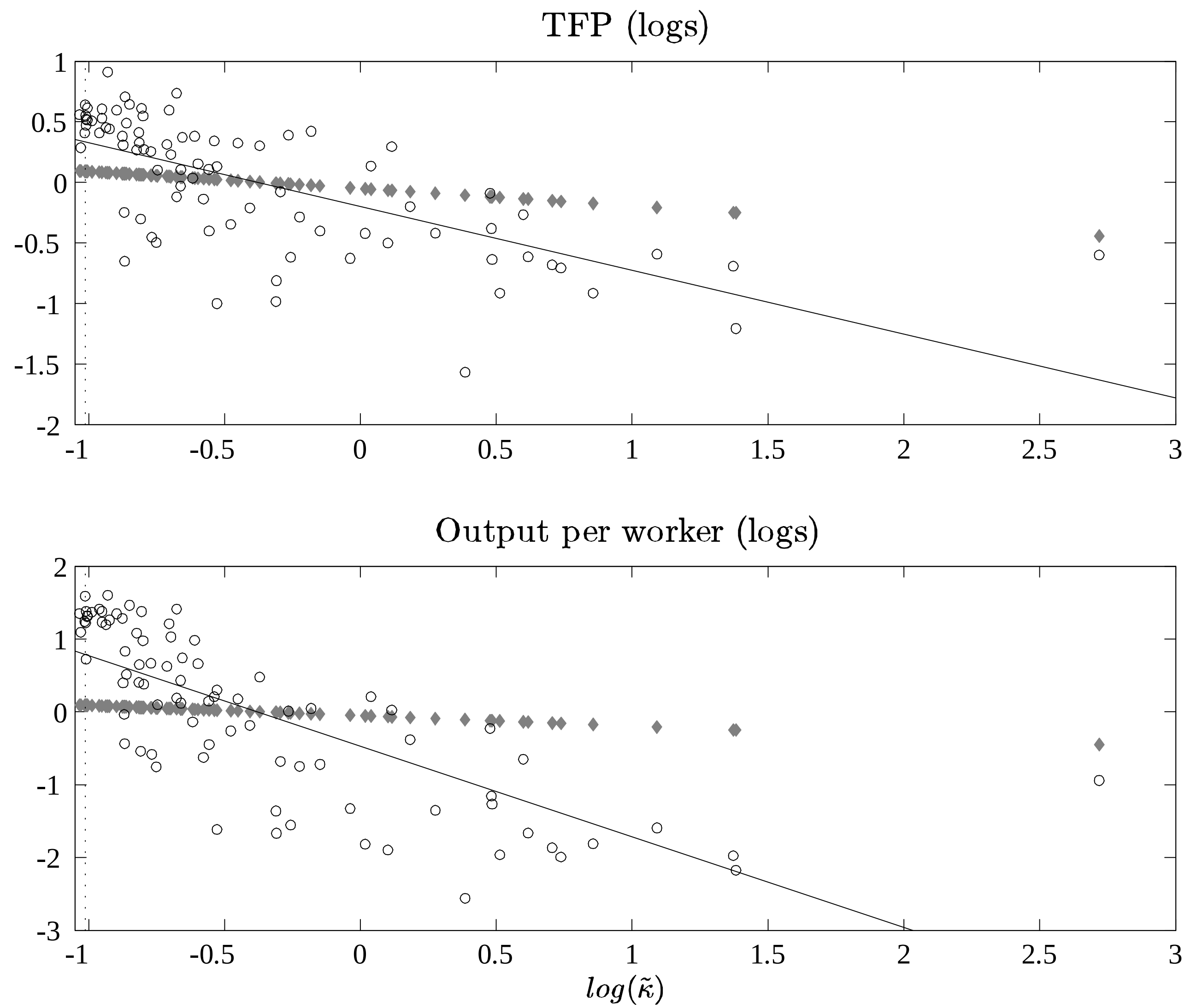

Figure 2: Output and TFP: year 2000 data (circles), regression line through the data, and benchmark model (gray diamonds); U.S. denoted by vertical dotted lines.

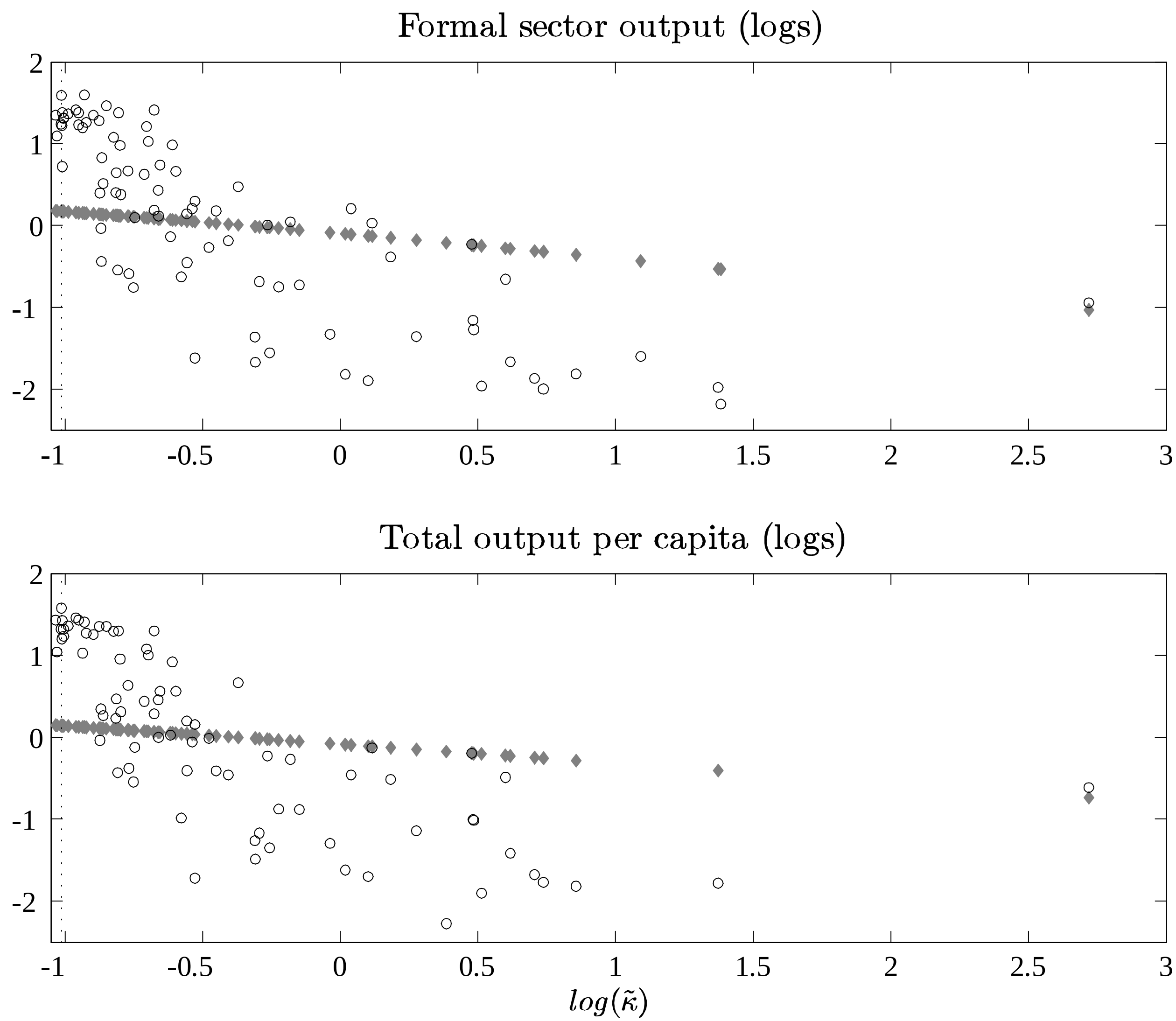

Figure 3: Formal sector output and total output per capita: year (2000) data (circles) and model (gray diamonds); U.S. denoted by vertical dotted lines.

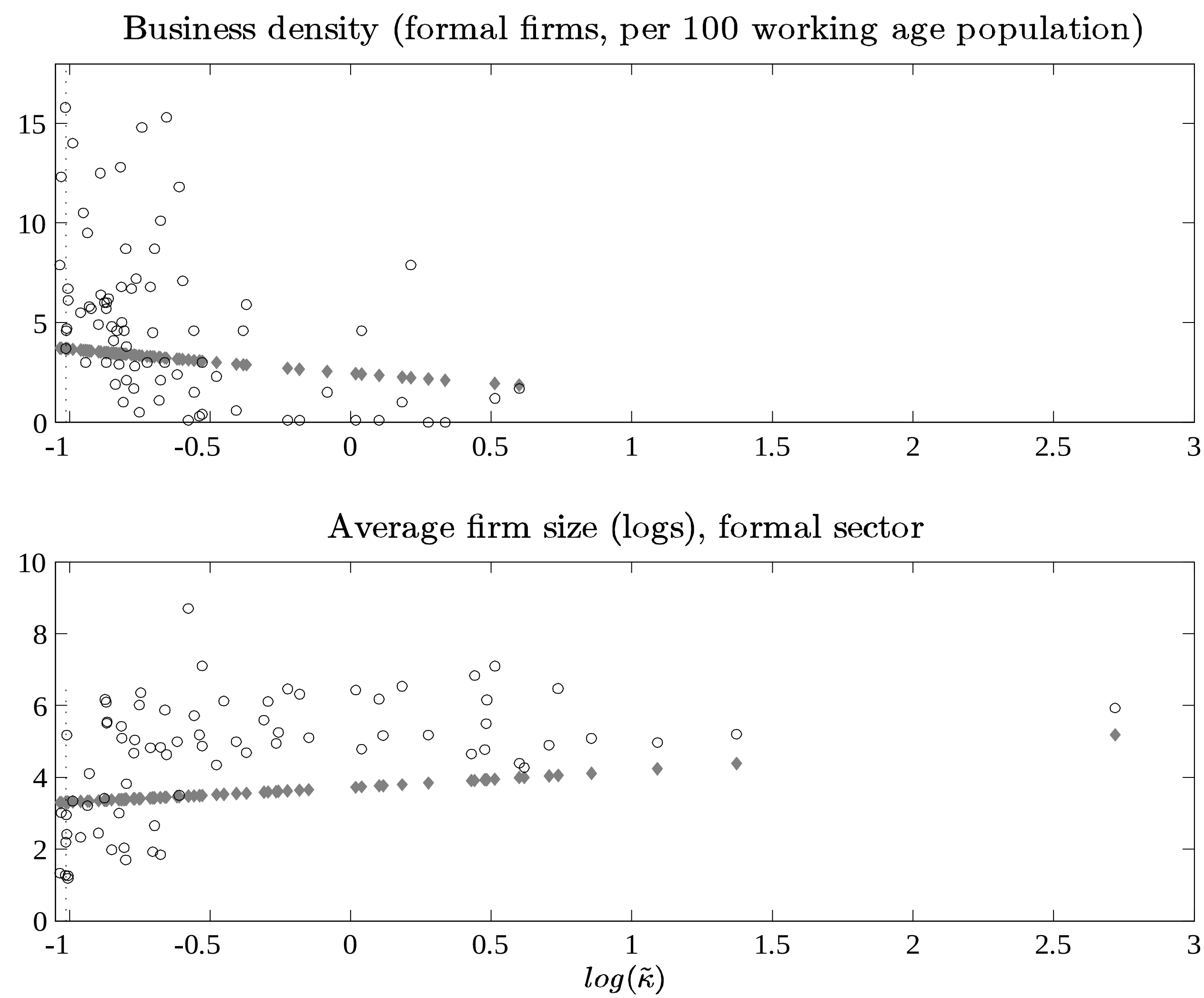

Figure 4: Business density and the average size of legally operating firms: data (circles) and model (gray diamonds); U.S. denoted by vertical dotted lines.

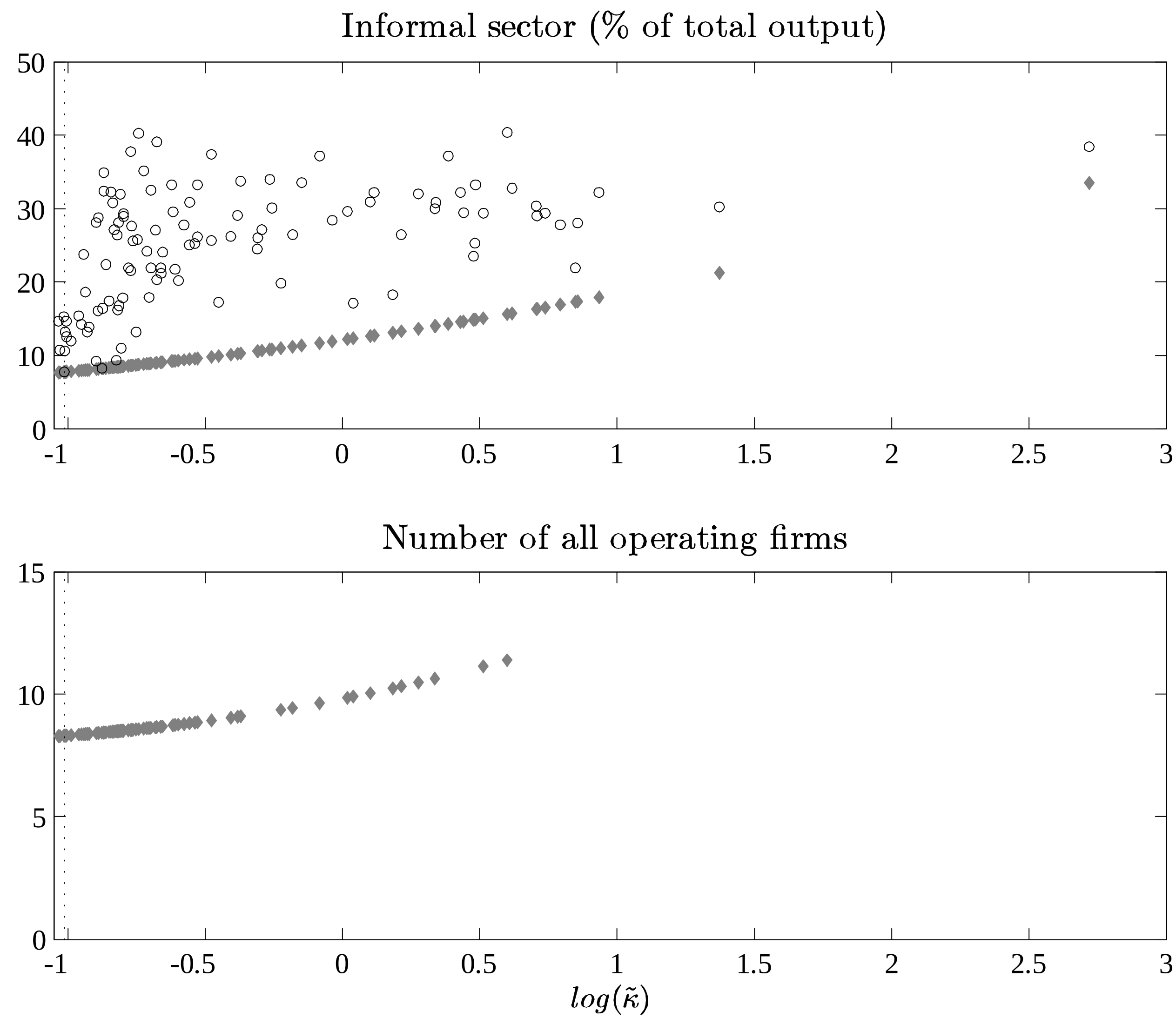

Figure 5: Size of the informal sector and the number of all operating firms (formal and informal): data (circles) and model (gray diamonds); U.S. denoted by vertical dotted lines.

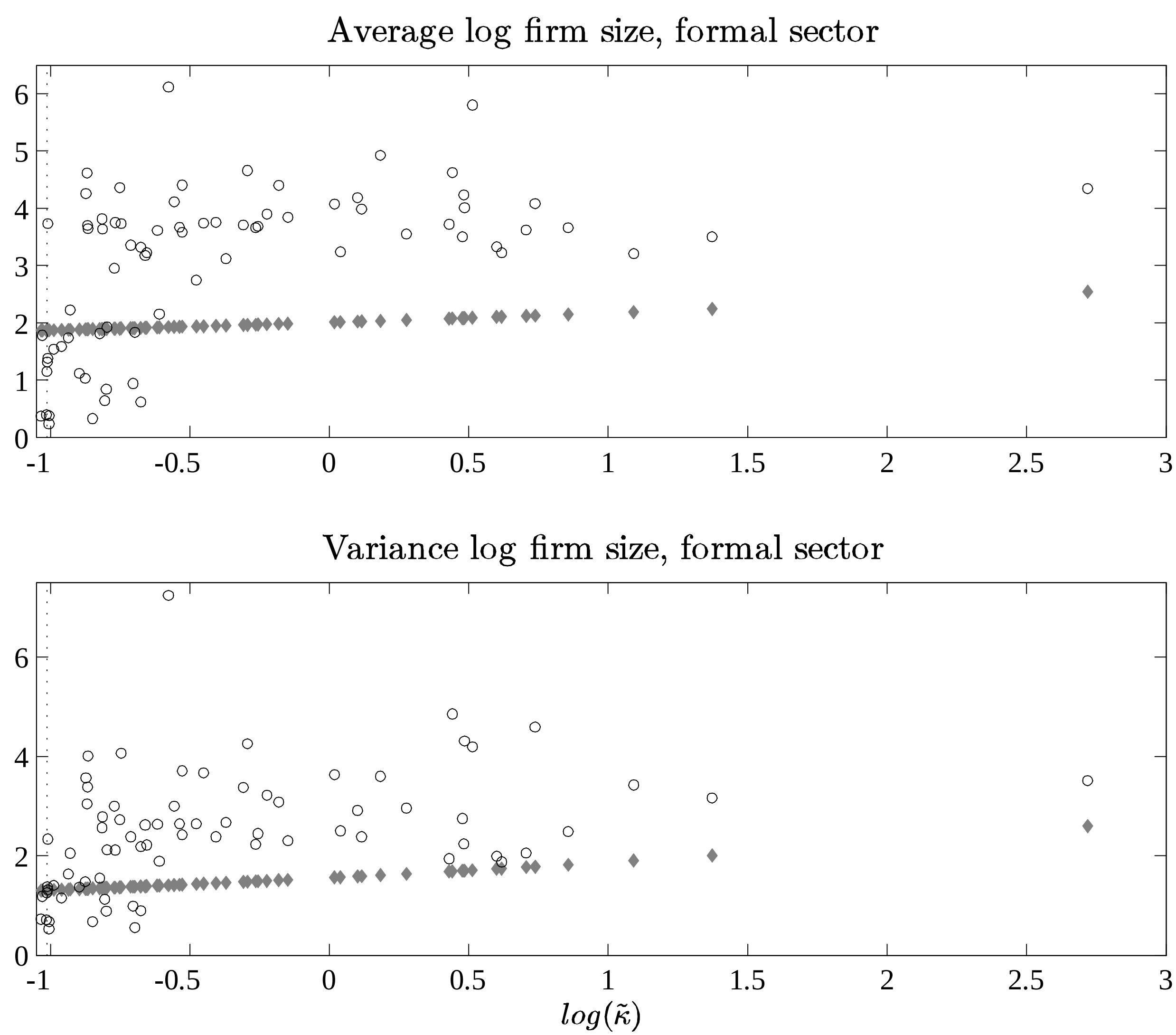

Figure 6: Moments of the distribution of firms by size: data (circles) and model (gray diamonds); U.S. denoted by vertical dotted lines.

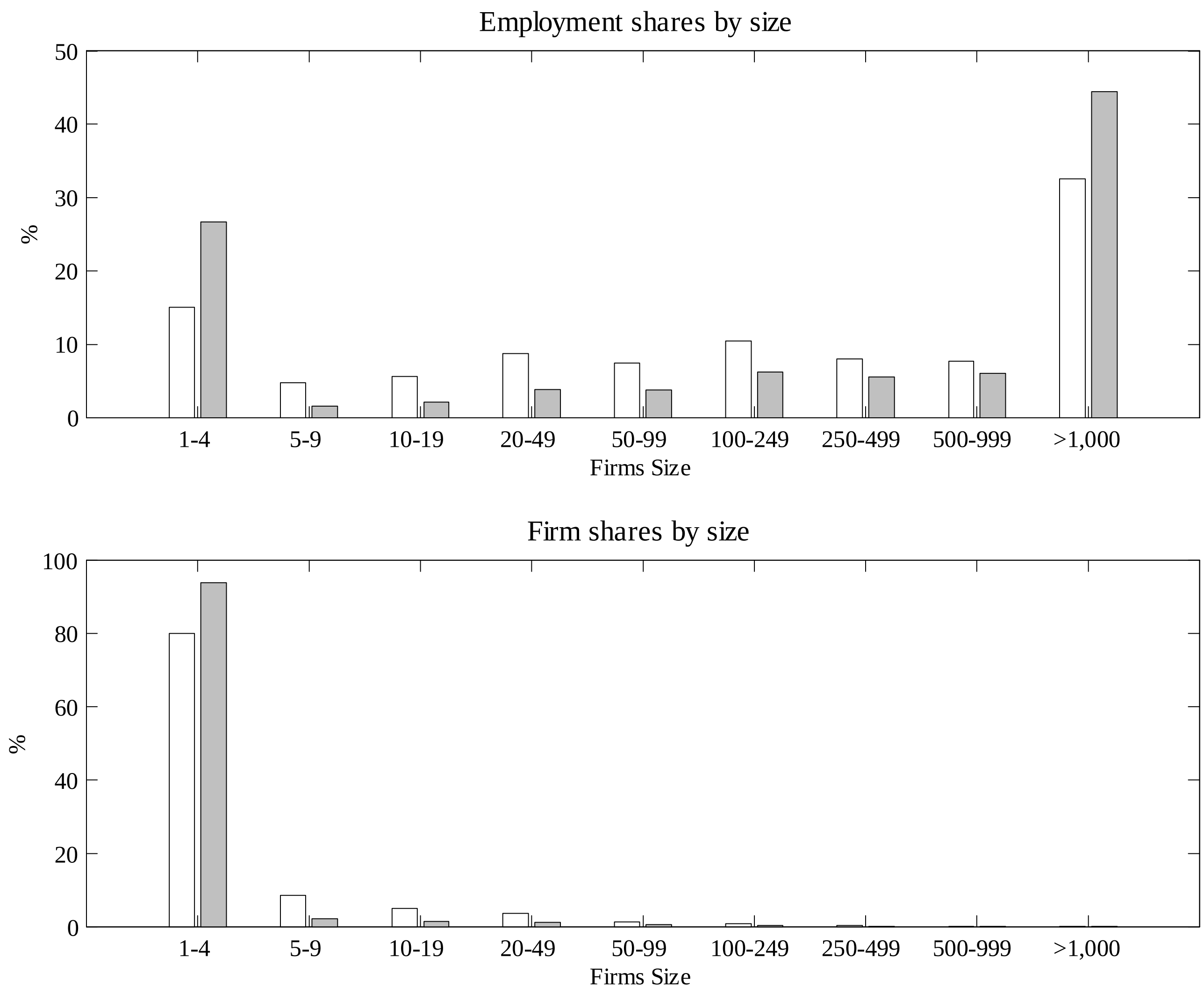

Figure 7: Distribution of employment and firms by size: high entry cost (gray bars) and low entry cost (white bars).

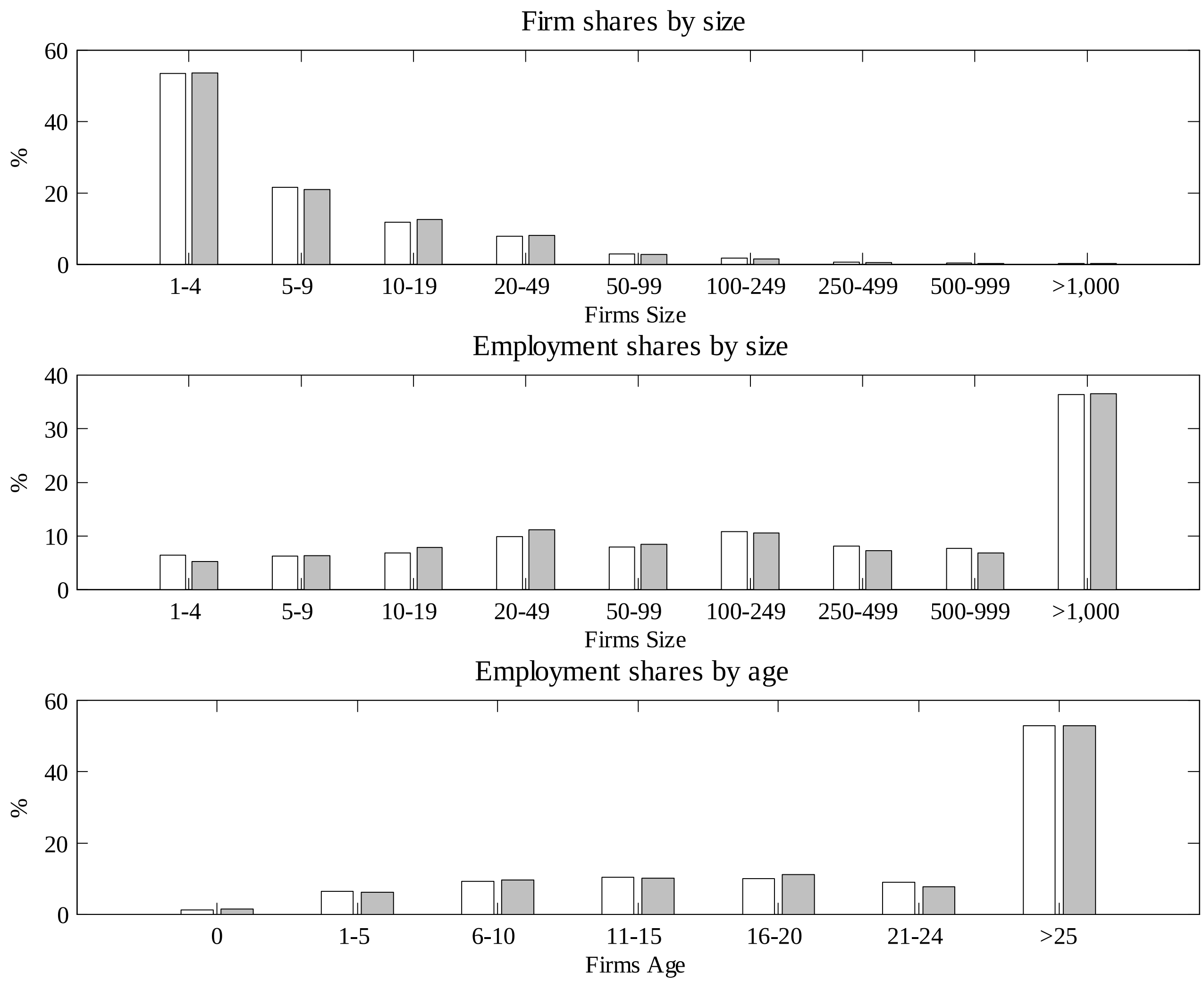

Figure 8: Features of the distribution of firms in the U.S.: data (gray bars) and calibrated long-live firms' model (white bars); log-normal productivity distribution.

A Data Sources and Definitions

1. Entry costs: The World Bank [2004, 2005, 2006a,b, 2007].[33]

    - Entry costs are constructed for "a 'standardized' firm which has the following characteristics: 1) it performs general industrial or commercial activities, it operates in the largest city (by population), 2) it is exempt from industry-specific requirements (including environmental ones), it does not participate in foreign trade and does not trade in goods that are subject to excise taxes (e.g., liquor, tobacco, gas), it is a domestically-owned limited liability company, 3) its capital is subscribed in cash (not in-kind contributions) and is the higher of (i) 10 times GDP per capita in 1999 or (ii) the minimum capital requirement for the particular type of business entity, it rents (i.e., does not own) land and business premises, it has between 5 and 50 employees one month after the commencement of operations, all of whom are nationals, it has turnover of up to 10 times its start-up capital, and it does not qualify for investment incentives."
    - Time required to complete the procedures required to start a business, i.e., the opportunity cost of the entrepreneur's time. This is measured in the same units as the entry cost above (i.e., as a percentage of GNI per capita) by dividing the number of days by 2.64.[34]
    - Construction permits[35]: is the cost of obtaining construction permits, inspections, and utility connections for a business in the construction industry to build a standardized warehouse.
    - Time required to obtain construction permits, including inspections and utility connections: Number of days divided by 2.64.

[33] Available at http://www.doingbusiness.org/.

[34] The number of days divided by 264, i.e., 22 working days per month times 12, gives the time in years. Multiplying by GNI per capita converts that in US$. Finally, dividing by GNI per capita and multiplying by 100 gives the value as a percentage of GNI per capita.

[35] See http://www.doingbusiness.org/MethodologySurveys/DealingLicenses.aspx.

- Minimum capital requirement: The paid-in minimum capital which a firms has to deposit in a bank or with a notary before registration begins.

For some countries, data for one or more of the years 2004-2008 are missing. We ignore these years when constructing averages. All but the last variables above have been converted as percentages of GDP per worker in 2000 multiplying by real gross domestic income and dividing by real GDP per worker from Heston et al. [2002].

2. Output: For 1996 and 2000 we use real GDP chain per worker from Heston et al. [2002];[36] for 2003 we use the same variable from Heston et al. [2006].[37]

3. TFP: Klenow and Rodriguez-Clare [2005] for 1996 and 2000;[38] for 2003 no measure of TFP is available.

4. Shadow economy (avg. 2000, 2002-2005): percentage of official GDP, from Dreher et al. [2007]. The shadow economy includes all market based legal production which is concealed from the authorities for a variety of reasons (e.g., evading taxes and social security contributions and avoiding compliance with labor market regulations). The shadow economy does not include illegal activities and home production.

5. Total output per worker, 2000: it is constructed as the product of real per capita output for 2000 from Penn World Table 6.1 and 1 plus the size of the informal sector as a fraction of GDP estimated by Schneider [2007] for 2000.

6. Distribution of employment and firms by size class for the U.S.: Helfand et al. [2007]. We averaged annual data over the period 1990-2005.

7. Distribution of employment by firm's age for the U.S.: Davis et al. [1996].[39] This data are relative to 1988. Annual data for the period 1978-98 is available for the same source

[36] This is the measure of real GDP used by Klenow and Rodriguez-Clare [2005] to construct TFP.

[37] See http://pwt.econ.upenn.edu/.

[38] Available at http://www.klenow.com/.

[39] This is the same data used by Atkeson and Kehoe [2005] and it is available at http://www.econ.umd.edu/~haltiwan/download/.

but only for fewer age classes. The 1988 distribution is used in our benchmark analysis in Section 3.4. The average distribution by age over 1978-98 is used in Section 5 to assess the robustness of our results.

8. Average of the distribution of employment by size class across countries: Alfaro et al. [2009]. This data is constructed from micro-data collected in Dun & Bradstreet's WorldBase. The unit of observation is the plant.

9. Entry rate and business density: Djankov et al. [2008].

    - Business density: "The number of businesses legally registered divided by working population (total population aged 15 to 64). Only businesses with more than one employee are included. The variable is scaled to measure the number of businesses per 100 people in the workforce."
    - Entry rate: "The average number of businesses that registered per year between 2000 and 2004. Only businesses with more than one employee are included."

B Entry Cost and Firms' Size

Supose that the distribution of productivity draws has a point mass at the left tail. With such a distribution, as the entry costs increase, the productivity cutoff $\underline{a}$ declines, eventually reaching the point mass. At that point an infinitesimal increase in the entry cost causes an infinitesimal decline in the cutoff $\underline{a}$, which results in a discrete jump in the number of operating firms and a discrete decline in the firms average productivity.[40] A positive relation between the entry cost and the number of operating firm can happen even with a less extreme assumption on the productivity distribution. For example, consider any mixture of Pareto and a uniform distribution on $[b, B)$, where $B > \frac{\theta+1}{\theta-1}b$. In any economy with an entry cost $\tilde{\kappa}_{high}$ such that $\underline{a}(\tilde{\kappa}_{high}) \in [b, B)$, the number of operating firms will larger than for any

[40] That is, when the distribution of productivity draws has point mass, the model exibits a threshold effect. This effect can be quite substantial in magnitude Barseghyan and DiCecio [2008].

economy with entry cost $\tilde{\kappa}_{low}$ such that $\underline{a}(\tilde{\kappa}_{high}) \geq B$. With our benchmark values of θ and ϕ, $b = 1$, $B = 3$, and a 50/50 mixture between the uniform and the Pareto distributions, the top-68 percent of countries by the entry cost in our sample would have a number of operating firms larger than that in the U.S., but the effect of the entry cost on economic activity is nearly identical to that in the benchmark model. Similarly, with our benchmark value of σ and ϕ, $b = 0.001$, $B = 0.004$, and a 50/50 mixture between the uniform and the log-normal distributions, the top-64 percent of countries by the entry cost in our sample would have a number of operating firms larger than that in the U.S., but the effect of the entry cost on economic activity is the same as in the benchmark model.