



Research Division
Federal Reserve Bank of St. Louis
Working Paper Series



**Entry Costs, Misallocation, and Cross-Country Income and
TFP Differences**

Levon Barseghyan
and
Riccardo DiCecio

Working Paper 2009-005A
<http://research.stlouisfed.org/wp/2009/2009-005.pdf>

February 2009

FEDERAL RESERVE BANK OF ST. LOUIS
Research Division
P.O. Box 442
St. Louis, MO 63166

The views expressed are those of the individual authors and do not necessarily reflect official positions of the Federal Reserve Bank of St. Louis, the Federal Reserve System, or the Board of Governors.

Federal Reserve Bank of St. Louis Working Papers are preliminary materials circulated to stimulate discussion and critical comment. References in publications to Federal Reserve Bank of St. Louis Working Papers (other than an acknowledgment that the writer has had access to unpublished material) should be cleared with the author or authors.

Entry Costs, Misallocation, and Cross-Country Income and TFP Differences¹

Levon Barseghyan

Riccardo DiCecio

Cornell University

Federal Reserve Bank of St. Louis

February 2009

¹We are grateful to an associate editor and three anonymous referees for many useful suggestions. We thank C. Azariadis, M. Boldrin, P. Buera, S. Durlauf, N. Jaimovich, F. Molinari, and G. Ventura for comments and discussions. We are indebted to L. Alfaro, A. Charlton, and F. Kanczuk for sharing their statistics on the firm-size distribution across countries. C. Gascon provided excellent research assistance. All errors are our own. Any views expressed are our own and do not necessarily reflect the views of the Federal Reserve Bank of St. Louis or the Federal Reserve System. Corresponding author: Levon Barseghyan, lb247@cornell.edu.

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 age and size. Higher entry costs lead to greater misallocation of productive factors and lower TFP and output. In the model, countries with entry costs in the lowest decile of the distribution have 2.32 times higher TFP (3.43 in the data) than countries in the highest decile. As in the data, higher entry costs are associated with higher mean and variance of the employment distribution across firms.

JEL: L16, O11, O40, O43, O47.

Keywords: entry costs, TFP, misallocation.

1 Introduction

Cross-country differences in entry costs provide one of the most striking examples of institutional failure. Most developed countries have negligible entry costs, but they average above 50 percent of per capita GDP and reach as high as 390 percent. In this paper we show that these differences account for a substantial part of the cross-country differences in productivity and output. We do so by constructing a variant of the neoclassical model, in which higher entry costs generate greater misallocation of productive factors across firms and, consequently, lower productivity and output. We find that a 1-percentage-point increase in entry costs is associated with a 0.14 percent decline in TFP, which translates into large differences in economic outcomes: In the model, countries in the lowest decile of the entry cost distribution have, on average, 2.32 times higher TFP than countries in the upper decile. The corresponding statistic in the data is 3.43.

Our study of the effects of entry costs in a general equilibrium setting builds upon the seminal contributions of Hopenhayn [1992] and Hopenhayn and Rogerson [1993]. In our model, firms live for multiple periods and have different levels of productivity; entry, operation, and exit decisions are endogenous. At the firm level, technology is subject to decreasing returns to scale with a fixed operating cost; at the aggregate level, output exhibits constant returns. The evolution of firms' productivity conforms with the stylized facts in the literature [Klette and Kortum, 2004]. A large number of firms exit soon after entry, but those that survive grow quickly. Eventually firms' productivity declines, forcing them to exit. In the steady state, the pool of producers contains firms of different productivity, ages, and sizes. Our empirical strategy is based on calibrating the parameters that determine firms' productivity to match the distributions of employment and firms by size and age in the U.S. We assume that all economies in our dataset are in steady state and that they are identical except for the cost of entry. For each country, we input the observed value of the entry cost into the calibrated model and compute the steady-state levels of TFP and output. Our calibrated model accounts for 66 percent of the relation between entry costs and TFP across countries observed in the data and for 40 percent of the cross-country relation between entry

costs and output.

The intuition behind our results goes back to Hopenhayn [1992]. Lower entry costs lead to more competition and a higher number of operating firms. Also, without the protection from potential entrants afforded by high entry costs, only the most productive firms can survive and operate: This implies that operating firms are more similar to each other, i.e., a low dispersion of firms' productivity. These predictions have strong empirical support. Both in the data and in the model, increases in entry costs are associated with a sharp decline in the number of operating firms and a significant increase in the variance of the firms' log-size distribution.¹

Our approach bridges the gap between two strands of the literature. First, several authors have argued that distortions to the allocation of resources across firms, by affecting TFP, are a major determinant of cross-country income differences. Hsieh and Klenow [2007] point to the misallocation of resources between consumption- and investment-producing sectors as the determinant of cross-country differences in TFP and output. In a more recent paper [2009] they argue that an important share of the TFP gap between China (and India) and the U.S. is due to a misallocation of productive factors across plants. Restuccia and Rogerson [2008] analyze the potential impact of different idiosyncratic tax schemes on the allocation of resources across firms, TFP, and aggregate output. Guner et al. [2008] analyze quantitatively the macroeconomic impact of policies that directly distort the size of firms. Alfaro et al. [2008] perform a similar exercise in a model with constant returns to scale and differentiated products. In Herrendorf and Teixeira [2005] barriers to international trade lead to the use of inefficient technologies in import-competing industries and negatively affect TFP. Erosa and Hidalgo-Cabrillana [2008] analyze the role of poor contract enforcement in the use of inefficient technologies, misallocation, and low TFP. Buera and Shin [2008] focus on financial frictions as the source of misallocation in explaining the observed slow transitional dynamics. Burstein and Monge-Naranjo [2009] investigate the importance of misallocation of managerial

¹The variance of the firms' log-productivity distribution is equal to the variance of the firms' log-size distribution because in our model productivity is proportional to employment.

know-how for cross-country productivity and income differences. As opposed to most of these contributions, our analysis directly relies on an observable measure of entry barriers available for a large number of countries. This allows us to assess the performance of the model by comparing its key implications with the data.

Second, other authors² have argued that the poor quality of institutions is responsible for slow growth and generates the dispersion in income across countries observed in the data. Barriers to entry have received particular attention. In an early and widely cited example, De Soto [1989, p. xiv] points out the cost of obtaining a business license in Peru was 32 times the monthly minimum wage and it took 289 days to obtain. Barseghyan [2008] identifies the difficulty of setting up new firms, measured by a higher entry cost, as a key institutional feature responsible for poor macroeconomic performance. This finding fits well with a number of observations. Nickell [1996] observes that competition leads to a higher rate of productivity growth for companies in the UK. Nicoletti and Scarpetta [2003] estimate that, in a sample of OECD countries, entry liberalization has a positive impact on productivity. Alesina et al. [2005], who assemble and analyze data from several industrial sectors in a sample of OECD countries, provide evidence that entry liberalization spurs investment. Bastos and Nasir [2004] find that competitive pressure accounts for a significant part of the variation in firm level productivity in five transition economies. Sivadasan [2008], looking at Indian plant-level data, shows that de-licensing has a positive effect on productivity. Bruhn [2008] finds that a reform in Mexico that reduced entry barriers in some sectors substantially increased employment and the number of operating businesses. Most contributions in this strand of the literature have been empirical: Without a model it is often difficult to pinpoint the exact nature and quantitative significance of economic mechanisms through which institutions affect macroeconomic variables.

The rest of the paper is structured as follows. Section 2 presents the model. Section 3 describes our calibration strategy. Section 4 discusses the quantitative implications of our

²See, for example, Acemoglu et al. [2002, 2003], Dollar and Kraay [2003], Easterly and Levine [2003], Rodrik et al. [2004].

calibrated model. Section 5 assesses the robustness of our results along several dimensions. We conclude in Section 6. Proofs of propositions on the model’s steady state properties, the derivation of the model’s distributions of employment and firms by size and age classes, and data sources and definitions are given in appendices.

2 The Model

The model is populated by infinitely lived households, firms, and the government.

2.1 Households

There is a continuum of measure one of households that inelastically supply a one unit labor, consume, invest, and own all firms in the economy. The problem of the representative household is given by

$$\begin{aligned} \max_{\{C_t, K_{t+1}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t U(C_t), \quad \beta \in (0, 1) \\ \text{s.t. } C_t + K_{t+1} - (1 - \delta) K_t = r_t K_t + w_t + \Pi_t + TR_t, \end{aligned} \tag{2.1}$$

where C_t denotes consumption, K_t is the total 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. We assume a constant elasticity of substitution utility function with elasticity $\sigma > 0$.

2.2 Firms

All firms are ex-ante identical and they maximize profits. There is a strictly positive sunk entry cost, κ_t .³ We assume that entry costs are a constant fraction of per capita GDP,

³To have a well-defined problem when entry costs are zero, the distribution of productivity draws must have a bounded support. Most of the commonly used distributions of the productivity draws have an

i.e., that the ratio κ_t/Y_t is constant. After the fixed entry cost is paid, each firm receives a productivity draw a_0 from the distribution F . In subsequent periods, each firm's productivity evolves according to

$$a_s = \begin{cases} \mu_s a_{s-1} & \text{with probability } p_s \\ 0 & \text{with probability } (1 - p_s) \end{cases}, \quad (2.2)$$

where the parameters governing the dynamics of firms' productivity, $\{\mu_\tau\}_{\tau=1}^\infty$, 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., $\bar{\mu}_0 = 1$), is denoted by $\bar{\mu}_t = \prod_{j=1}^t \mu_j$. We assume that the function $\bar{\mu}$ is (weakly) increasing and then (weakly) decreasing, which is consistent with the notion that, conditional on survival, the 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., $\lim_{t \rightarrow \infty} \bar{\mu}_t \rightarrow 1$.⁴

The exogenous component of the survival function is given by $\bar{p}_t = \prod_{j=1}^t p_j$ 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 production function for a firm with productivity a is given by $y = a^{1-\gamma} (k^\alpha n^{1-\alpha})^\gamma$, 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.⁵ 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

$$\pi_t(a) = \max_{k_t, n_t} a^{1-\gamma} (k_t^\alpha n_t^{1-\alpha})^\gamma - r_t k_t - w_t (n_t + \phi). \quad (2.3)$$

unbounded support.

⁴This mild regularity condition has no bearing on our results, as discussed in Section 5.

⁵This is what Lucas [1978] calls managers' span of control.

The value function for a firm of vintage s with productivity a is given by⁶

$$V_t(a, s) = \max \left[\pi_t(a) + \frac{p_{s+1}}{R_{t+1}} V_{t+1}(\mu_{s+1}a, s+1), 0 \right]. \quad (2.4)$$

Free entry implies that the expected value of a firm at birth should not exceed the entry cost:

$$\kappa_t \geq \int_0^\infty V_t(a, 0) dF(a). \quad (2.5)$$

2.3 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 productivity ratio:

$$\frac{y(a)}{y(b)} = \frac{k(a)}{k(b)} = \frac{n(a)}{n(b)} = \frac{a}{b}, \quad \forall a, b, \quad (2.6)$$

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

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

where ν_t is the measure of operating firms, \bar{a}_t is the firms' average productivity, K_t and N_t are aggregate capital and labor, respectively, and u_t is 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 as overhead: $(1 - u_t)N_t = \nu_t\phi$. Using this expression we can rewrite aggregate output in a standard Cobb-Douglas form:

$$Y_t = TFP_t K_t^{\alpha\gamma} N_t^{1-\alpha\gamma}, \quad (2.7)$$

where the economy's TFP is defined as follows:

$$TFP_t \equiv \phi^{\gamma-1} \bar{a}_t^{1-\gamma} \left[u_t^{(1-\alpha)\gamma} (1 - u_t)^{1-\gamma} \right]. \quad (2.8)$$

⁶To economize on notation, we suppress state variables as arguments in the firms' value function. Instead, we index V_t by the time subscript.

There are two variable components of TFP: one is the 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 relation between firm level variables and aggregate variables (capital, labor, and profits), as well as average productivity, are expressed as follows:

$$K_t = \sum_{s=0}^{\infty} \int k_t(a, s) dH_t(a, s), \quad (2.9)$$

$$N_t = \sum_{s=0}^{\infty} \int [n_t(a, s) + \phi] dH_t(a, s), \quad (2.10)$$

$$\Pi_t = \sum_{s=0}^{\infty} \int \pi_t(a, s) dH_t(a, s) - e_t \kappa_t, \quad (2.11)$$

$$\bar{a}_t = \sum_{s=0}^{\infty} \int a dH_t(a, s) / \sum_{s=0}^{\infty} \int dH_t(a, s), \quad (2.12)$$

where e_t denotes the measure of firms entering the market in period t and $H_t(a, s)$ is the time- t measure of productivity across firms of age s . The rental rate on capital and the wage rate are

$$r_t = \alpha \gamma \frac{Y_t}{K_t}, \quad (2.13)$$

$$w_t = (1 - \alpha) \gamma \frac{Y_t}{u_t N_t}. \quad (2.14)$$

2.4 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:

$$TR_t = e_t \kappa_t. \quad (2.15)$$

The resource constraint is standard:

$$C_t + K_{t+1} - (1 - \delta) K_t = Y_t. \quad (2.16)$$

2.5 Evolution of Firms' Productivity

The operation decision of an age- s firm with productivity a at time t is denoted by $x_t(a, s)$. Then, taking into account that a fraction $(1 - p_{s+1})$ of firms receive a zero productivity draw and exit, we can express the evolution of the firms' age-specific productivity measure as

$$\begin{aligned} H_{t+1}(a, s+1) &= p_{s+1} \int_0^{\frac{a}{\mu_{s+1}}} x_t(z, s) dH_t(z, s), \\ H_t(a, 0) &= e_t \int_0^a x_t(z, 0) dF(z). \end{aligned} \quad (2.17)$$

2.6 Competitive Equilibrium and Steady State

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

- (i) consumers choose C and K optimally by solving (2.1);
- (ii) firms optimize: the factor demand functions, k and n , solve (2.3); the operation decision, x , is optimal, i.e., it is consistent with (2.4), a firm's profit and value function are determined according to (2.3) and (2.4), respectively;
- (iii) the free entry condition, eq. (2.5), is satisfied;
- (iv) markets clear, i.e., (2.9), (2.10), and (2.16) are satisfied;
- (v) the government's budget constraint, eq. (2.15), is satisfied;
- (vi) $H_t(a, s)$ evolves according to (2.17).

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.

2.6.1 Computing the Steady State

Before stating the existence, uniqueness, and properties of the model's steady-state equilibrium, we elaborate on how the optimality conditions are used to construct such equilibrium.

Let \underline{a} denote the level of productivity at which a firm makes exactly zero profits in the steady state, i.e., \underline{a} solves $\pi(\underline{a}) = 0$. We call \underline{a} *the productivity cutoff*, the point where the firm's profit, net of payments to variable inputs, is equal to the operating cost:

$$(1 - \gamma) y(\underline{a}) = \phi w. \quad (2.18)$$

Firms with a higher level of productivity generate positive profits; firms with lower productive take losses. Firms' productivity (conditional on survival) increases and eventually declines. For a firm whose productivity is already on the declining path, the break-even productivity is \underline{a} since in the following periods it will be making negative profits.

For younger firms this is not the case. A firm with productivity below the cutoff \underline{a} operates if it expects a big enough rise in its future productivity. Expected profits of a firm with productivity draw a are given by

$$V(a, 0) = \frac{\phi w}{a} \left[(a - \underline{a}) + \frac{\bar{p}_1}{R} (\bar{\mu}_1 a - \underline{a}) + \dots + \frac{\bar{p}_{\underline{N}}}{R^{\underline{N}}} (\bar{\mu}_{\underline{N}} a - \underline{a}) \right],$$

where $\underline{N}(a)$ represents the last period in which the firm makes positive profits, i.e., $\underline{N}(a) = \max_n \{(\bar{\mu}_n a - \underline{a}) \geq 0\}$. In order to find the level of the initial productivity draw, \underline{a}_0 , which makes the firm indifferent between operating or not, we must equate the expression above to zero: $V(\underline{a}_0, 0) = 0$. A firm that gets an initial draw above \underline{a}_0 will operate while its productivity increases and it eventually becomes profitable; as productivity declines, it eventually falls below \underline{a} , the firm becomes no longer profitable and it exits. This allows us to write the steady-state free entry condition as:

$$\frac{\kappa}{Y} = \phi \frac{w}{Y} \left[\sum_{j=0}^{\underline{N}} \frac{\bar{p}_j}{R^j} \int_{\underline{a}_0}^{\infty} \left(\bar{\mu}_j \frac{a}{\underline{a}} - 1 \right) dF(a) + \sum_{j=\underline{N}+1}^{\infty} \frac{\bar{p}_j}{R^j} \int_{\frac{\underline{a}}{\bar{\mu}_j}}^{\infty} \left(\bar{\mu}_j \frac{a}{\underline{a}} - 1 \right) dF(a) \right]. \quad (2.19)$$

The first summation term in the previous equation aggregates expected discounted profits (as a fraction of output) for the first $(\underline{N} + 1)$ periods after entry. At age 0 these are equal to

$$\phi \frac{w}{Y} \int_{\underline{a}_0}^{\infty} \left(\frac{a}{\underline{a}} - 1 \right) dF(a).$$

At age one, a firm survives with probability \bar{p}_1 . If it does survive, its productivity grows to $\bar{\mu}_1$ times its initial draws. Thus, we can compute expected profits at age one by integrating against the distribution of the original productivity draws:

$$\phi \frac{w}{Y} \frac{\bar{p}_1}{R} \int_{\underline{a}_0}^{\infty} \left(\bar{\mu}_1 \frac{a}{\underline{a}} - 1 \right) dF(a).$$

Notice that the lower limit of integration is unchanged: Until age $(\underline{N} + 1)$ the operating firm with the lowest productivity level in its age cohort remains the same.

At age $(\underline{N} + 1)$ this is no longer the case. The second summation term in (2.19) takes this into account when adding up expected discounted profits. The lower limit of integration is $\underline{a}/\bar{\mu}_j$, so the productivity of the marginal operating firm is equal to the productivity cutoff \underline{a} : $\bar{\mu}_j \times (\underline{a}/\bar{\mu}_j) = \underline{a}$.

The only endogenous variables in (2.19) are $\frac{w}{Y}$, \underline{a}_0 , and \underline{a} . We would like this expression to depend only on the cutoff \underline{a} . Since the ratio $\frac{\underline{a}_0}{\underline{a}}$ is known, only the labor share, $\frac{w}{Y}$, remains to be expressed as a function of \underline{a} . Using the expression for the wage rate we get that $\frac{w}{Y} = (1 - \alpha) \gamma \frac{1}{u}$ and solve for u as follows:

$$\phi (1 - \alpha) \gamma \frac{Y}{u} = \phi w = (1 - \gamma) y(\underline{a}) = (1 - \gamma) \frac{\underline{a} Y}{\bar{a} \nu} = \frac{\underline{a}}{\bar{a}} \frac{Y}{\frac{1}{\phi}(1 - u)},$$

where the second equality is the cutoff condition (2.18), the third stems from the fact that output is proportional to productivity, and the fourth uses the fact that the number of operating firms is equal to the number of overhead workers scaled by $1/\phi$. Hence, the fraction of labor used directly in production is given by

$$u = \left[1 + \frac{1 - \gamma}{(1 - \alpha) \gamma} \frac{\underline{a}}{\bar{a}} \right]^{-1}.$$

Average productivity in steady state, \bar{a} , can be expressed as a function of the productivity cutoff, \underline{a} , as follows:

$$\bar{a} = \frac{\sum_{j=0}^{\underline{N}} \bar{p}_j \bar{\mu}_j \int_{\underline{a}_0}^{\infty} a dF(a) + \sum_{j=\underline{N}+1}^{\infty} \left(\bar{p}_j \bar{\mu}_j \int_{\underline{a}/\bar{\mu}_j}^{\infty} a dF(a) \right)}{\sum_{j=0}^{\underline{N}} \bar{p}_j \int_{\underline{a}_0}^{\infty} dF(a) + \sum_{j=\underline{N}+1}^{\infty} \left(\bar{p}_j \int_{\underline{a}/\bar{\mu}_j}^{\infty} dF(a) \right)}. \quad (2.20)$$

Finally, the steady-state free entry condition (2.19) is

$$\tilde{\kappa} = (1-\alpha)\gamma\phi \left[1 + \frac{1-\gamma}{(1-\alpha)\gamma} \frac{\underline{a}}{\bar{a}} \right] \left[\sum_{j=0}^{\underline{N}} \frac{\bar{p}_j}{R^j} \int_{\underline{a}_0}^{\infty} \left(\bar{\mu}_j \frac{a}{\underline{a}} - 1 \right) dF(a) + \sum_{j=\underline{N}+1}^{\infty} \frac{\bar{p}_j}{R^j} \int_{\underline{a}/\bar{\mu}_j}^{\infty} \left(\bar{\mu}_j \frac{a}{\underline{a}} - 1 \right) dF(a) \right],$$

where the left-hand side is the measure of entry barriers, $\tilde{\kappa} = (\kappa/Y)$. Since \underline{a}_0 and \bar{a} are known functions of the productivity cutoff \underline{a} , the right hand side is a function of \underline{a} . If, given $\tilde{\kappa}$, this equation has a unique solution, then our model has a unique steady state.

2.6.2 Steady State's Properties

Formally, the properties of the steady-state equilibrium are described in Propositions 1-4.⁷

Assumption 1 *The distribution of initial productivity draws is such that $\frac{af(a)}{1-F(a)}$ is (weakly) increasing.*

Proposition 1 *Under Assumption 1, average productivity is increasing in the productivity cutoff, \underline{a} .*

Proposition 2 *If average productivity is increasing in \underline{a} , then a steady-state equilibrium exists and is unique. Furthermore, \underline{a} is decreasing in the entry cost, $\tilde{\kappa}$.*

Proposition 3 *If average productivity is increasing in \underline{a} , then steady-state TFP and output are increasing in \underline{a} and decreasing in the entry cost, $\tilde{\kappa}$.*

Assumption 2 *The productivity-weighted mass of firms surviving beyond age \underline{N} is relatively small: $\sum_0^{\underline{N}} \bar{\mu}_j \bar{p}_j \gg \sum_{\underline{N}+1}^{\infty} \bar{\mu}_j \bar{p}_j$.*

⁷Proofs of the propositions below are collected in Appendix A.

Assumption 3 *The distribution of initial productivity draws F is such that $E_F\left(\frac{a}{x} | a > x\right) \equiv \frac{\int_x^\infty adF(a)}{x(1-F(x))}$ is decreasing in x .*

We define business density as the number of firms per one hundred workers: $d = 100 \times (1 - u) / \phi$. It is also the inverse of the firms' average size, scaled by 100.

Proposition 4 *If average productivity is increasing in \underline{a} and Assumptions 2-3 hold, business density (the average firm size) is increasing (decreasing) in \underline{a} , and, therefore, decreasing (increasing) in the entry cost $\tilde{\kappa}$.*

Assumptions 1 and 3 are satisfied for a variety of continuous distributions with support in \mathbb{R}_+ , including uniform, log-normal, and exponential distributions. Assumption 2 holds in our calibrated model below, as well as in all calibration exercises in the robustness section.

3 Estimating the Model

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

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 measure 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 assume a lognormal distribution $F(a; \mu_a, \sigma_a)$ for the initial productivity draws. The parameters μ_a and σ_a denote the mean and the standard deviation of productivity draws (in logs), respectively. It can be shown that μ_a is a scale parameter—its value has no bearing on any of our results. For computational reasons, we set μ_a to a low value of -15 ; this keeps the search for the productivity cutoff within a compact range. We calibrate the parameter σ_a , as discussed below.

The evolution of firms' productivity is parametrized as follows:

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

$$\bar{\mu}_s = 1 + \text{Beta}\left(\frac{s}{\bar{N}}; \eta_1, \eta_2\right), \quad 0 \leq s \leq \bar{N},$$

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 $\xi \geq 0$, $\eta_1 \geq 1$, $\eta_2 \geq 1$ are to be calibrated. In the model \bar{p} is the survival function for the first few years after the entry. The value of ξ controls the survival rate, and the assumed shape guarantees that \bar{p} is a convex function, as it has been documented in the data for a number of countries [Bartelsman et al., 2004, 2005]. The Beta function can generate essentially any shape; with the restriction that the parameters η_1 and η_2 are greater than one, it first increases then decreases.

We also let the data dictate the value of the parameter ϕ —the amount of overhead labor.⁸ In sum, our model requires five more parameters than the standard neoclassical model, $[\phi, \xi, \eta_1, \eta_2, \sigma_a]$. 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. In the model, productivity is proportional to employment, therefore we calibrate the productivity distribution to match

⁸This parameter (along with the discount rate, β , and the functions $\bar{\mu}$ and \bar{p}) determines the size of the smallest operating firms. Thus, one way to assess the implications of this parameter's value is to compare the size of the smallest firm in the model and in the data (i.e., one employee). We pursue this comparison when reporting the calibrated values of the parameters.

the distribution of firms and employment by size classes. In addition, we utilize data on the distribution of firms by age to capture how productivity changes over time. Overall, to calibrate our five parameters we use twenty-five moments from the data depicted as gray bars in Figure 1: eighteen of these moments relate to the distribution of firms and employment by size; the remaining seven of these are associated to the distribution of employment by age.⁹ The calibration routine determines parameter values that minimize the Euclidean distance between the moments generated by the model and their empirical counterparts. The model economy is assumed to be in steady state. The value of the entry cost in this procedure is set to 0.74%, its empirical counterpart for the U.S. Figure 1 compares the moments generated by the calibrated model with their data counterparts. The average squared distance between the two sets of moments is equal to 0.0011.

The estimated parameters are reported in Table 1. The estimated value of σ_a 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 0.86 employees. This value is close to the minimum firm size in the data, i.e., one employee. The estimated functions \bar{p}_s and $\bar{\mu}_s$ are depicted in Figure 2. The top panel implies a higher death rate at early ages. Conditional on survival, the bottom panel points toward an initial rapid growth, a productivity peak at around age twenty, and a decline afterwards. These patterns are consistent with the stylized facts about the firms' evolution over time, summarized in Klette and Kortum [2004].

Finally, the model matches well a number of available statistics that have not been used in the calibration. The entry rate in the model is identical to its empirical counterpart of 8.1 percent. The job creation (destruction) in the model is 5.2 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

⁹We do not have data on the distribution of firms by age. See Appendix B for a derivation of the distribution of firms and employment by size class and the distribution of employment by firm's age.

productivity shocks. The variance of the log-employment distribution generated by the model is 1.34, while it is 1.25 in the data.

4 Results

Before presenting our main results, we briefly summarize the data which we use to assess the impact of the entry cost on economic activity.¹⁰ In the data, the entry costs, measured as official fees that small firms must pay, vary dramatically across countries (see Table 2). Entry costs are on average 58 percent of per capita GDP, and they have a standard deviation of 75 percent of per capita GDP. The cost of entry ranges from 0 to 390 percent of per capita GDP. Entry costs are negatively correlated with TFP and output: The correlation coefficient in both cases exceeds 0.60 in absolute value. It is worth emphasizing the economic significance of these relationships. A percentage-point increase in the cost of entry is associated with a 0.21 percent decline in TFP and a 0.53 percent decline in output. Finally, entry costs are negatively correlated with business density and positively correlated with the mean and the variance of the firms' size distribution (in logs). All of these correlations are statistically significant at the 1 percent level.

We now assess the ability of our model to explain the observed correlation between entry costs and the following: TFP and output, as well as business density and the moments of the firms' log size distribution. We assume that all economies in our dataset are in steady state and that they are identical except for the cost of entry. For each country, we input the observed value of the entry cost into the calibrated model and compute the steady-state levels of TFP, output, and the other statistics of interest.

The first panel of Figure 3 plots the relationship between TFP and entry cost (both in logs) in the model and in the data. Since this relation in the model is almost perfectly linear, it is natural to compare it with the best linear fit to the data. The slope of the relation in our model is -0.14 , implying the model accounts for 66 percent of the (average) relation

¹⁰See Appendix C for data sources and definitions.

between the entry cost and TFP observed in the data. We also compare the TFP differences across countries exhibiting the highest and lowest entry costs. In the model, the countries in the first decile (quartile) of the entry cost distribution have, on average, 2.32 (1.87) times higher TFP than countries in the last decile (quartile). In the data the corresponding figure is 3.43 (2.54). The second panel of Figure 3 plots output per worker. As in the previous case the relation between the entry cost and output is linear, with a slope of -0.21 : The model captures 40 percent of the observed relation between entry costs and output.

It is not surprising that the model accounts for such a higher fraction of the effect of the entry cost on TFP than on 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 exactly these 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.¹¹ Barseghyan [2008] also finds that entry costs are correlated with property rights, which affect output through the capital-to-output ratio less so than through human capital accumulation. When controlling for property rights,¹² our model explains about 54% of the relation between the entry cost and output.

The intuition behind our results traces back to Hopenhayn [1992]. With free entry, a higher entry cost must be offset by higher expected profits. For this to happen, competitive pressure must be lower, i.e., the number of operating firms must be smaller. In addition, since a higher entry cost protects all incumbents from potential entrants, firms with lower productivity survive and continue to operate. Thus, a higher entry cost leads to a lower number of operating firms and lowers firms' average productivity.

We illustrate the first effect in Figure 4, which portrays the relation between entry costs

¹¹Recall that in the steady state of the neoclassical growth model, $\log(Y) = \text{constant} + 1/(1 - s_k) \cdot \log(TFP)$; When the share of capital is $1/3$, $1/(1 - s_k) = 1.5$.

¹²In the data we control for property rights by considering the part of output and entry costs not related, in a regression sense, to the debt recovery rate. The model's implied output is obtained by using as an input for the model the part of entry costs orthogonal to property rights, as measured by the debt recovery rate.

and business density in the model and in the data. In the data, business density declines sharply with a rise in the cost of entry and the model generates a similar pattern. Quantitatively the model does well along this dimension. Notice that our model is calibrated to match the firms' average size or, equivalently, the business density in the U.S.¹³ 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.

To illustrate the second effect we start with Figure 5, which portrays the density function of productivity across operating firms for the U.S., which has the fourth-lowest entry cost in our sample, and Niger, which has the highest entry cost. The two dashed vertical lines mark the respective productivity cutoffs, denoted by $\log(\underline{a}^{USA})$ and $\log(\underline{a}^{NER})$. In the figure the lowest productivity levels of the entering firms correspond to the lower end of the support of the two distributions.¹⁴ Because Niger has a lower productivity cutoff (i.e., the distribution of entering firms gets truncated at a lower point), this distribution has a lower mean and a wider support and it is more dispersed.

Since in our model productivity and employment are proportional, the moments of the

¹³The slight discrepancy between the value implied by the model and the one measured in the data by Djankov et al. [2008] for the U.S. is due to different ways of measuring business density. In the model, business density is given by the number of firms per 100 workers and it is the reciprocal of the firms' average size; in U.S. data, the average firm employs 21.8 workers and the model matches this value. In Djankov et al. [2008], business density is defined as the number of establishments per 100 members of the working age population. In fact, the ratio between the two notions of business densities for the U.S. coincides with the product of the firms-to-establishments ratio and employment, divided by the working age population.

¹⁴The two productivity densities in Figure 5 also show how a substantial number of firms (roughly 20 percent) operate with a productivity level below the break-even threshold \underline{a} . These are young firms that choose to operate because they expect that their productivity will grow over time: After paying the entry cost, these firms continue to invest amounts equal to their (negative) profits. This mechanism gives rise to the notion of organization capital, emphasized by Atkeson and Kehoe [2005].

productivity distribution are closely related to the moments of the employment distribution. In particular, it can be shown that

$$\text{Var}(\log(a)) = \text{Var}(\log(N - \phi)) \approx \text{Var}(\log(N)). \quad (4.1)$$

It follows that a higher entry cost implies a higher variance of the log-employment distribution. In the second panel of Figure 6 we plot the relation between the entry cost and the variance of log employment. The relation in the data is positive, with a linear slope of 0.35. The slope generated by the model is 0.14, or about 40 percent of that in the data. For completeness, we also plot the relation between the entry cost and the mean of log employment in the top panel of Figure 6. Both in the model and in the data, higher entry costs are associated with higher average log-employment. This occurs because the number of operating firms declines as the entry cost rises.¹⁵ The slope generated by the model is 0.07, while in the data the corresponding figure is 0.51.

5 Robustness Analysis

In this Section we assess the robustness of our results along several dimensions.

5.1 Calibration

Distribution of firms by age/size in the U.S. In our benchmark calibration we use data on the distribution of employment and firms by size class (averages over 1990-2005) because entry costs are measured at the firm level. However, the distribution of employment by age is constructed with plant-level data for 1988, for which more age categories are available than for more recent firm-level data (see Appendix C). The model's implications in terms

¹⁵Notice that the mean of the log-employment distribution is not equal to $E \log(a)$, which declines with the entry cost. Rather, it can be shown that $E \log(N) \approx E \log(N - \phi) = \text{constant} + E \log(a) - \log(\underline{a})$. As the entry cost rises, $\log \underline{a}$ falls at a faster rate than $E \log(a)$, therefore, $E \log(N)$ rises. Also, even though employment is proportional to productivity, the size of the smallest operating firm does not decline with the productivity cutoff—it is constant across all economies.

of output and TFP are robust to the use of different moments from the U.S. data in the calibration. First, we use the average distribution of firms by age over 1978-98. Notice that having fewer age categories provides much less information on the evolution of firms' productivity. Second, we consider the distributions by size relative to establishments, as opposed to firms, for 1988 (i.e., the same year as the distribution by age in our benchmark analysis) from the County Business Patterns (CBP). Our results are robust to the use of these two alternative sets of moments of the distribution of U.S. firms. The second and third rows of Table 3 report the following: the parameter values obtained by re-calibrating the model to match these two different sets of moments, along with the fraction of the entry cost effect on output and TFP captured by these two versions of the model. We report two measures of the latter: the fraction of the slope and the fraction of the 1st/4th quartile average effect (denoted by $Q^{0.25}/Q^{0.75}$) accounted for by the model.

Upper bound on the firms' age. The upper bound on the firms' age, \bar{N} , is set to 400 in our benchmark calibration. We set this to 250 and 1000 and re-calibrate our model. The resulting parameter values and the corresponding effects of the cost of entry on economic activity are reported in rows four and five of Table 3. The performance of the model is not sensitive to the value of the parameter \bar{N} .

Older firms' productivity. Our functional form for $\bar{\mu}$ is such that its value converges to one from above as a firm ages. A firm with a very high initial productivity draw exits only if it receives a permanent zero-productivity shock. We are agnostic as to whether this is the best way to capture the productivity evolution of old firms. To this end we set $\bar{\mu}_s = \text{Beta}((1+s)/\bar{N}; \eta_1, \eta_2)$ with a normalization $\bar{\mu}_0 = 1$ and re-calibrate the model. In this specification, firms' productivity eventually falls below the productivity draw at birth and it converges to zero as firms age. The resulting parameter values are reported in the sixth row of Table 3. The predicted effect of the entry cost on economic activity remains very close to that in the benchmark model.

Returns to scale in variable inputs. 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 $\gamma = 0.83$. Re-calibrating our model with $\gamma = 0.80$ allows us to explain an even larger part of the observed relation between the entry cost and macroeconomic outcomes (see Table 3, seventh row). In this case, a percentage-point increase in the entry cost implies a 0.19 percent decline in TFP. Conversely, with a higher value of this parameter, i.e., $\gamma = 0.90$, the model’s explanatory power is reduced, but it still accounts for sizeable fractions of the effect of entry costs on TFP and output. (Table 3, last row).

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)¹⁶ does not significantly change any of the statistics reported in the paper or the quantitative success of our model.

5.2 Evolution of firms productivity

Our modeling of the evolution of firms’ productivity is motivated by the stylized empirical facts documented in the literature. Furthermore, our calibrated model closely matches the moments of the age and size distribution of U.S. firms. Below we present additional evidence in support of our modeling choices.

Distribution of productivity draws at birth. Figure 7 portrays the relation between entry cost and entry rate. Both in the data and in the model a higher entry cost is associated with a lower entry rate; in the data this relation is more pronounced. In our model there is no robust connection between the steady-state entry rate and the entry cost. For example, if firms’ productivity were constant over time, i.e., $\bar{\mu}_s = 1$, the entry rate would not depend on the productivity cutoff, \underline{a} ; therefore it would be unrelated to the entry cost. In our model the entry rate can be expressed as $\chi = \left(\sum_0^{\underline{N}} \bar{p}_s + \sum_{\underline{N}+1}^{\bar{N}} \bar{p}_s \frac{1-F(\underline{a}/\bar{\mu}_s)}{1-F(\underline{a}_0)} \right)^{-1}$. The relation between the entry cost and the entry rate is determined by the properties of the function F . More specifically, the signs of the derivatives of the ratios $(1 - F(\underline{a}/\bar{\mu}_s)) / (1 - F(\underline{a}_0))$ with

¹⁶As discussed in Appendix C, TFP data for 2003 are not available.

respect to \underline{a} determine the relation between entry cost and entry rate. For the log-normal distribution these ratios increase with \underline{a} and this generates the negative relation between the entry cost and the entry rate.¹⁷

Learning. In our model an entering firm faces uncertainty, even after receiving its productivity draw. In subsequent periods its productivity will either grow or fall to zero. Yet the revelation of a firm's productivity type is instantaneous, since it is determined by the initial productivity draw. We explore the sensitivity of our results to this formulation in two ways.

First, we allow for a gradual revelation of productivity types. After paying the entry cost a firm receives a productivity draw with probability q_0 . If it does not get to draw, it can wait until the following period by paying the operating cost (ϕw) .¹⁸ In the following period the firm gets a productivity draw with probability q_1 . If it does not, again it can wait by paying the operating cost (ϕw) , and so on. At any given point in time, once a firm receives a productivity draw it faces the same problem as described in Section 2.2. We parameterize the probability of not having received a productivity draw up to age s as

$$\bar{q}_s = \varkappa_1(1 + s)^{-\varkappa_2}, \quad \varkappa_1, \varkappa_2 > 0, \quad (5.1)$$

and re-calibrate the model with seven parameters (\varkappa_1 , \varkappa_2 , and the five parameters in the benchmark specification). The calibrated model implies a very limited role for firms' learning about their productivity: 99.9 percent of the firms receive a productivity draw immediately; afterward they either grow quickly or exit, as in the benchmark model.

Second, we maintain the assumption on how firms' learn their productivity type, but eliminate exogenous exit by setting \bar{p}_s to one for all ages. This specification might allow for a larger role for the gradual revelation of productivity types, because exit at early ages

¹⁷We conjecture that with additional degrees of freedom it should be possible to modify the properties of the right tail of the function F such that the elasticity of $(1 - F(\underline{a}/\bar{\mu}_s)) / (1 - F(\underline{a}_0))$ with respect to \underline{a} would increase without affecting the rest of our results.

¹⁸This specification is close to the assumption that a worker (manager) needs to be hired to design a blueprint in Atkeson and Kehoe [2005].

may occur only when a firm receives a productivity draw lower than \underline{a}_0 . We find a very limited role for this mechanism as well. These two experiments do not significantly alter the cross-country predictions of our model.

5.3 Open Economy Considerations

In our model the interest rate is the same for every country: The model is consistent with unrestricted capital flows.¹⁹ 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. This assumption is standard in the literature.

5.4 Entry Costs: Broader Measures and Correlated Distortions

Broader measures of the cost of entry. Several considerations suggest that the narrow measure of entry cost used in our analysis understates the overall cost firms pay to enter a market. Djankov et al. [2002] construct a broader measure of entry costs that accounts for the costs associated with regulation compliance in addition to the entry fees. This “total entry cost” measure, as well as the number of required entry procedures, are highly correlated with the narrower measure that we use. The “total entry cost” measure is, on average, twice as large as our measure. Omitting indirect costs from our measure has little effect on our results, since the relation between entry cost and TFP (both in logs) is very close to linear. If we double the entry cost for all countries and reestimate, the model picks up 69 percent of the relation between entry cost and TFP (up from 66 percent) and 43 percent of the relation between entry cost and output (up from 40 percent). Moreover, the measure used

¹⁹Models with heterogeneous firms and endogenous TFP have been very successful in the trade literature. See Melitz [2008] and the references therein.

in the paper is for small firms (5 to 50 workers) that are entirely domestically owned and not engaged in import-export activities. Entry for larger firms, exporters, and importers is likely to be more expensive. One simple way to correct for this in our framework would be to multiply the entry cost in all countries by the same factor. As noted above, this would improve the explanatory power of the model. Another manifestation of high barriers to entry is the uncertainty surrounding the entry process. For example, Guner et al. [2008] report that during the 1980s and 1990s opening a retail store in Japan required a “...*consensus of interested parties...which often led to the abandonment of the plans altogether.*” By the mid 1980s, the application procedure involved 7 to 16 stages and could have been stopped at any stage.²⁰ Presence of such practices not only implies that our entry cost measure is conservative, but also that we understate its magnitude by a larger factor in countries with *higher* official entry costs.

Operating costs. Overhead labor costs paid by young firms in our model can be interpreted as the necessary expenses to acquire and learn how to use a particular technology. In the model these costs are quite substantial. Roughly 20 percent of all U.S. firms generate negative profits while continuing to invest (i.e., absorb losses) in anticipation of future productivity growth. Interestingly, in the model, payments to organization capital, i.e., the return on these investments, are about 8 percent of GDP, which is the share of intangible capital in the U.S. manufacturing sector [see Atkeson and Kehoe, 2005].²¹

However, if overhead labor costs vary systematically with the entry cost, the model might overstate the effects of the cost of entry. Consider varying the amount of overhead labor, the parameter ϕ . In our steady-state calculations ϕ appears in the definition of TFP, eq. (2.8), and in the free entry condition, eq. (2.19). Since an increase in ϕ implies a higher overhead cost, its direct effect on TFP is negative. However, an increase in ϕ has a positive indirect effect on TFP because, in the free entry condition, it has the same effect as a reduction in the entry cost. An increase in the operating cost increases the amount of profits required for

²⁰During this period, the number of applications for opening a store fell more than 2.5 times.

²¹The model does not support a more gradual learning of productivity, which would increase the amount of these sunk costs (see Section 5.2).

firms to break even and the productivity cutoff \underline{a} . To evaluate the importance of this channel we calibrate the model with the parameter ϕ increasing linearly from 1 in the country with the lowest entry cost to 10 in the country with the highest.²² Though the model's ability to generate TFP differences is reduced, it still captures 43 percent of the empirical relation between the entry cost and TFP.

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 mark-up on measured entry costs, τ^κ . To illustrate the effect of these distortions, we recall the free entry condition (2.19). For simplicity, we write it for the case of one-period-lived firms:

$$(1 + \tau^\kappa)\tilde{\kappa} = (1 - \tau^\pi)\phi\frac{(1 - \alpha)\gamma}{u}\int_{\underline{a}_0}^{\infty}\left(\frac{a}{\underline{a}_0} - 1\right)dF(a). \quad (5.2)$$

Thus, corruption acts as a multiplier, $(1 + \tau^\kappa)/(1 - \tau^\pi) > 1$, on entry cost. Countries with higher entry cost tend to have higher corruption. Hence, corruption magnifies the negative effect of higher entry costs on economic activity.

Until now we considered the entry cost payments as part of a country's income. If unofficial payments, induced by corruption, trump in magnitude the official entry fees, most of the firms' total cost of entry would not be included in output. To check whether this can make a difference, we compute output net of the entry fees. Net output is almost perfectly correlated with gross output and these measures have essentially identical elasticities with respect to the entry cost. In countries with higher entry costs, fewer firms pay the cost of entry and the ratio of net-to-gross output is nearly constant across countries.

Borrowing constraints. If entrepreneurs must borrow to finance entry, then the effective cost will be higher. Since entrepreneurs typically face higher borrowing costs in poorer countries [see Banerjee and Duflo, 2005], it follows that borrowing constraints would magnify the effect of entry costs on economic activity and lead to even higher cross-country

²²This approach is conservative. First, the highest cross-country cost of technology adoption reported in Parente and Prescott [1994, pp. 314-5] is 3.5 times the cost in the U.S. Second, we are changing the operating cost that firms pay at all ages, overstating the share of overhead costs associated with learning.

productivity differences than implied by our model.

5.5 Employment share of small firms

Tybout [2000] shows in a small sample of countries that the employment share of smaller firms is substantially higher in least developed and developing countries than in the U.S. This evidence is hard to reconcile with the negative relations between income and the mean and between income and the variance of the firms' size distribution [see Alfaro et al., 2008], unless in poorer countries very large firms employ the remainder of the workers. For both of these patterns to hold, firms in poorer countries must be either very big or very small. Our model can generate this feature by modifying the distribution of productivity draws at birth, F , to allow for a point mass in the left tail of the distribution and a low density between the point mass and the productivity cutoffs of high-income countries. Such a distribution would imply significant threshold effects: As entry costs increase and drive the productivity cutoff below the point mass, TFP and output would decline by much more than predicted by our benchmark model. The magnitude of this decline can be quite large, reaching as much as 18 percent for TFP and 31 percent for output.²³

An alternative explanation stems from the work of Guner et al. [2008].²⁴ They show that size-dependent policies naturally lead to a point mass in the distribution of productivity across firms.²⁵ Firms in the mid-range of the productivity distribution purposefully do not grow; in this way, they avoid paying disproportionately higher taxes. In our model, the size distribution is anchored to productivity at the lower tail (in all countries the lowest productivity firm has size 0.86). Consider two countries with identical size-dependent policies

²³These values are analytical upper bounds on the threshold effect. In a related paper [Barseghyan and DiCecio, 2008] we construct examples where the threshold effect for TFP and output are 10 and 16 percent, respectively.

²⁴Rauch [1991] makes a similar argument in a model with formal and informal sectors.

²⁵In the framework of Guner et al. [2008] size-dependent policies generally reduce the firms' average size. Thus, size-dependent policies per se cannot reconcile the evidence in Tybout [2000] with the evidence provided by Alfaro et al. [2008].

but different entry costs. In the high-entry-cost country the size distortion would place the point mass at a lower productivity level than in the low-entry-cost country, leading to much larger differences in TFP and output than predicted by our benchmark model. In our framework, a given size-dependent policy generates a point mass that changes its position with the entry cost: The higher the entry cost is, the farther to the left is the point mass.

6 Conclusions

Misallocation of resources across firms caused by policy distortions is often seen as a reason for cross-country variation in productivity and output. However, to identify which policies are important and how much they affect economic outcomes, theoretical constructs must be confronted with the data. In this paper we have shown that the observed variation in entry barriers explains a substantial part of cross-country differences in TFP and output. The mechanism through which entry costs influence productivity in our model finds strong empirical support: Countries with high entry barriers have lower business density and higher variance of employment distribution across firms.

The importance of entry costs does not supersede other sources of misallocation analyzed in the literature. These other sources may explain the part of the variability of TFP and output unaccounted for by cross-country heterogeneity in entry costs. For example, we leave for further research the study of the interaction of entry costs with borrowing constraints [see Buera and Shin, 2008] and an empirical analysis of various distortionary policies of the kind analyzed by Restuccia and Rogerson [2008] and Guner et al. [2008] in conjunction with costly entry.

References

- D. Acemoglu, S. Johnson, and J. A. Robinson. Reversal of fortune: Geography and institutions in the making of the modern world income distribution. *Quarterly Journal of Economics*, 117(4):1231–94, November 2002.
- D. Acemoglu, S. Johnson, J. A. Robinson, and Y. Tchaicharoen. Institutional causes, macroeconomic symptoms: Volatility, crises and growth. *Journal of Monetary Economics*, 50(1):49–123, 2003.
- A. Alesina, S. Ardagna, G. Nicoletti, and F. Schiantarelli. Regulation and investment. *Journal of the European Economic Association*, 3(4):791–825, 2005.
- L. Alfaro, A. Charlton, and F. Kanczuk. Plant-size distribution and cross-country income differences. NBER Working Paper No. 14060, Jun 2008.
- A. Atkeson and P. J. Kehoe. Modeling and measuring organizational capital. *Journal of Political Economy*, 113(5):1026–53, October 2005.
- A. Banerjee and E. Duflo. Growth theory through the lens of development economics. In P. Aghion and S. Durlauf, editors, *Handbook of Economic Growth*. Elsevier Science, North-Holland, Amsterdam, New York and Oxford, 2005.
- L. Barseghyan. Entry costs and cross-country differences in productivity and output. *Journal of Economic Growth*, 13(2):145–67, June 2008.
- L. Barseghyan and R. DiCecio. Endogenous productivity and multiple steady states. Federal Reserve Bank of St. Louis, Working Paper No. 2008-023A, 2008.
- E. Bartelsman, S. Scarpetta, and F. Schivardi. Comparative analysis of firm demographics and survival: evidence from micro-level sources in OECD countries. *Industrial And Corporate Change*, 14(3):365–391, 2005.

- E. J. Bartelsman, J. Haltiwanger, and S. Scarpetta. Microeconomic evidence of creative destruction in industrial and developing countries. Tinbergen Institute, Tinbergen Institute Discussion Papers: 04-114/3, 2004.
- F. Bastos and J. Nasir. Productivity and investment climate: What matters most? World Bank Policy Research Working Paper No. 3335, June 2004.
- S. Basu. Procyclical productivity: Increasing returns or cyclical utilization? *Quarterly Journal of Economics*, 111(3):719–751, August 1996.
- M. Bruhn. License to sell: The effect of business registration reform on entrepreneurial activity in Mexico. The World Bank, Policy Research Working Paper Series: 4538, 2008.
- F. J. Buera and Y. Shin. Financial frictions and the persistence of history: A quantitative exploration. Washington University in St. Louis, unpublished manuscript, April 2008.
- A. Burstein and A. Monge-Naranjo. Foreign know-how, firm control, and the income of developing countries. *Quarterly Journal of Economics*, 124(1), 2009. forthcoming.
- Y. Chang. Wages, business cycles, and comparative advantage. *Journal of Monetary Economics*, 46(1):143–71, August 2000.
- S. J. Davis, J. C. Haltiwanger, and S. Schuh. *Job creation and destruction*. M.I.T. Press, Boston, MA, 1996.
- H. De Soto. *The Other Path: The Invisible Revolution in the Third World*. Harper and Row, New York, 1989.
- S. Djankov, R. La Porta, F. Lopez-de-Silanes, and A. Shleifer. The regulation of entry. *The Quarterly Journal of Economics*, 117(1):1–37, 2002.
- S. Djankov, T. Ganser, C. McLiesh, R. Ramalho, and A. Shleifer. The effect of corporate taxes on investment and entrepreneurship. NBER Working Paper No. 13756, January 2008.

- D. Dollar and A. Kraay. Institutions, trade and growth. *Journal of Monetary Economics*, 50(1):133–62, 2003.
- W. Easterly and R. Levine. Tropics, germs, and crops: How endowments influence economic development. *Journal of Monetary Economics*, 50(1):3–39, 2003.
- A. Erosa and A. Hidalgo-Cabrillana. On finance as a theory of TFP, cross-industry productivity differences, and economic rents. *International Economic Review*, 49(2):437–73, May 2008.
- N. Guner, G. Ventura, and Y. Xu. Macroeconomic implications of size-dependent policies. *Review of Economic Dynamics*, 11(4):721–44, October 2008.
- J. Helfand, A. Sadeghi, and D. Talan. Employment dynamics: Small and large firms over the business cycle. *Monthly Labor Review*, 130(3):39–50, March 2007.
- B. Herrendorf and A. Teixeira. How barriers to international trade affect TFP. *Review of Economic Dynamics*, 8(4):866–76, October 2005.
- A. Heston, R. Summers, and B. Aten. Penn world table version 6.2. Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, 2006.
- H. A. Hopenhayn. Entry, exit, and firm dynamics in long run equilibrium. *Econometrica*, 60(5):1127–1150, September 1992.
- H. A. Hopenhayn and R. Rogerson. Job turnover and policy evaluation: A general equilibrium analysis. *Journal of Political Economy*, 101:915–938, 1993.
- C.-T. Hsieh and P. J. Klenow. Relative prices and relative prosperity. *American Economic Review*, 97(3):562–85, June 2007.
- C.-T. Hsieh and P. J. Klenow. Misallocation and manufacturing TFP in China and India. *Quarterly Journal of Economics*, 124(4), 2009. Forthcoming.

- P. J. Klenow and A. Rodriguez-Clare. Externalities and growth. In P. Aghion and S. Durlauf, editors, *Handbook of Economic Growth*. Elsevier Science, North-Holland, Amsterdam, New York and Oxford, 2005.
- T. J. Klette and S. Kortum. Innovating firms and aggregate innovation. *Journal Of Political Economy*, 112(5):986–1018, 2004.
- R. E. Lucas, Jr. On the size distribution of business firms. *Bell Journal of Economics*, 9(2): 508–523, Autumn 1978.
- E. R. McGrattan and E. C. Prescott. Taxes, regulations, and the value of U.S. and U.K. corporations. *Review of Economic Studies*, 72(3):767–96, July 2005.
- M. J. Melitz. International trade and heterogeneous firms. In S. N. Durlauf and L. E. Blume, editors, *The New Palgrave Dictionary of Economics*. Palgrave Macmillan, 2nd edition edition, 2008.
- S. J. Nickell. Competition and corporate performance. *Journal of Political Economy*, 104 (4):724–746, 1996.
- G. Nicoletti and S. Scarpetta. Regulation, productivity and growth: OECD evidence. *Economic Policy*, 18(36):9–72, April 2003.
- S. L. Parente and E. C. Prescott. Barriers to technology adoption and development. *Journal of Political Economy*, 102:298–321, 1994.
- J. E. Rauch. Modelling the informal sector formally. *Journal of Development Economics*, 35 (1):33–47, January 1991.
- D. Restuccia and R. Rogerson. Policy distortions and aggregate productivity with heterogeneous establishments. *Review of Economic Dynamics*, 11(4):707–20, October 2008.
- D. Rodrik, A. Subramanian, and F. Trebbi. Institutions rule: The primacy of institutions over geography and integration in economic development. *Journal of Economic Growth*, 9(2):131–165, 2004.

- J. Sivadasan. Barriers to competition and productivity: Evidence from india. University of Michigan, unpublished manuscript, November 2008.
- The World Bank. *Doing Business in 2004 - Understanding Regulation*. The International Bank for Reconstruction and Development / The World Bank, Washington, D.C., 2004.
- The World Bank. *Doing Business in 2005 - Removing Obstacles to Growth*. The International Bank for Reconstruction and Development / The World Bank, Washington, D.C., 2005.
- The World Bank. *Doing Business in 2006 - Creating Jobs*. The International Bank for Reconstruction and Development / The World Bank, Washington, D.C., 2006a.
- The World Bank. *Doing Business in 2007 - How to Reform*. The International Bank for Reconstruction and Development / The World Bank, Washington, D.C., 2006b.
- The World Bank. *Doing Business in 2008*. The International Bank for Reconstruction and Development / The World Bank, Washington, D.C., 2007.
- J. R. Tybout. Manufacturing firms in developing countries: How well do they do, and why? *Journal of Economic Literature*, 38(1):11–44, March 2000.
- M. Veracierto. Employment flows, capital mobility, and policy analysis. *International Economic Review*, 42(3):571–95, August 2001.

Fixed parameters	Estimated parameters
R	ϕ 0.46
δ	ξ 0.69
γ	η_1 2.78
α	η_2 27.80
μ_a	σ_a 4.22

Table 1: Parameters values

Variable	Obs.	Mean	Std. Dev.	Min	Max	Corr. with entry costs	Corr. with log entry costs
Entry costs (% of per capita GDP)	128	58.13	75.44	0.00	390.54	1.00	0.80*
Entry costs (logs)	127	3.14	1.56	-1.71	5.97	0.80*	1.00
Output per worker (logs)	128	9.35	1.10	6.90	11.54	-0.69*	-0.76*
TFP (logs)	85	5.87	0.54	4.30	6.77	-0.65*	-0.69*
Business density	76	5.01	4.00	0.00	15.78	-0.41*	-0.47*
Avg. firm size (logs)	75	3.04	1.39	1.39	6.12	0.41*	0.63*
Std. dev. firm size (logs)	75	2.48	1.19	1.19	7.23	0.34*	0.51*

Table 2: Summary statistics: * denotes significance at the 1 percent level.

	Estimated parameters					Calibrated model vs. data	
	ϕ	ξ	η_1	η_2	σ_a	$\log(TFP)$ and $\log(\tilde{\kappa})$	$\log(Y)$ and $\log(\tilde{\kappa})$
Benchmark	0.46	0.69	2.78	27.80	4.22	Slope 66.1 $Q^{0.25}/Q^{0.75}$ 73.7	Slope 40.1 $Q^{0.25}/Q^{0.75}$ 27.3
Distr. of firms by age, 1978-98	0.46	0.60	5.61	60.17	4.18	60.2	40.0
Distr. of establishments by size	0.99	0.94	5.13	52.82	3.62	62.6	38.0
$\bar{N} = 250$	0.48	0.57	2.75	18.20	4.29	66.1	40.1
$\bar{N} = 1000$	0.42	0.93	2.94	62.98	4.02	65.9	40.0
Older firms' productivity	0.39	0.96	2.64	18.09	3.95	65.8	40.0
$\gamma = 0.8$	0.64	0.70	2.86	28.40	4.27	88.2	53.5
$\gamma = 0.9$	0.29	0.66	2.71	27.32	4.14	44.1	26.8

Table 3: Robustness analysis: parameters values and relations between entry costs and TFP/output.

$Q^{0.25}/Q^{0.75}$ denotes the fraction of the 1st/4th quartile average effect accounted for by the model.

Slope denotes the fraction of the OLS slope of the relation accounted for by the model.

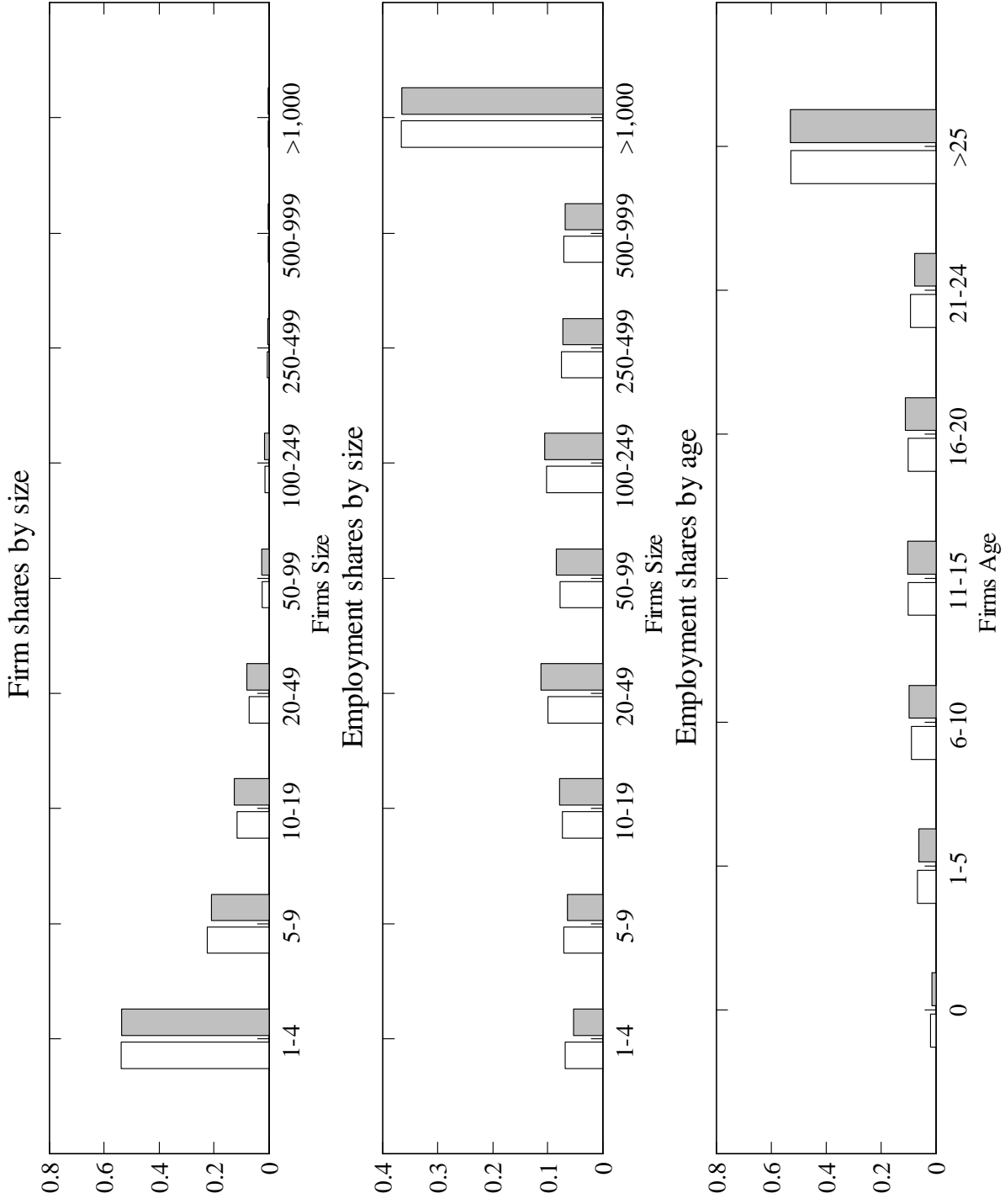


Figure 1: Features of the distribution of firms in the U.S.: data (gray bars) and calibrated model (white bars).

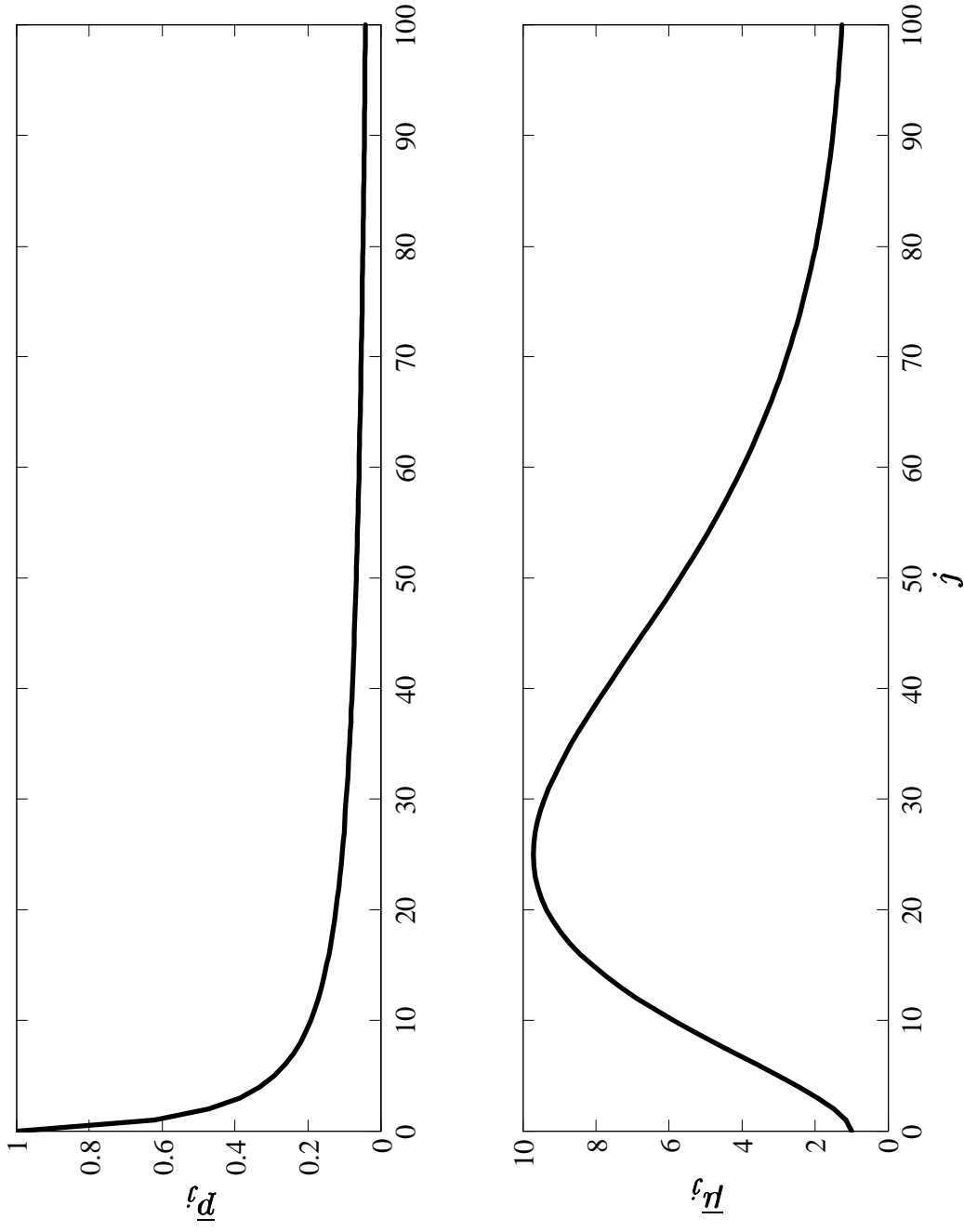


Figure 2: Firms' productivity evolution in the calibrated model.

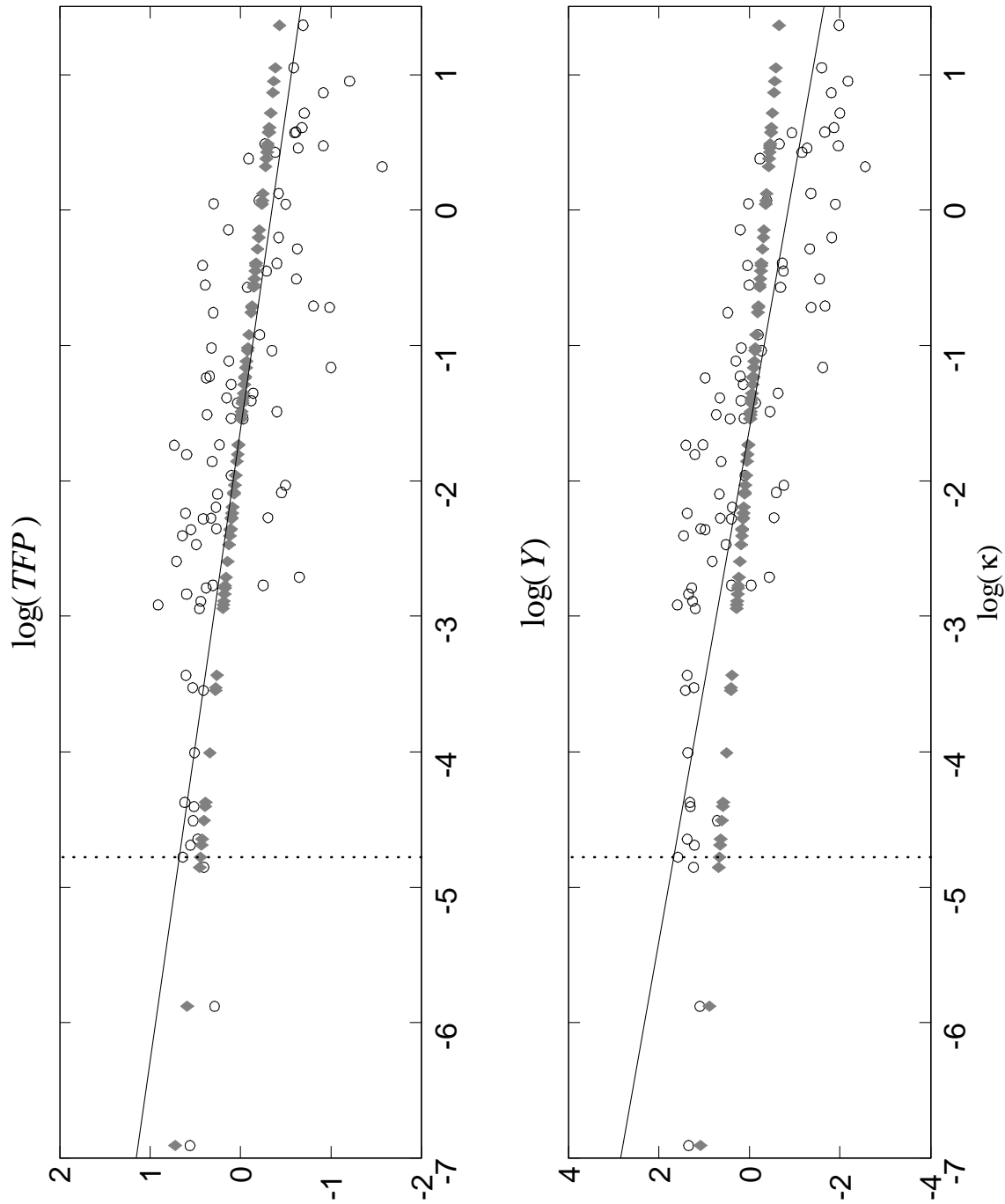


Figure 3: Output and TFP: year 2000 data (circles), regression line through the data, and model (gray diamonds); U.S. denoted by vertical dotted lines.

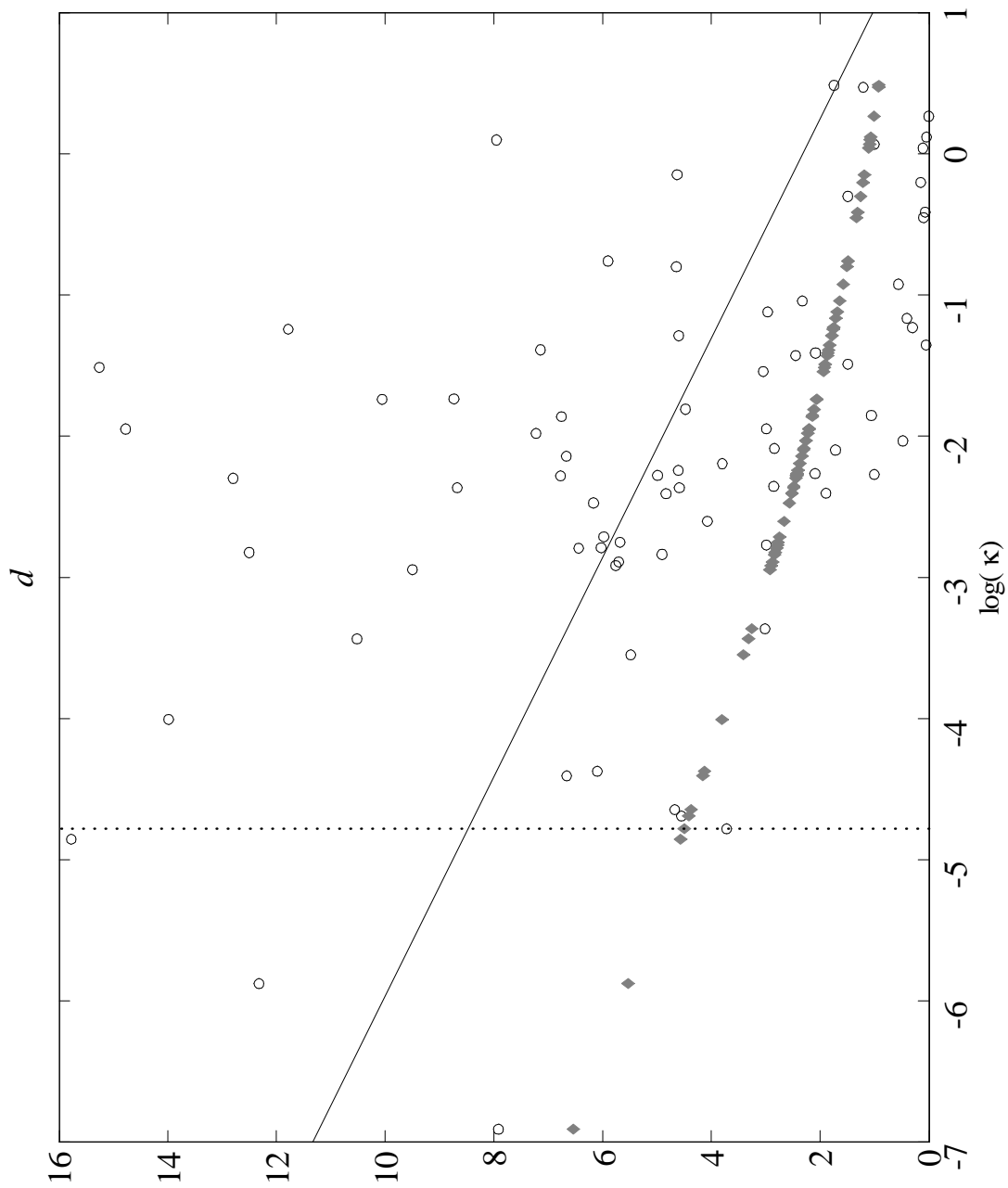


Figure 4: Business density (per 100 members of working population): data (circles), regression line through the data, and model (gray diamonds); U.S. denoted by vertical dotted line.

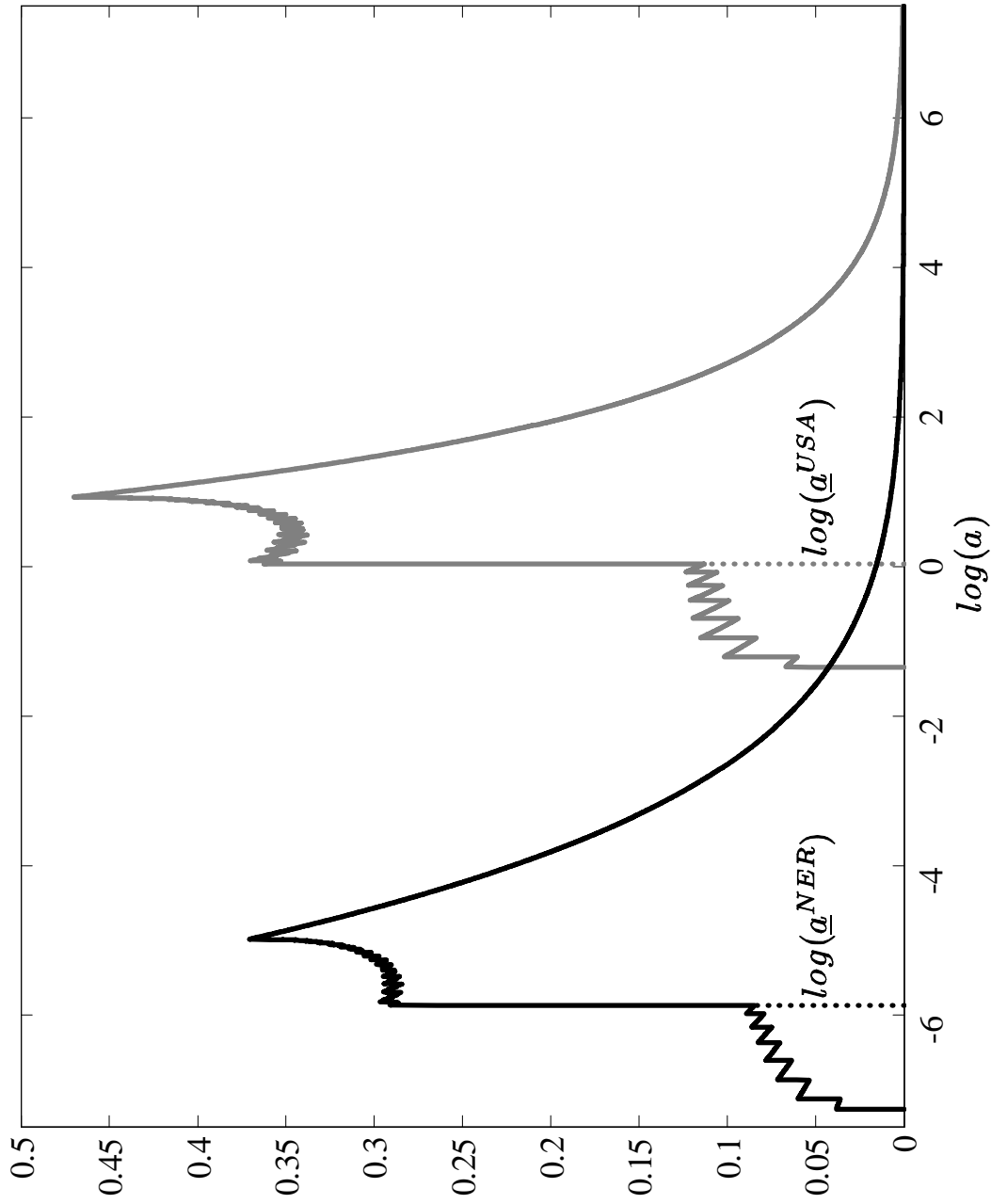


Figure 5: Density functions of productivity across firms generated by the model: U.S. (gray) vs. Niger (black).

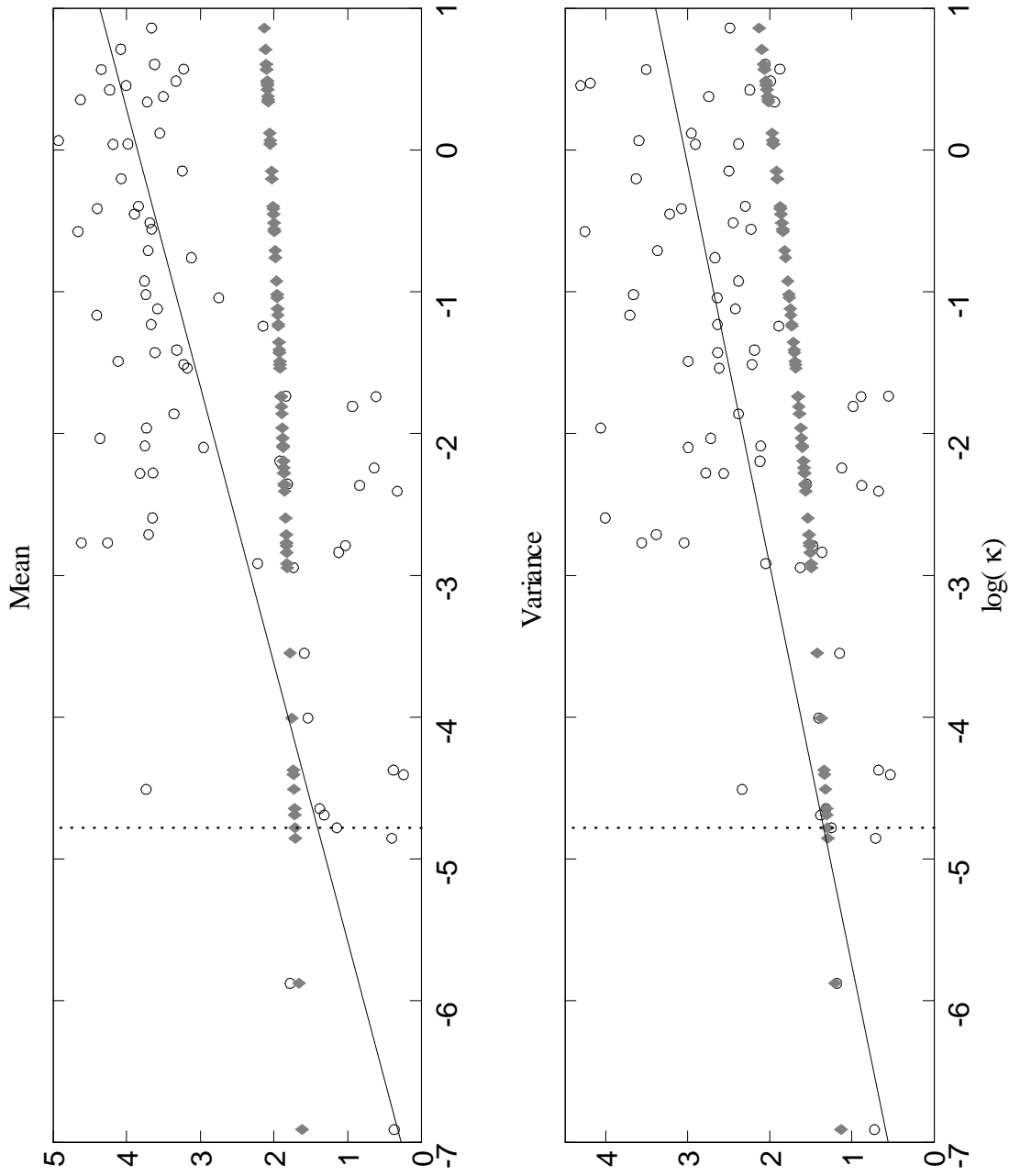


Figure 6: Moments of the distribution of log-employment: data (circles), regression line through the data, and model (gray diamonds); U.S. denoted by vertical dotted line.

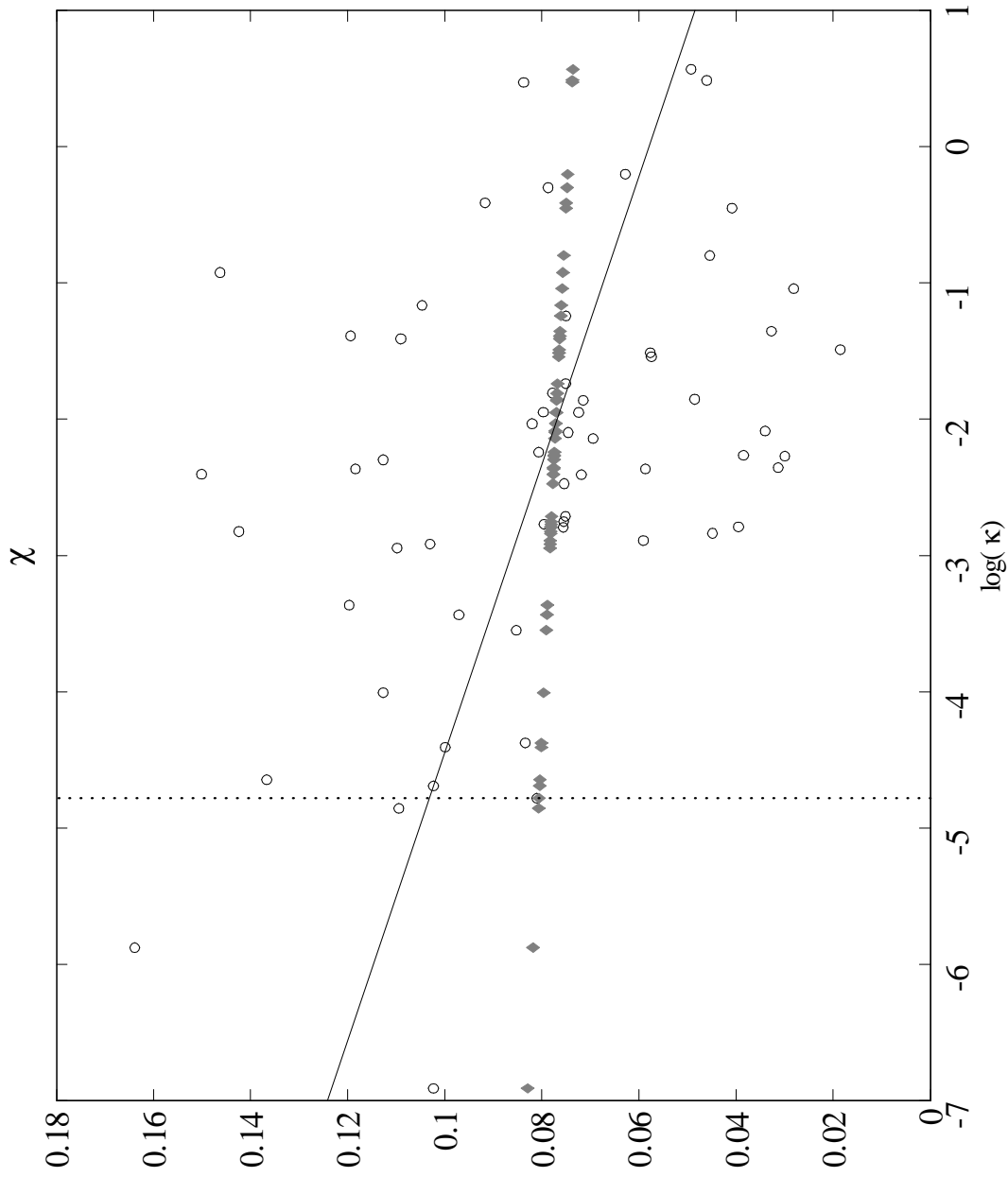


Figure 7: Entry rate: data (circles), regression line through the data, and model (gray diamonds); U.S. denoted by vertical dotted line.

A Proofs of Propositions 1-4

Proof of Proposition 1. Average productivity is increasing if and only if the expression in braces below is:

$$\text{signum } \frac{\partial \bar{a}(\underline{a}_0)}{\partial \underline{a}_0} = \text{signum } \left\{ \begin{aligned} & \left(\sum_{j=0}^N \bar{p}^j \int_{\underline{a}_0}^{\infty} dF(a) + \sum_{\underline{N}+1}^{\bar{N}} \bar{p}^j \int_{\frac{\underline{a}}{\bar{\mu}_j}}^{\infty} dF(a) \right) \times \\ & \times \left[\frac{\partial}{\partial \underline{a}_0} \left(\sum_{j=0}^N \bar{p}^j \bar{\mu}_j \int_{\underline{a}_0}^{\infty} adF(a) + \sum_{\underline{N}+1}^{\bar{N}} \bar{p}^j \bar{\mu}_j \int_{\frac{\underline{a}}{\bar{\mu}_j}}^{\infty} adF(a) \right) \right] + \\ & - \left(\sum_{j=0}^N \bar{p}^j \bar{\mu}_j \int_{\underline{a}_0}^{\infty} adF(a) + \sum_{\underline{N}+1}^{\bar{N}} \bar{p}^j \bar{\mu}_j \int_{\frac{\underline{a}}{\bar{\mu}_j}}^{\infty} adF(a) \right) \times \\ & \times \left[\frac{\partial}{\partial \underline{a}_0} \left(\sum_{j=0}^N \bar{p}^j \int_{\underline{a}_0}^{\infty} dF(a) + \sum_{\underline{N}+1}^{\bar{N}} \bar{p}^j \int_{\frac{\underline{a}}{\bar{\mu}_j}}^{\infty} dF(a) \right) \right] \end{aligned} \right\}$$

It is apparent that

$$\text{signum } \left\{ \begin{aligned} & \left(\sum_{j=0}^N \bar{p}^j \int_{\underline{a}_0}^{\infty} dF(a) \right) \times \left[\frac{\partial}{\partial \underline{a}_0} \left(\sum_{j=0}^N \bar{p}^j \bar{\mu}_j \int_{\underline{a}_0}^{\infty} adF(a) \right) \right] + \\ & - \left(\sum_{j=0}^N \bar{p}^j \bar{\mu}_j \int_{\underline{a}_0}^{\infty} adF(a) \right) \times \left[\frac{\partial}{\partial \underline{a}_0} \left(\sum_{j=0}^N \bar{p}^j \int_{\underline{a}_0}^{\infty} dF(a) \right) \right] \end{aligned} \right\} = +1.$$

Also, taking into account that $\underline{a} = \underline{a}_0 \left(\sum_{j=0}^N \frac{\bar{p}_j \bar{\mu}_j}{R^j} \right) / \left(\sum_{j=0}^N \frac{\bar{p}_j}{R^j} \right)$:

$$\begin{aligned} & \text{signum } \left\{ \begin{aligned} & \left(\sum_{\underline{N}+1}^{\bar{N}} \bar{p}^j \int_{\frac{\underline{a}}{\bar{\mu}_j}}^{\infty} dF(a) \right) \times \frac{\partial}{\partial \underline{a}_0} \left[\sum_{\underline{N}+1}^{\bar{N}} \bar{p}^j \bar{\mu}_j \int_{\frac{\underline{a}}{\bar{\mu}_j}}^{\infty} adF(a) \right] + \\ & - \left(\sum_{\underline{N}+1}^{\bar{N}} \bar{p}^j \bar{\mu}_j \int_{\frac{\underline{a}}{\bar{\mu}_j}}^{\infty} adF(a) \right) \left[\frac{\partial}{\partial \underline{a}_0} \left(\sum_{\underline{N}+1}^{\bar{N}} \bar{p}^j \int_{\frac{\underline{a}}{\bar{\mu}_j}}^{\infty} dF(a) \right) \right] \end{aligned} \right\} = \\ & = \text{signum } \left\{ \begin{aligned} & \left(\sum_{\underline{N}+1}^{\bar{N}} \bar{p}^j \int_{\frac{\underline{a}}{\bar{\mu}_j}}^{\infty} dF(a) \right) \times \frac{\partial}{\partial \underline{a}} \left[\sum_{\underline{N}+1}^{\bar{N}} \bar{p}^j \bar{\mu}_j \int_{\frac{\underline{a}}{\bar{\mu}_j}}^{\infty} adF(a) \right] + \\ & - \left(\sum_{\underline{N}+1}^{\bar{N}} \bar{p}^j \bar{\mu}_j \int_{\frac{\underline{a}}{\bar{\mu}_j}}^{\infty} adF(a) \right) \left[\frac{\partial}{\partial \underline{a}} \left(\sum_{\underline{N}+1}^{\bar{N}} \bar{p}^j \int_{\frac{\underline{a}}{\bar{\mu}_j}}^{\infty} dF(a) \right) \right] \end{aligned} \right\} = \\ & = \text{signum } \left[\left(\sum_{\underline{N}+1}^{\bar{N}} \bar{p}^j \frac{1}{\bar{\mu}_j} f\left(\frac{\underline{a}}{\bar{\mu}_j}\right) \right) \left(\sum_{\underline{N}+1}^{\bar{N}} \bar{p}^j \bar{\mu}_j \int_{\frac{\underline{a}}{\bar{\mu}_j}}^{\infty} (\bar{\mu}_j \underline{a} - \underline{a}) dF(a) \right) \right] = +1. \end{aligned}$$

Hence, differentiating the remaining terms, dividing by \underline{a}_0 , and rearranging:

$$\begin{aligned}
& \text{signum} \frac{\partial \bar{a}(\underline{a}_0)}{\partial \underline{a}_0} = \\
= & \text{signum} \left\{ \sum_{\substack{\bar{N} \\ \underline{N}+1}} \bar{p}_j \left\{ \underbrace{\left(\frac{\sum_{j=0}^N \frac{\bar{p}_j}{R^j}}{\sum_{j=0}^N \frac{\bar{p}_j}{R^j} \bar{\mu}_j} \right) \frac{[1 - F(\frac{\underline{a}}{\bar{\mu}_j})]}{\frac{1}{\bar{\mu}_j} f(\frac{\underline{a}}{\bar{\mu}_j})} \frac{\int_{\frac{\underline{a}}{\bar{\mu}_j}}^{\infty} \left[\left(\sum_{j=0}^N \bar{p}_j \right) \bar{\mu}_j \frac{\underline{a}}{\bar{\mu}_j} - \left(\sum_{j=0}^N \bar{p}_j \bar{\mu}_j \right) \right] dF(\underline{a})}{1 - F(\frac{\underline{a}}{\bar{\mu}_j})}}}_{1^{st} \text{ term}} + \right. \\
& \left. + \frac{1 - F(\underline{a}_0)}{f(\underline{a}_0)} \underbrace{\left[\left(\sum_{j=0}^N \bar{p}^j \bar{\mu}_j \right) \frac{\underline{a}}{\underline{a}_0} - \left(\sum_{j=0}^N \bar{p}_j \right) \left(\frac{\sum_{j=0}^N \frac{\bar{p}_j}{R^j} \bar{\mu}_j}{\sum_{j=0}^N \frac{\bar{p}_j}{R^j}} \right) \right] dF(\underline{a})}_{2^{nd} \text{ term}} \right\} .
\end{aligned} \tag{A.1}$$

Notice that, since $\bar{\mu}_j \geq 1 \forall j$,

$$\sum_{j=0}^N \bar{p}_j \bar{\mu}_j - \frac{\sum_{j=0}^N \bar{p}_j \sum_{j=0}^N \frac{\bar{p}_j}{R^j} \bar{\mu}_j}{\sum_{j=0}^N \frac{\bar{p}_j}{R^j}} \geq 1.$$

This ensures that all the second terms of the summation in (A.1) are positive. If any element in the first terms of the summation in (A.1) is negative, then by assumption 1

$$\text{signum} \left\{ \left(\frac{\sum_{j=0}^N \frac{\bar{p}_j}{R^j}}{\sum_{j=0}^N \frac{\bar{p}_j}{R^j} \bar{\mu}_j} \right) \frac{[1 - F(\frac{\underline{a}}{\bar{\mu}_j})]}{\frac{1}{\bar{\mu}_j} f(\frac{\underline{a}}{\bar{\mu}_j})} \frac{\int_{\frac{\underline{a}}{\bar{\mu}_j}}^{\infty} \left[\left(\sum_{j=0}^N \bar{p}_j \right) \bar{\mu}_j \frac{\underline{a}}{\bar{\mu}_j} - \left(\sum_{j=0}^N \bar{p}_j \bar{\mu}_j \right) \right] dF(\underline{a})}{1 - F(\frac{\underline{a}}{\bar{\mu}_j})}} + \right. \\
\left. + \frac{1 - F(\underline{a}_0)}{f(\underline{a}_0)} \left[\left(\sum_{j=0}^N \bar{p}^j \bar{\mu}_j \right) \frac{\underline{a}}{\underline{a}_0} - \left(\sum_{j=0}^N \bar{p}_j \right) \left(\frac{\sum_{j=0}^N \frac{\bar{p}_j}{R^j} \bar{\mu}_j}{\sum_{j=0}^N \frac{\bar{p}_j}{R^j}} \right) \right] dF(\underline{a}) \right\} =$$

$$= \text{signum} \left[\begin{aligned} & \left(\sum_{j=0}^N \bar{p}_j \right) \left(\frac{\sum_{j=0}^N \frac{\bar{p}_j}{R^j} \bar{\mu}_j}{\sum_{j=0}^N \frac{\bar{p}_j}{R^j}} \right) E(\bar{\mu}_j \frac{a}{\bar{\mu}_j} | a > \frac{a}{\bar{\mu}_j}) - \left(\sum_{j=0}^N \bar{p}_j \right) + \\ & + \left(\sum_{j=0}^N \bar{p}_j \right) E(\frac{a}{\underline{a}_0} | a > \underline{a}_0) - \left(\sum_{j=0}^N \bar{p}_j \right) \left(\frac{\sum_{j=0}^N \frac{\bar{p}_j}{R^j} \bar{\mu}_j}{\sum_{j=0}^N \frac{\bar{p}_j}{R^j}} \right) \end{aligned} \right] = +1$$

where the last equality follows because $E(\bar{\mu}_j a / \bar{\mu}_j | a > a / \bar{\mu}_j)$ and $E(a / \underline{a}_0 | a > \underline{a}_0)$ are both greater than 1. Thus, average productivity (\bar{a}) is increasing in the productivity cutoff at firms' birth (\underline{a}_0). **Q.E.D.**

Proof of Proposition 2. To prove this property it suffices to show that equation (2.19) has a unique solution. Notice that

$$\begin{aligned} \frac{\partial}{\partial \underline{a}} \left[\sum_{j=0}^N \frac{\bar{p}^j}{R^j} \int_{\underline{a}_0}^{\infty} (\bar{\mu}_j a - \underline{a}) dF(a) \right] &= - \left[\underline{a} (1 - F(\underline{a}_0)) \sum_{j=0}^N \frac{\bar{p}^j}{R^j} \right], \\ \frac{\partial}{\partial \underline{a}} \left[\sum_{N+1}^{\bar{N}} \frac{\bar{p}^j}{R^j} \int_{\frac{\underline{a}}{\bar{\mu}_j}}^{\infty} (\bar{\mu}_j a - \underline{a}) dF(a) \right] &= - \sum_{N+1}^{\bar{N}} \frac{\bar{p}^j}{R^j} \frac{a}{\bar{\mu}_j} \left(1 - F\left(\frac{a}{\bar{\mu}_j}\right) \right). \end{aligned}$$

Therefore, the right-hand side of equation (2.19) is decreasing in \underline{a} . In addition, when $\underline{a} \rightarrow 0$ ($\underline{a} \rightarrow +\infty$) the right-hand side of equation (2.19) goes to plus infinity (zero). Thus, for any value of $\tilde{\kappa}$ there exists a unique \underline{a} for which equation (2.19) holds. **Q.E.D.**

Proof of Proposition 3. The steady state fraction of labor used in production is

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

Then,

$$\text{signum} \left(\frac{\partial TFP}{\partial \underline{a}} \right) = \text{signum} \left[\begin{aligned} & (1 - \gamma + (1 - \alpha) \gamma) \frac{(1 - \alpha) \gamma}{(1 - \alpha) \gamma \underline{a} + (1 - \gamma) \bar{a}} \frac{\partial \bar{a}}{\partial \underline{a}} + \\ & + \frac{(1 - \alpha)^2 \gamma^2}{(1 - \alpha) \gamma \underline{a} + (1 - \gamma) \bar{a}} \frac{\bar{a} - \underline{a}}{\underline{a}} \end{aligned} \right].$$

Hence TFP is increasing in the productivity cutoff. This implies that output is increasing as well in \underline{a} . **Q.E.D.**

Proof of Proposition 4. Under assumption 2, \bar{a} / \underline{a} inherits the properties of the distribution of the productivity draws. Therefore, it is decreasing in \underline{a} if Assumption 3 is

satisfied. From the definition of business density,

$$d = 100 \frac{1-u}{\phi} = \frac{1}{\phi} \frac{100}{1 + \frac{1-\gamma}{(1-\alpha)\gamma} \frac{\bar{a}}{\underline{a}}},$$

Proposition 4 immediately follows. **Q.E.D.**

B Distributions of Employments and Firms by Size and Age Classes

Taking into account that ϕ managers are needed to start a firm and of the proportionality between employment and productivity, in our model the employment size classes identify productivity size classes as follows:

$$a_{l,t} = \frac{N_l - \phi}{\phi} \frac{1 - u_t}{u_t} \bar{a}_t.$$

Thus, the fraction of firms in size class l , i.e., whose employment is between N_l and N_{l+1} , is given by:

$$\begin{aligned} \iota_l = & \frac{\sum_{j=0}^{\underline{N}} \bar{p}_j \left[F \left(\max \left(\underline{a}_{0,t}, \frac{a_{s+1,t}}{\bar{\mu}_j} \right) \right) - F \left(\max \left(\underline{a}_{0,t}, \frac{a_{s,t}}{\bar{\mu}_j} \right) \right) \right]}{(1 - F(\underline{a}_{0,t})) \sum_{j=0}^{\underline{N}} \bar{p}_j + \sum_{j=\underline{N}+1}^{\bar{N}} \left[\bar{p}_j \left(1 - F \left(\frac{\underline{a}_t}{\bar{\mu}_j} \right) \right) \right]} + \\ & + \frac{\sum_{j=\underline{N}}^{\infty} \bar{p}_j \left[F \left(\max \left(\frac{\underline{a}_t}{\bar{\mu}_j}, \frac{a_{s+1,t}}{\bar{\mu}_j} \right) \right) - F \left(\max \left(\frac{\underline{a}_t}{\bar{\mu}_j}, \frac{a_{s,t}}{\bar{\mu}_j} \right) \right) \right]}{(1 - F(\underline{a}_{0,t})) \sum_{j=0}^{\underline{N}} \bar{p}_j + \sum_{j=\underline{N}+1}^{\bar{N}} \left[\bar{p}_j \left(1 - F \left(\frac{\underline{a}_t}{\bar{\mu}_j} \right) \right) \right]}, \quad l = 1, \dots, L. \end{aligned}$$

Similarly, the fraction of firms of age smaller than T is given by:

$$\varsigma(T) = \begin{cases} \frac{(1-F(\underline{a}_{0,t})) \sum_{j=0}^T \bar{p}_j}{(1-F(\underline{a}_{0,t})) \sum_{j=0}^{\underline{N}} \bar{p}_j + \sum_{j=\underline{N}}^{\infty} \left[\bar{p}_j \left(1 - F \left(\frac{\underline{a}_t}{\bar{\mu}_j} \right) \right) \right]} & T \leq \underline{N} \\ \frac{(1-F(\underline{a}_{0,t})) \sum_{j=0}^{\underline{N}} \bar{p}_j + \sum_{j=\underline{N}+1}^T \left[\bar{p}_j \left(1 - F \left(\frac{\underline{a}_t}{\bar{\mu}_j} \right) \right) \right]}{(1-F(\underline{a}_{0,t})) \sum_{j=0}^{\underline{N}} \bar{p}_j + \sum_{j=\underline{N}+1}^{\bar{N}} \left[\bar{p}_j \left(1 - F \left(\frac{\underline{a}_t}{\bar{\mu}_j} \right) \right) \right]} & \underline{N} < T \leq \bar{N} \end{cases}$$

Thus, the fraction of firms in age bracket $[T_j, T_{j+1})$ is

$$\varsigma_j = \varsigma(T_{j+1}) - \varsigma(T_j).$$

Let \mathcal{A} be a set of productivity values of firms with certain characteristics. For example, \mathcal{A} can be the set of productivity levels of firms in a given age or size interval. The employment shares are related to the firms shares as follows:

$$\underbrace{\frac{\sum_{s=0}^{\bar{N}} \int_{\mathcal{A}} (n(a, s) + \phi) dH(a, s)}{1}}_{\text{Employment share}} = \underbrace{\frac{\sum_{s=0}^{\bar{N}} \int_{\mathcal{A}} dH(a, s)}{\sum_{s=0}^{\bar{N}} \int dH(a, s)}}_{\text{Firms share}} \left[\underbrace{\frac{\sum_{s=0}^{\bar{N}} \int_{\mathcal{A}} adH(a, s)}{\sum_{s=0}^{\bar{N}} \int adH(a, s)}}_{\text{Cond. mean / mean}} \times u + (1 - u) \right].$$

C Data Sources and Definitions

1. 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.
2. Distribution of employment and establishments by size class for the U.S.: For one of the robustness exercises in Section 5 we considered the distributions by size relative to establishments, as opposed to firms, for 1988 from the County Business Patterns.²⁶
3. Distribution of employment by firm's age for the U.S.: Davis et al. [1996].²⁷ This data are relative to 1988. Annual data for the period 1978-98 is available for the same source but only for fewer age classes. The 1988 distribution is used in our benchmark analysis in Section 4. The average distribution by age over 1978-98 is used in Section 5 to assess the robustness of our results.
4. Entry costs: The World Bank [2004, 2005, 2006a,b, 2007].²⁸

²⁶Available at <http://www.census.gov/epcd/cbp/index.html>.

²⁷These are the same data used by Atkeson and Kehoe [2005] and they are available at <http://www.econ.umd.edu/~haltiwan/download/>.

²⁸Available at <http://www.doingbusiness.org/>.

- 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.”
- The recovery rate is recorded as cents on the dollar recovered by claimants—creditors, tax authorities and employees—through the bankruptcy proceedings. The calculation takes into account whether the business is kept as a going concern during the proceedings, as well as bankruptcy costs and the loss in value due to the time spent closing down.

For some countries, data for one or more of the years 2004-2008 are missing. We ignore these years when constructing averages.

5. 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 work force.”
- Entry rate: “The average number of businesses that registered per year between 2000 and 2004. Only businesses with more than one employee are included.”

6. Output and TFP: Klenow and Rodriguez-Clare [2005] for 1996 and 2000;²⁹ for 2003 no measure of TFP is available and we use real GDP chain per worker from Heston et al. [2006].³⁰
7. Moments of the distribution of employment by size class across countries: Alfaro et al. [2008]. This data is constructed from micro-data collected in Dun & Bradstreet's WorldBase. The unit of observation is the plant.

²⁹Available at <http://www.klenow.com/>.

³⁰See <http://pwt.econ.upenn.edu/>.