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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 on cross-country differences in output and TFP, we construct a model with endogenous entry and operation decisions by firms. We calibrate the model to match the U.S. distribution of employment and 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 1.32 to 1.45 times higher TFP and 1.52 to 1.75 times higher output per worker than countries in the highest decile. As in the data, higher entry costs are associated with lower entry rates and business density.

JEL: L16, O11, O4.

Keywords: entry costs, TFP, industry structure.

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, 1.32 times higher TFP and 1.52 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. The firm's productivity does not change over time and firms face an exogenous death probability. At the firm level, production is subject to decreasing returns to scale with a fixed operating cost (overhead labor)—only firms with sufficiently 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 are lower since there is less competition for labor. Lower-productivity firms choose to operate, sullying the pool of producers; firms' average productivity and TFP are smaller.

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

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

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. 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 industries, most of sunk entry costs 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 identical except for the legal cost of entry. We compute TFP and output in steady state for each country and compare them with their empirical counterparts. Our calibrated model accounts for 25 percent of the unconditional correlation between entry costs and TFP across countries observed in the data and 16 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, 1.32 times higher TFP than countries in the upper decile.

We consider alternative measures of entry costs. We add the costs of construction permits and

income and productivity differences.

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 45 percent productivity differences between countries in the lower decile and the upper decile of the entry cost distribution.

We also pursue an alternative calibration strategy. We extend our model along the lines of Hopenhayn and Rogerson [1993] to allow for firms' productivity to evolve stochastically. We calibrate the model parameters, including the entry cost, to match the following features of the U.S. economy: the distribution of firms and employment by firms' size, the entry rate, a measure of job turnover (the gross job reallocation rate), the average size of entering and exiting firms relative to the average size of incumbents, and the aggregate value of firms' organization capital. The resulting cross country differences in productivity and output induced by the variation in entry costs are similar to those found in the benchmark exercise. This model also captures a significant part of the negative correlation between the entry cost and the entry rate and between the entry cost and business density.

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 that improper regulation is a major contributor 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] argue 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.[2] Buera et al. [2010] 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. 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 consistent 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 assesses the robustness of our results. We conclude in Section 5. Data sources and definitions are given in the Appendix.

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

[2] See also Herrendorf and Teixeira [2005], Erosa and Hidalgo-Cabrillana [2008], Buera and Shin [2010], and Burstein and Monge-Naranjo [2009].

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.

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, 3.26 (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 with entry rates.

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.

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.

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 Hopenhayn and Rogerson [1993] and Atkeson and Kehoe [2005].

3.1 The Model

The model economy is populated by infinitely lived households and 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 a 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.[3] 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

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

Firms face a constant, exogenous exit rate, λ. A firm with productivity a will operate only if its value its non-negative:

$$V_t\left(a\right) = \max\left[\pi_t\left(a\right) + \frac{1-\lambda}{R_t} V_{t+1}\left(a\right), 0\right].$$

Free entry implies that the expected value of a firm is equal to the entry cost:

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

The distribution of productivity for operating firms evolves according to

$$H_{t+1}\left(a\right) = \frac{\left(1-\lambda\right) H_t\left(a\right) + e_t \int_0^a x_t\left(a\right) dF\left(a\right)}{\left(1-\lambda\right) + e_t \int_0^{\infty} x_t\left(a\right) dF\left(a\right)}, \tag{3.4}$$

where $x_t\left(a\right)$ is the operation decision for a firm and e_t is the measure of entry.

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 productivity:

$$\frac{y(a)}{y(b)} = \frac{k(a)}{k(b)} = \frac{n(a)}{n(b)} = \frac{a}{b}, \ \forall a, b, \tag{3.5}$$

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

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

number of operating firms (times ϕ) is equal to the amount of labor used as overhead: $(1-u_t)N_t = \nu_t\phi$. Using this expression we can rewrite aggregate output in a standard Cobb-Douglas form:

$$Y_t = TFP_t K_t^{\alpha\gamma} N_t^{1-\alpha\gamma}, \tag{3.6}$$

where the economy's TFP is defined as follows:

$$TFP_t \equiv \left(\frac{\bar{a}_t}{\phi}\right)^{1-\gamma} \left[u_t^{(1-\alpha)\gamma} (1-u_t)^{1-\gamma}\right]. \tag{3.7}$$

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:

$$K_t = \nu_t \int_0^\infty k_t(a) dH_t(a), \tag{3.8}$$

$$N = N_t = \nu_t \int_0^\infty (n_t(a) + \phi) dH_t(a), \tag{3.9}$$

$$\Pi_t = \nu_t \int_0^\infty \pi_t(a) dH_t(a) - e_t\kappa_t, \tag{3.10}$$

$$\bar{a}_t = \frac{\int_0^\infty a dH_t(a)}{\int_0^\infty dH_t(a)}, \tag{3.11}$$

where e_t and ν_t denote the measures of firms entering the market in period t and operating in period t. The rental rate on capital and the wage rate are

$$r_t = \alpha\gamma\frac{Y_t}{K_t}, \tag{3.12}$$

$$w_t = (1-\alpha)\gamma\frac{Y_t}{u_t N_t}. \tag{3.13}$$

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:

$$TR_t = e_t\kappa_t^R. \tag{3.14}$$

The resource constraint is

$$C_t + e_t\kappa_t^{NR} + K_{t+1} - (1-\delta) K_t = Y_t. \tag{3.15}$$

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) the distribution of firms' productivity evolves according to (3.4)
- (v) markets clear, i.e., eqs. (3.8), (3.9), and (3.15) are satisfied;
- (vi) the government's budget constraint, eq. (3.14), is satisfied.

A steady-state equilibrium is an equilibrium in which the prices and quantities as well as the measures of entry and of firms' productivity are all constant over time.

3.2 Steady State 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:

$$\pi(a) = (1-\gamma)a^{1-\gamma}\left(k^{\alpha}n^{1-\alpha}\right)^{\gamma} - \phi w.$$

The corresponding value of a firm is

$$V\left(a\right) = \frac{\pi\left(a\right)}{1-\frac{1-\lambda}{R}}$$

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, $\underline{a}$, which makes the marginal firm indifferent to producing or not: i.e., $V\left(\underline{a}\right) = 0$ or, equivalently, $\pi\left(\underline{a}\right) = 0$. Firms with productivity above the cutoff will produce, and those with lower productivity will not.

In steady state the entry rate and the exit rate coincide. This implies that the distribution of productivity across operating firms is the distribution of productivity at birth, F, truncated at $\underline{a}$:

$$H(a) = \begin{cases} \frac{F(a)}{1-F(\underline{a})} & \text{for } a \geq \underline{a} \\ 0 & \text{for } a < \underline{a} \end{cases},$$

and average productivity simplifies to:

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

Since firms' gross profits are proportional to their productivity, the free-entry condition can be written as[4]

$$\kappa = \frac{\phi w}{1-\beta(1-\lambda)} \int_{\underline{a}}^{\infty} \left(\frac{a}{\underline{a}} - 1\right) dF(a). \tag{3.16}$$

The cutoff condition, $\pi(\underline{a}) = 0$, and eq. (3.13) imply that the fraction of labor used in production can be expressed as follows:

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

Substituting for w from eq. (3.13) and then for u from the expression above in the free-entry condition, we obtain an equation relating the entry cost (relative to output) to the productivity cutoff $\underline{a}$:

$$\frac{1-\beta(1-\lambda)}{(1-\alpha)\gamma\phi}\tilde{\kappa} = \left[1 + \frac{1-\gamma}{(1-\alpha)\gamma}\frac{\underline{a}}{\overline{a}}\right]\left(\frac{\overline{a}}{\underline{a}} - 1\right)(1 - F(\underline{a})), \tag{3.17}$$

where average productivity is only a function of the cutoff (eq. 3.11). TFP can be expressed as:

$$TFP = \phi^{\gamma-1}\left(\frac{(1-\alpha)\gamma}{1-\gamma}\right)^{(1-\alpha)\gamma}\left(\frac{\overline{a}}{\underline{a}}\right)^{1-\alpha\gamma}\left(1 + \frac{(1-\alpha)\gamma}{1-\gamma}\frac{\overline{a}}{\underline{a}}\right)^{1-\alpha\gamma}\underline{a}^{1-\gamma}. \tag{3.18}$$

Differentiating the right-hand side of eqs. (3.17) and (3.18) we obtain that the cutoff, $\underline{a}(\tilde{\kappa})$, is a decreasing function of the entry cost, $\tilde{\kappa}$, and that TFP is an increasing function of the cutoff. Therefore, $TFP(\tilde{\kappa})$ 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

[4] If F has support over $[x, \infty)$, where x is strictly positive, then the free-entry condition can be written as in eq. (3.16) 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.

less competition for labor. Thus, lower-productivity firms choose to operate, sullying the pool of producers; firms' average productivity and TFP fall.

As expressions (3.17) and (3.18) 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 (3.17) describes a log-linear relationship between the entry cost and marginal productivity:

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

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[5]:

$$\ln TFP = \text{constant} - \frac{1-\gamma}{\theta} \ln \tilde{\kappa}. \tag{3.20}$$

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. (3.20) 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 that the mapping from legal entry costs to economic outcomes depends significantly on the magnitude of other non-regulatory 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 $\tilde{\kappa}_i^R$:

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

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

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. (3.17): 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.[6]

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

[6] Put differently, the observed κ/Y ratio determines TFP for each country in the model. 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.

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. The parameter λ is set to 0.082, which yields an entry rate of 8.2% as in Djankov et al. [2010].

We consider two productivity distributions: a log-normal distribution, $F(a; \mu, \sigma)$,[7] 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. (3.16) 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.[8] The ratios of the entry cost to the fixed operating cost for different industries are summarized in Table 2.[9] 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.[10] 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 $\frac{\tilde{\kappa}_{USA} Y_{USA}}{\phi w_{USA}} = \frac{(\tilde{\kappa}^{NR} + \tilde{\kappa}^{R}_{USA}) Y_{USA}}{\phi w_{USA}} = 0.82$. 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

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

[8] 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 4.

[9] 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.

[10] 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.

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 2.2 employees. This value is close to the minimum firm size in the data: i.e., one employee. The implied value of the nonregulatory component of the sunk entry cost is 20.8 percent of output per worker, and the entry cost in the U.S., inclusive of legal fees, $\tilde{\kappa}_{USA} Y_{USA}$, is \$13,670. 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 9.28, 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., $(20.8 - 0.38) = 20.42$ percent—plus the observed legal entry fee 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 -0.55, implying that the model accounts for 25 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, 1.32 (1.23) times higher TFP than countries in the last decile (quartile). In the data the corresponding value is 3.26 (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.[11] 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. 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.[12]

The second panel of Figure 2 plots the log of output per worker.[13] In the model, the relation between the entry cost and output is linear, with a slope of -0.21: The model captures 16 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. The latter is determined by the steady-state interest rate, assumed to be identical across countries. Barseghyan [2008] finds these same patterns in the data.

[11] 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.

[12] 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).

[13] 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.

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.[14] 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 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 between countries in the bottom and top decile (by entry cost).

4.1 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, 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).

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)[15] does not significantly change any of the statistics reported in the paper or the quantitative success of our model.

[14] 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, $1/(1-s_k) = 1.5$.

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

4.2 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.[16] 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 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 reflect mainly the cost of building the premises.[17] 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 $\$73,356$ 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, 1.45 times higher productivity and 1.75 times higher output per worker than the countries in the

[16] 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.

[17] 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.

top decile (Table 6, Row 2). 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).

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 317.7 percent of output per worker, which is $205,030 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 29 and 46 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.

4.3 Stochastic Evolution of Firms' Productivity

In our benchmark analysis in Section 3, we assume that firms face an exogenous death probability and, conditional on survival, their productivity does not change over time. The non-regulatory component of the entry cost was pinned down by available estimates of the entry-to-operating cost ratio. In this section we consider a stochastic law of motion for firms' productivity similar to that in Hopenhayn and Rogerson [1993]. This allows us to calibrate the non-regulatory component of the entry cost—and other parameters governing the evolution of firms' productivity—based on a number of additional features of the U.S. industry structure: the entry rate,[18] the gross job reallocation rate, the size of the entering and exiting firms relative to the size of the incumbents, and the share of output that is paid to the owners of organization capital.

The structure of the model is identical to that of the benchmark model, except the evolution of firms' productivity over time: After the fixed entry cost is paid, each firm receives a productivity draw from a discrete distribution $\left\{\hat{F}(a^j)\right\}_{j=1}^{N}, a^i < a^j$ if $i < j$. In subsequent periods, each firm's productivity evolves according to a transition matrix $P = \{p_{ij}\}_{i\in(1:N),j\in(1:N)}$.

The value function[19] for a firm with productivity a^j and the free-entry condition are given by

$$V_t\left(a^j\right) = \max\left[\pi_t\left(a^j\right) + \sum_i V_{t+1}\left(a^i\right)p_{ij}, 0\right], \tag{4.1}$$

$$\kappa_t = \sum_i V_t\left(a^i\right)\hat{f}_i. \tag{4.2}$$

We assume that the economy in a steady-state equilibrium: prices, quantities, and the measures of entry and operation are all constant over time. In this model, entry(exit) rates, job turnover rate, the relative size of the entering and exiting firms and organization capital are endogenous. In

[18] In our model—as in other models with a stationary distribution of firms—entry and exit rates are equal.

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

particular, for a given distribution $\hat{F}$ these quantities depend on the transition matrix P and the entry cost.

We parametrize the model as follows. The distribution $\hat{F}$ is a discretized log-normal distribution $F(a;\mu,\sigma)$ over 250 points with an exponential step of 10 percent: $a^{i+1} = 1.10 \times a^i$. The transition matrix P is fully described by two parameters, p_L and p_H : for any productivity level a^j the probability of transiting to the productivity level a^{j+i} is equal to $(p_H)^i$ times the probability of staying at the productivity level a^j; the probability of transiting to the productivity level a^{j-i} is $(p_L)^i$ times the probability of staying at the productivity level a^j. To illustrate, a four by four diagonal block of the matrix P is

$$P(j:j+4, j:j+4) = \begin{bmatrix} \frac{1}{Q_j} & \frac{p_L}{Q_{j+1}} & \frac{p_L^2}{Q_{j+2}} & \frac{p_L^3}{Q_{j+3}} \\ \frac{p_H}{Q_j} & \frac{1}{Q_{j+1}} & \frac{p_L}{Q_{j+2}} & \frac{p_L^2}{Q_{j+3}} \\ \frac{p_H^2}{Q_j} & \frac{p_H}{Q_{j+1}} & \frac{1}{Q_{j+2}} & \frac{p_L}{Q_{j+3}} \\ \frac{p_H^3}{Q_j} & \frac{p_H^2}{Q_{j+1}} & \frac{p_H}{Q_{j+2}} & \frac{1}{Q_{j+3}} \end{bmatrix},$$

where Q_j's are scaling factors which normalize to one the sum of each column.[20]

This version of the model requires calibrating two more parameters than the benchmark model: p_L and p_H. In addition, we let the data dictate the magnitude of the non-regulatory component of the entry cost. In total, we need to estimate five parameters: $\left[\sigma, \phi, p_L, p_H, \tilde{\kappa}^{NR}\right]$.[21] The model's empirical properties are determined mostly by the distribution of the firms' productivity draws at birth and their evolution over time. Since productivity is proportional to employment, we use the distribution of firms and employment by size classes, as in Section 3.3. In addition, we aim to match the entry (exit) rate, the (gross) job reallocation rate, the size of the entering and exiting firms relative to the size of incumbents and organization capital. Overall, we use 22 moments to calibrate five parameters.

The vector of calibrated parameters is [3.67, 0.56, 0.74, 0.63, 12.15]. The values of σ and ϕ are similar to those in the benchmark calibration. The firms have a slightly higher chance of transiting to lower productivity state than to a higher productivity state. The calibrated value of the non-regulatory component of the entry cost is 12.15 percent of GDP per worker, which is slightly lower

[20] That is, $Q_j = 1 + \sum_{i=1}^{j-1} p_L^{j-i} + \sum_{i=j+1}^{N} p_H^{i-j}$.

[21] As in the benchmark analysis, the scale parameter μ is set to -10.

than the estimated values in our benchmark calibration.

The model reproduces quite well the distribution of firms and employment by size (see first two panels of Figure 3). The entry rate in the model is 6.8 percent, while in the data it is 8.2 percent. The job reallocation rate in the model is 28.08 percent, in the data it is 26.28 percent. The average size of the entering and exiting firms relative to the average size of the incumbents is 0.34, which coincides with its empirical counterpart. Payments to organization capital in the model are 7.6 percent, while in the data they are 8 percent.[22]

The model matches well a number of statistics that have not been used in the calibration. The model generates a hazard function that is very close to its empirical counterpart (see the last panel of Figure 3). The smallest firm size in the model is 2.48 employees.

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. Since the estimated value of the entry cost is somewhat smaller than that in the benchmark model, the resulting impact of entry barriers on economic activity is slightly larger. In this experiment, countries in the first decile of the entry cost distribution have, on average, 1.40 (1.67) times higher TFP (output) than countries in the last decile. In the benchmark case the corresponding figure is 1.32 (1.50).

Finally, the model captures about 18 percent of the negative relationship between entry cost and business density observed in the data and about 26 percent of the negative relationship between entry cost and entry rate.[23] The slope of the log-log relationship between entry cost and business density is -0.74 in the model and -3.85 in the data. The slope of the relationship between entry cost and entry rate (both in logs) is -0.39 in the model and -1.46 in the data.

4.4 Open Economy Considerations

In our model, the interest rate is the same for every country: The model is consistent with unrestricted capital flows.[24] In addition, allowing firms' equity shares to be traded within or across

[22] These are 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].

[23] In the data, the correlation between entry cost and business density (both in logs) is significant at the 1 percent level; the correlation between entry cost and entry rate is significant at the 5 percent level.

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

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.

5 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 1.32 to 1.45 TFP ratio between countries with the lowest and the highest costs. The corresponding ratio in the data is 3.26.

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, 2010, Buera et al., 2010] 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]
Entry rate	60	8	3.31	1.9	16.4	−0.15 [0.249]	0.28 [0.0321]	0.26 [0.0785]

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	Pareto
R	Interest rate	1.041	ϕ	Overhead labor	0.49	0.64
δ	Depreciation rate	0.08	σ	Log-normal parameter	3.73	-
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
λ	Entry/exit rate	0.082	$\tilde{\kappa}^{NR}$	nonregulatory entry cost	20.8%	27.6%

*normalization

Table 3: Parameters values

Parameters values	**TFP**	**Output per worker**
Benchmark	1.32	1.52
$\gamma = 0.8$	1.40	1.64
$s_k = 0.65$	1.35	1.84
Data	3.26	16.00

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.

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**
Benchmark	1.32	1.52
(1)	1.33	1.53
(2)	1.45	1.75
(3)	1.43	1.71
(4)	1.29	1.47
(5)	1.45	1.74
Data	3.26	16.00

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.

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

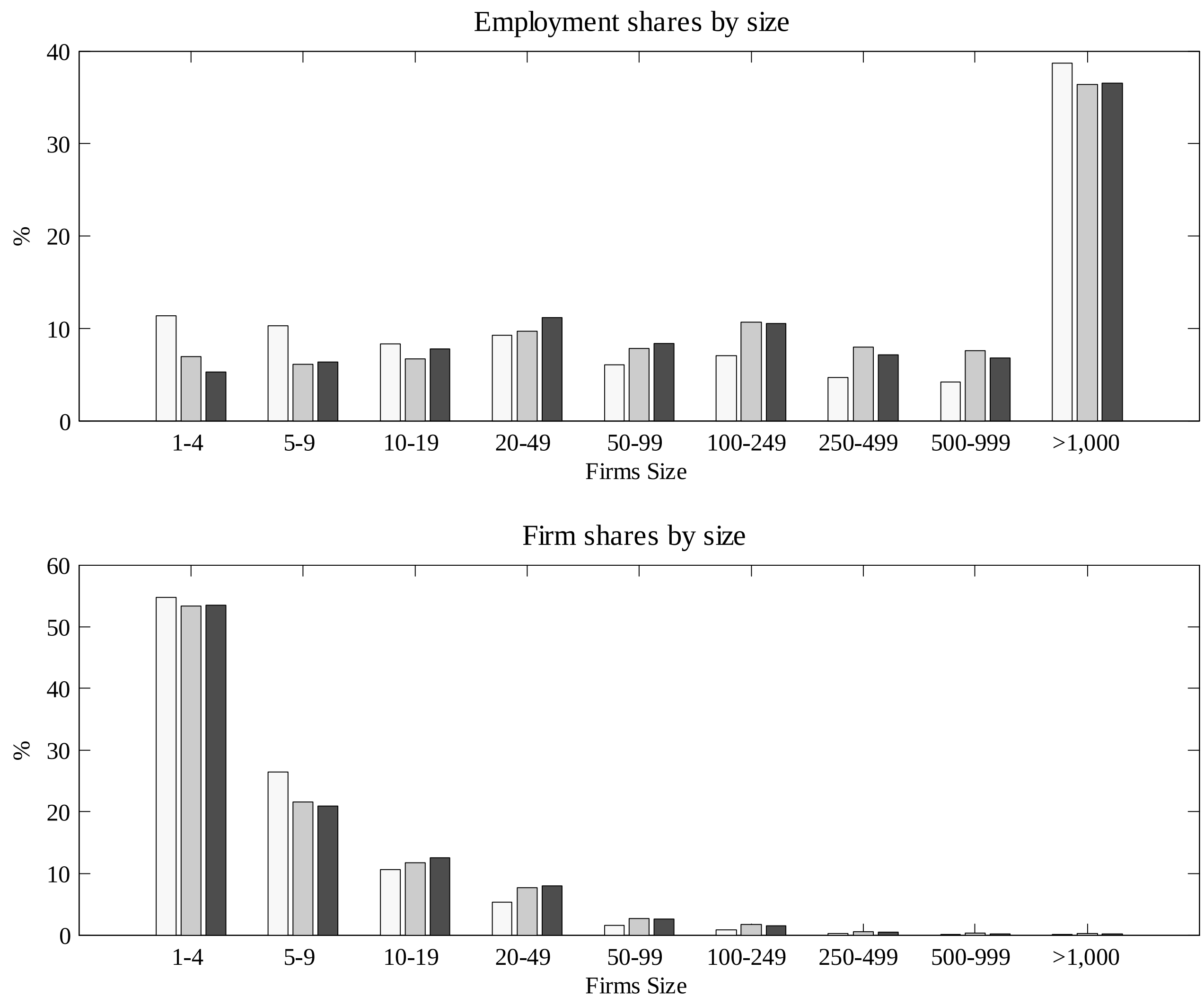

Figure 1: Distribution of employment and firms by size in the U.S.: benchmark model (Pareto productivity, cream; log-Normal productivity, light gray) and data (dark gray).

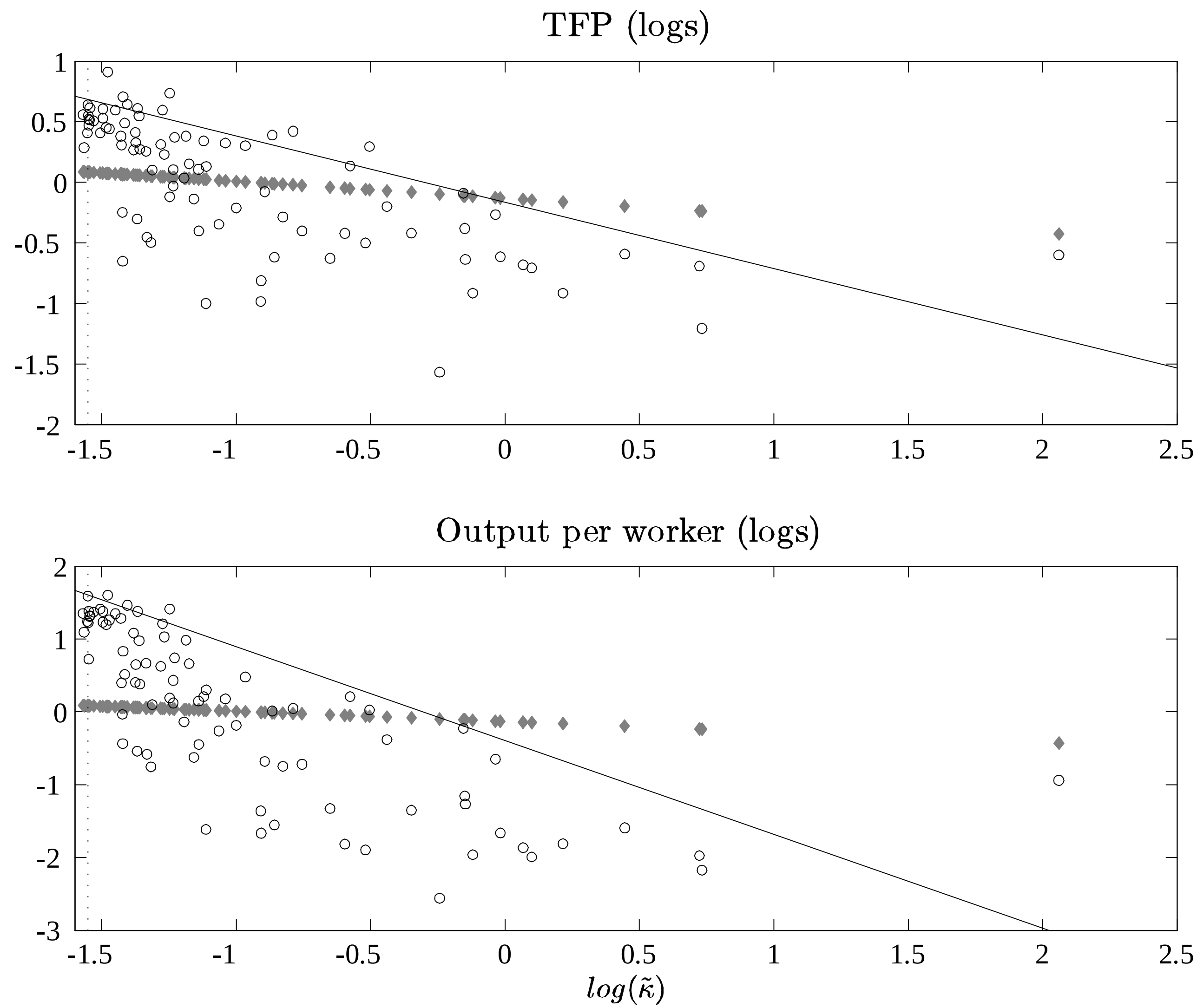

Figure 2: Output and TFP: year 2000 data (circles), regression line through the data, and benchmark model (gray diamonds); U.S. denoted by vertical dotted lines.

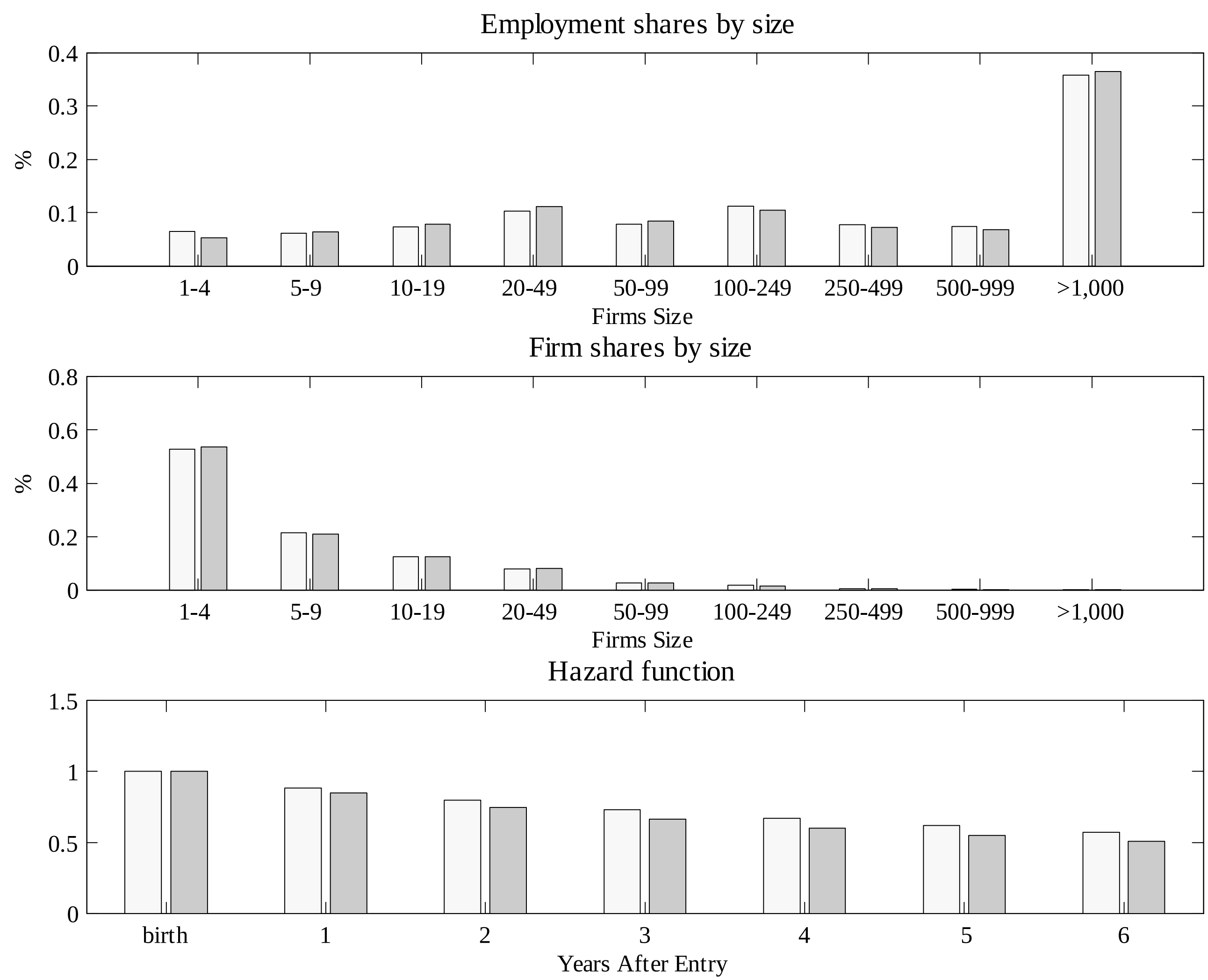

Figure 3: Industry structure for the U.S.: alternative model (light gray) and data (dark gray).

A Data Sources and Definitions

1. Entry costs: The World Bank [2004, 2005, 2006a,b, 2007].[25]

    - 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.[26]
    - Construction permits[27]: 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.
    - Minimum capital requirement: The paid-in minimum capital which a firms has to deposit in a bank or with a notary before registration begins.

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

[26] 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.

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

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];[28] for 2003 we use the same variable from Heston et al. [2006].[29]

3. TFP: Klenow and Rodriguez-Clare [2005] for 1996 and 2000;[30] for 2003 no measure of TFP is available.

4. 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.

5. Gross job reallocation rate: average 1992-2005; Business Employment Dynamics (BED) and Business Dynamics Statistics (BDS).[31]

   The BED provides quarterly data for firms and establishments; the BDS provides annual data for establishments. We can combine this information to construct annual job creation and destruction rates for firms as follows:

$$\begin{aligned} JC_{\text{A, F}} &= \frac{JC_{\text{A, E}}}{JC_{\text{Q, E}}} JC_{\text{Q, F}} = \frac{16.62}{7.74} 6.51 = 13.98\%, \\ JD_{\text{A, F}} &= \frac{JD_{\text{A, E}}}{JD_{\text{Q, E}}} JD_{\text{Q, F}} = \frac{14.79}{7.31} 6.08 = 12.30\%, \end{aligned}$$

   where the subscripts Q, A, E, and F denote quarterly, annual, establishments, and firms, respectively. The gross job reallocation rate is the sum of the job creation and job destruction rates: $(13.98 + 12.30) = 26.28\%$.

6. Hazard function and size of entering/exiting firms relative to incumbents: Bartelsman et al. [2004].

7. Share of output paid to the owners of organization capital: Atkeson and Kehoe [2005, Table 1, p. 1045].

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

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

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

[31] See http://www.bls.gov/bdm/ and http://www.ces.census.gov/index.php/bds.

8. Entry rate and business density: Djankov et al. [2010].

- 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."