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ENTRY COSTS, FINANCIAL FRICTIONS, AND CROSS-COUNTRY DIFFERENCES IN INCOME AND TFP

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This paper develops a model to assess the quantitative effects of entry costs and financial frictions on cross-country income and total factor productivity (TFP) differences, with a primary focus on the interaction between entry costs and financial frictions. The model is calibrated to match the establishment-level statistics for the U.S. economy, assuming a perfect financial market. The simulations based on the calibrated model show that entry costs and financial frictions together account for 55% and 46% of the cross-country variation in output and TFP in the data. Moreover, a substantial portion of the variation is accounted for by the interaction between entry costs and financial frictions. The main mechanism is that financial frictions amplify the effect of entry costs.

Keywords: Entry Costs, Financial Frictions, GDP Per Capita, Total Factor Productivity

1. INTRODUCTION

Income per capita differs by more than a factor of thirty between rich and poor countries. Research on growth accounting finds that the majority of the differences are the result of cross-country differences in total factor productivity (TFP).[1] It is worth noting also that many poor countries have poorly developed financial markets as well as substantial costs for starting new businesses. Both of these factors have been found to be negatively correlated with income per capita across countries. For example, Djankov et al. (2002) find a negative correlation between GDP per capita and the ratio of entry cost to GDP per capita, Nicoletti and Scarpetta (2003, 2006) find that entry costs are negatively related to TFP in

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OECD countries, and Beck et al. (2000) establish a negative relationship between financial development and economic growth. Accordingly, the goal of this paper is to quantify the importance of financial frictions and entry costs in cross-country differences with respect to income per capita and TFP.

There are a number of studies that have examined the effect of financial frictions and/or the effect of entry costs on cross-country differences. This paper, however, investigates whether there is any interaction between entry costs and financial frictions and, if so, how such interaction may contribute to cross-country income and TFP differences. Intuitively, underdeveloped financial markets may amplify the effect of entry costs, as entrepreneurs cannot borrow enough to overcome such costs. In contrast, a better-developed financial market may have less impact on how entry costs affect output and TFP. Understanding such interactions can guide policymakers in improving overall TFP and output. For instance, if the interaction is important, simplifying the entry process and improving the financial market conditions will have a much greater impact on economic development than addressing just one of the two factors.

To explore this issue, this paper develops a model that incorporates both financial frictions and entry costs and then uses the calibrated model to analyze the quantitative importance of the interaction between the two frictions. We find that financial frictions amplify the effect of entry costs on economic development. Moreover, the interaction accounts for a substantial portion of the differences in cross-country income and TFP.

The model builds on the industry model studied by Hopenhayn (1992) and Hopenhayn and Rogerson (1993). In the model, establishments have different levels of productivity that evolve over time. The technology is subject to decreasing returns to scale with fixed production costs. Although establishments finance capital and the fixed production cost from the financial market, the financial market is imperfect, and an establishment can only borrow up to a fraction of its expected discounted lifetime profits. Furthermore, existing establishments may exit if they experience lower productivity. In contrast, new establishments can enter after paying an upfront entry cost that can be financed from the financial market subject to a borrowing constraint similar to the one faced by existing establishments.

The model is calibrated to match the establishment-level statistics in the U.S. economy, assuming a perfect financial market for the United States. The calibrated model is then used to analyze the cross-country differences in income per capita and TFP. To perform the analysis, we simulate the model to jointly match the ratio of entry cost to GDP per worker and the ratio of debt to GDP for a large set of countries. The linear regression of the data on the model prediction shows that entry costs and financial frictions together can account for 55% and 46% of the cross-country variation in output and TFP, respectively, as measured by R^2. In addition, the two frictions reduce output to 9% and TFP to 25% of the U.S. level in low-income countries. More importantly, a substantial portion of the decline in output and TFP is generated by the interaction between the two frictions. This finding suggests that to take advantage fully of the reduction in entry costs, it is better to improve the conditions of entry and the financial market simultaneously.

The intuition for the results consists of three parts. First, higher entry costs protect existing establishments. Hence, establishments with lower productivity can survive, and output and TFP decrease. Second, financial frictions limit borrowing and lead to a lower capital-to-output ratio. Moreover, financial frictions distort the allocation of capital and labor toward establishments with more capital stocks. This drives down TFP. Third, financial frictions amplify the effect of entry costs on output and TFP. To understand this, note that when there are frictions in the financial market, some of the profitable entrants may not be able to open their businesses, as they cannot finance the required upfront entry cost. This raises the effective entry cost. The effect is equivalent to an increase in the entry cost. Hence, output and TFP decline. Furthermore, as financial market conditions deteriorate, the amplification effect increases, as does the decrease in output and TFP.

Entry costs and financial frictions affect output and TFP through effects on the capital-to-output ratio and the distribution of establishments. To evaluate the model prediction on these dimensions, we compare the capital-to-output ratio, entry rate, average establishment size, and variance of establishment size from the model with the cross-country data. We find that the model is broadly consistent with the cross-country data, and a version of the model with capital adjustment costs fits the data better.

This paper is related to the broad literature that investigates the effects of financial frictions on economic development. Levine (2005) conducts a comprehensive literature review in this area. Many of these works cited by Levine (2005), both theoretically and empirically, show that poor financial development leads to low economic development. However, a recent quantitative paper by Chakraborty and Lahiri (2007) finds that financial frictions modeled as intermediation costs of capital in a standard neoclassical model cannot account for the large income differences between rich and poor countries. Banerjee and Dufflo (2005) point out that financial frictions may affect income through borrowing constraints and also provide evidence for the prevalence of borrowing constraints in poor countries. Following the idea of modeling financial frictions as borrowing constraints, Amaral and Quintin (2010) and Buera et al. (2011) show that financial frictions can generate sizable differences in output and TFP across countries, D'Erasmo and Boedo (2012) find that the financial market structure and the costs of informality have important quantitative implications for cross-country TFP differences, and Azariadis and Kaas (2014) find that credit market frictions limit capital mobility across sectors and lead to low TFP and economic growth.[2]

This paper is also related to several other papers in the literature that emphasize the importance of entry costs on cross-country income and TFP differences. Barseghyan and DiCecio (2011) quantify the effect of entry costs on economic development, and Moscoso Boedo and Mukoyama (2012) analyze the effects of entry costs and firing costs on cross-country differences in income and productivity. We view this paper as a complement to these works of entry costs and financial frictions on cross-country income and TFP differences. We develop an industry model that incorporates both entry costs and financial frictions, allowing us to investigate how the interaction between entry costs and financial frictions affects income and TFP. Moreover, the simulations based on the calibrated model show that the interaction is quantitatively important. Our findings are consistent with Midrigan and Xu (2014), which finds that financial frictions generate small losses from misallocation, but potentially sizable losses from the inefficiently low level of entry, because traditional producers cannot borrow to overcome the barriers to entry to the modern sector.

This paper is connected with the literature that studies the relationship between various policies and the cross-country income and TFP differences.[3] For instance, Parente and Prescott (1999) and Herrendorf and Teixeira (2011) examine the role of monopoly rights in blocking the use of more efficient technologies, whereas Lagos (2006) examines how labor market institutions affect TFP. Erosa and Cabrillana (2008) investigate the role of poor contract enforcement in explaining the use of inefficient technologies and low TFP in poor countries, and Guner et al. (2008) and Restuccia and Rogerson (2008) study the effect of size-dependent policies on macroeconomic aggregates.

The rest of the paper is organized as follows. Section 2 presents the model and defines the steady state equilibrium. Section 3 describes the calibration strategy. Section 4 assesses the quantitative implication of the calibrated model and the robustness of the results. Section 5 concludes the paper.

2. THE ECONOMY

We consider a discrete-time model with heterogeneity in establishment-level productivity. The model can best be described as embedding borrowing constraints in the industry model studied by Hopenhayn and Rogerson (1993). In the model economy, an establishment must finance capital and the fixed production cost ahead of production by borrowing from an imperfect financial market. More importantly, there are many potential entrants who can enter after paying a front-loaded set-up cost upon entry, and this cost must also be financed. The details follow.

2.1. Production

Technology. The production unit is the establishment. There is a continuum of existing establishments that differ in their productivity z. Each of these establishments hires labor, invests in capital, and produces according to the following production function:

$$y = zk^{\alpha}h^{\gamma}, \tag{1}$$

where the individual establishment productivity z changes over time. Specifically, z is the same as the last period value with probability λ, and evolves according to the distribution $F(z)$ with probability $1-\lambda$. The parameter λ controls the

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persistence of the idiosyncratic productivity shock. The establishment's production technology is assumed to have decreasing returns to scale; i.e., $\alpha + \gamma < 1$. To stay in operation, each establishment must pay a fixed production cost f every period, measured in the unit of output. As in Hopenhayn and Rogerson (1993), the fixed production cost generates an explicit exit and prevents establishments from staying in the economy while not producing. Capital is owned by establishments. We use k_{-1} to denote the establishment's capital holdings during the last period and k to denote the optimal choice of capital in the current period. The capital good is homogenous across establishments and can be traded freely in the market. Hence, if $k > (1-\delta)k_{-1}$, establishments expand and raise capital, and otherwise, establishments downsize and sell capital in the market.

Financial market. The financial market consists of many competitive intermediaries that receive deposits and lend to establishments at a constant rate r. We assume that borrowing and lending are within the same period and that establishments cannot default on the debt. Thus, the zero-profit condition for the intermediaries implies that the interest rate paid on the deposit is also r.

An establishment's ability to borrow is limited by its prospects and current capital holdings. For simplicity, we assume that an establishment can borrow up to a fraction η of its discounted lifetime profits. Each establishment finances capital and fixed production cost, and the borrowing constraint is described as follows:

$$k - (1-\delta)k_{-1} + f \le \eta v(z, k_{-1}), \tag{2}$$

where $v(z, k_{-1})$ represents the value of an establishment, and the establishment's state at the beginning of a period is summarized by (z, k_{-1}). The credit constraint imposes an upper bound on the current-period capital usage. As demonstrated later in this section, $v(z, k_{-1})$ is increasing in both z and k_{-1}. Hence, the credit constraint captures the idea that establishments with more collateral and better productivity can borrow more from the financial market.[4] The development of financial markets differs across countries because of differences in contract enforcement. For simplicity, we use η to capture the degree of financial development in different countries, with the interpretation that a larger η represents a better financial market.

The timing of decisions within a period is as follows. At the beginning of a period, the productivity z is realized. After seeing the new productivity, an establishment with capital holding k_{-1} can choose to stay in operation if the continuation value is higher than the value of its nondepreciated capital, or exit otherwise. If the establishment decides to stay, it chooses how much labor to hire, how much capital to use, and therefore, how much money to borrow from the financial market, taking into account the borrowing constraint. At the end of the period, production takes place, and the establishment repays the debt. If the establishment decides to exit, it sells its capital and exits the market.

Subject to the borrowing constraint (2) and the non-negativity constraint on capital, an establishment's value $v(z, k_{-1})$ measured immediately after the realization of productivity is given by

$$v(z, k_{-1}) = \max_{k,h} zk^{\alpha}h^{\gamma} - wh - (1+r)[k - (1-\delta)k_{-1} + f]$$

$$+\beta\lambda \max[v(z, k), (1+r)(1-\delta)k] \quad \textbf{(3)}$$

$$+\beta(1-\lambda)\int \max[v(z', k), (1+r)(1-\delta)k]dF(z'). \quad \textbf{(4)}$$

An establishment's value consists of its current-period profit and the next period's value, which reflects the evolution of productivity and the establishment's staying or exiting decision as indicated by the maximization operator nested on the right-hand side. When exiting, an establishment can sell its nondepreciated capital $(1-\delta)k$ and earn interest on the proceeds, as described by the second term inside the maximization operator. As there is no distortion in the labor market, the first-order condition implies that $h = (\frac{zk^{\alpha}\gamma}{w})^{1/(1-\gamma)}$.

The value function (4) implicitly defines three types of establishments: expanding, downsizing, and exiting establishments. The expanding establishments raise capital and the fixed production cost through borrowing from the financial market. The downsizing establishments sell the extra capital and deposit the proceeds and also borrow from the financial market to pay for the fixed production cost.[5] The exiting establishments sell their capital and earn interest.

If the financial market is perfect, equation (2) will not bind. In this case, regardless of their capital holdings, establishments can always borrow the optimal amount of capital, as determined only by the productivity. Hence, all the decision rules, including usage of capital and labor and the stay/exit decision, depend only on productivity. However, if the financial market is imperfect, the decision rules will depend on both z and k_{-1}. In particular, the capital usage could be either less or greater than the level in the perfect financial market for an establishment with the same state (z, k_{-1}). On one hand, equation (2) sets an upper bound for k and may force some establishments to operate on a smaller scale; on the other hand, establishments with larger k_{-1} and smaller z have some probability of drawing a better productivity in the future and optimally choosing to hold more capital.

When the financial market is perfect, the stay/exit decision does not depend on capital holdings, as it is characterized by a cutoff rule for z. In contrast, when the financial market is imperfect, an establishment with more capital holdings can operate on a larger scale, as more capital holdings imply not only that the establishment has more capital to begin with but also that the establishment can borrow more from the financial market because v is an increasing function k_{-1}, as established in the following lemma.

LEMMA 1. (i) $v(z, k_{-1})$ *is increasing in* z *and* k_{-1}*;*
(ii) $v(z, k_{-1}) - (1+r)(1-\delta)k_{-1}$ *is increasing in* k_{-1}.

Proof. See the Appendix. ■

As v is increasing in z, the decision to stay or exit is characterized by a cutoff rule for z at a given value of k_{-1}. In particular, the rule is to exit if z is below the cutoff value and to stay otherwise. Lemma 1 (ii) proves that an increase in k_{-1} leads to a greater increase in v. It follows that the decision to stay or exit is also characterized by a cutoff rule for k_{-1} at a given value of z. Moreover, the monotonicity proven in Lemma 1 also implies the monotonicity of the cutoff values. Specifically, the cutoff value of k_{-1} becomes smaller as z increases and the cutoff value of z becomes smaller as k_{-1} increases.

Entry. There is a continuum of an infinite number of ex ante identical establishments that can enter each period after paying the entry cost f_e, measured in the unit of output. To pay the entry cost, the entrant can borrow from the financial market at the rate r up to the fraction η of its value of entry. The debt is, again, within the period and must be repaid at the end of the period. Once the entry cost is paid, each establishment receives a productivity draw z from the same distribution as the existing establishments $F(z)$. The productivity draws are i.i.d. across entering establishments. After the productivity draw is realized, the entering establishment decides to stay or exit. If the establishment chooses to stay, it then decides how much to borrow and how much to produce. The borrowing constraint for entrants choosing to stay is as follows:

$$k + f + f_e \leq \eta v(z, 0). \quad \textbf{(5)}$$

As in Hopenhayn and Rogerson (1993), as there is an infinite number of potential entrants in each period, the value of entry for an entering establishment should not exceed the entry cost in the equilibrium when the financial market is perfect. In this economy, the entrant, after paying the entry cost, is in the same position as the existing establishment with the same productivity and zero capital. Hence, when making the stay/exit decision, the entrant will compare the value of staying $v(z, 0)$ with the value of exiting 0. Thus, the free entry condition can be described as follows:

$$\int \max[v(z, 0), 0] dF(z) - r f_e \leq f_e, \quad \textbf{(6)}$$

where f_e on the right-hand side denotes the entry cost and rf_e on the left-hand side is the interest payment on the entry cost. The integral is taken over all the possible productivity draws. For future reference, note that the left-hand side of (6) denotes the value of entry for a new establishment.

If there is no financial friction, the free-entry condition (6) must hold in the steady state equilibrium. In this paper, we will focus on the steady state equilibrium with entry and exit.[6] As proven in Hopenhayn (1992), if a steady state equilibrium with entry and exit exists, it is a unique equilibrium and (6) will hold with equality. Otherwise, more establishments will enter and produce, which drives down the value of entry until it is no longer profitable for more establishments to enter.

When there are financial frictions, the free-entry condition may not hold in the steady state equilibrium. To see this, note that as for an existing establishment, a new establishment can only borrow up to a fraction η of its value of entry. Hence, if f_e is greater than the borrowing limit for a potential entrant, no establishment can pay the up-front cost to enter. In such cases, a steady state equilibrium with entry and exit cannot exist even when the free-entry condition holds. This implies that f_e must be less than or equal to the borrowing limit for a new establishment in the steady state equilibrium. As the left-hand side of equation (6) is the value of entry for a new establishment, the borrowing constraint is as follows:

$$\eta \left\{ \int \max[v(z,0),0]dF(z) - f_e r \right\} \geq f_e. \tag{7}$$

Simple manipulation gives

$$\int \max[v(z,0),0]dF(z) - f_e r \geq \frac{f_e}{\eta}. \tag{8}$$

If $\eta \geq 1$, there is no contradiction between equations (6) and (8), and therefore, the free-entry condition will hold with equality at equilibrium. This implies that if the friction in the financial market is moderate, all the profitable new establishments can borrow f_e, and the entry decision is not distorted. However, if $\eta < 1$, the entry decision is distorted, and the free-entry condition cannot hold at equilibrium. In such cases, the entrant's borrowing constraint (8) binds. Otherwise, more establishments can acquire the up-front cost f_e from the financial market, and it is also profitable for these establishments to enter, because the value of entry is higher than the entry cost. This drives up the labor demand and wage rate, therefore driving down the value of entry until equation (8) holds with equality.

For future reference, note that from equations (6) and (8), it is evident that when $\eta \geq 1$, the value of entry equals the entry cost f_e, but when $\eta < 1$, the value of entry equals f_e/η. Thus, when $\eta < 1$, f_e/η can be viewed as the effective entry cost, as the entrants make entry decisions according to f_e/η instead of f_e, and therefore output and TFP also adjust according to the effective entry cost. Hence, as long as η is small, even if the entry cost is not substantial, the effective entry cost could still be significantly large. This implies that financial frictions interact with entry costs and amplify the effects of entry costs on cross-country incomes and TFP differences by boosting the effective entry cost. Moreover, the magnitude of the amplification effect depends on the severity of the friction.

2.2. Household

There is an infinitely lived representative household that inelastically supplies one unit of labor each period and values a single consumption good c according to the utility function

$$\sum_{t=0}^{\infty} \beta^t \log(c_t),$$

where $0 < \beta < 1$ is the discount factor. The household can deposit its savings a and earn interest at a rate r from the financial intermediaries. The household also owns all the establishments in the economy. Let $W(a)$ denote the value function of the household. The problem of the representative household is given by

$$W(a) = \max_{c,a'} \log(c) + \beta W(a')$$
$$\text{s.t.} \quad c + a' = w + a(1+r) + \Pi, \tag{9}$$

where w is the wage rate and Π is the total profits generated by the production sector.

A simple manipulation of the first-order condition implies that if a stationary equilibrium exists, $r = 1/\beta$.

2.3. Definition of the Steady State Equilibrium

A steady state competitive equilibrium is composed of prices w and r, value functions $W(a)$ and $v(z, k_{-1})$, a measure of productive establishments $\mu(z, k_{-1})$, total profit Π, a mass of entry M, policy functions $c(a)$, $a'(a)$, $h(z, k_{-1})$, and $k(z, k_{-1})$, and the stay/exit decision $x(z, k_{-1})$ with the convention that $x(z, k_{-1}) = 1$ corresponds to stay and $x(z, k_{-1}) = 0$ corresponds to exit, such that

(i) Given prices, all agents solve their maximization problems.
(ii) $r = 1/\beta$.
(iii) If $\eta \geq 1$, (6) holds with equality, and if $\eta < 1$, (8) holds with equality.
(iv) μ is time-invariant.
(v) Labor, good, and credit markets clear:

$$1 = \int h(z, k_{-1}) d\mu(z, k_{-1}), \tag{10}$$

$$c(a) + \delta K = Y - \int f d\mu(z, k_{-1}) - M f_e, \tag{11}$$

$$a = \delta K + \int f d\mu(z, k_{-1}) + M f_e, \tag{12}$$

where K and Y are defined as $K = \int k(z, k_{-1}) d\mu(z, k_{-1})$ and $Y = \int z k(z, k_{-1})^{\alpha} h(z, k_{-1})^{\gamma} d\mu(z, k_{-1})$.

(vi) Profit Π is as follows:

$$\Pi = Y - w - \delta K(1+r) - (1+r) \int f d\mu(z, k_{-1}) - M f_e (1+r). \tag{13}$$

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The labor market and good market clearing conditions (10) and (11) are standard. To understand the credit market clearing condition (12), note that the deposits received by the financial intermediary come from three sources: household savings, capital sold by downsizing, and exiting establishments. The lending by the financial intermediary is applied to three sources: capital raised by expanding establishments, fixed production costs, and entry costs. In the steady state equilibrium, the economywide capital stock equalizes across periods, and new capital must be raised only to replace the depreciated capital. Hence, the credit market clearing can be described as in equation (12). The total profit received by the household is the aggregation of current period profits net of the entry costs. Equation (13) can then be derived using the labor market and the credit market clearing conditions.

3. CALIBRATION

This section calibrates the parameters to match observations in the steady state with data on the U.S. economy. For this purpose, the U.S. economy is treated as an economy without distortion in the financial market.[7] We assume that one period in the model corresponds to one year in the data, and therefore, we target the steady state interest rate r to be 4% per year. This implies that $\beta = 0.96$. We follow the literature and set the returns to scale at the establishment level to be 0.8, and we set the capital share to be one-third of the returns to scale and the labor share to be two-thirds of the returns to scale.[8] This indicates that $\alpha = 0.27$ and $\gamma = 0.53$. To calibrate the depreciation rate, we follow Guner et al. (2008) and target the capital-to-output ratio in the U.S. business sector to be 2.3 and the implied δ to be 0.08.

To calibrate the persistence of the productivity process λ, we target the entry/exit rates of U.S. establishments. The most recent value is approximately 10%, as reported by the U.S Census business dynamics statistics (BDS).[9] We assume a lognormal distribution $F(z)$ with support $[0, z_{\max}]$ for the productivity process. In an economy without financial frictions, all establishments operate at their optimal scale and the establishment employment level is uniquely determined by z for any given price. Hence $z_{\max}$ can be inferred from the maximum employment level of establishments in the steady state equilibrium, which we assume to be 1,500, as in Moscoso Boedo and Mukoyama (2012).

The parameters that remain to be assigned are the entry cost f_e, the fixed production cost f, and the mean ϕ and the variance σ of the distribution F. We follow Hopenhayn and Rogerson (1993) in normalizing the wage rate to be one and calibrating the four parameters jointly to match the ratio of entry cost to GDP per worker, the average establishment size, and the share of the total number of establishments at different sizes in the U.S. economy.[10] The World Development Indicators (WDI) dataset from the World Bank provides entry costs in terms of GDP per capita for a large set of countries.[11] Because we abstract from the complexity of the household sector and assume that the representative household

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TABLE 1. Parameter values

Parameter	Value
r	4%
β	0.96
α	0.27
γ	0.53
δ	0.08
λ	0.9
$z_{\max}$	5.48
f_{e}	0.013
f	0.55
ϕ	−5.78
σ	1.25

Note: The table reports calibrated parameter values.

supplies all its labor endowment, the appropriate counterpart of output in the model is GDP per worker in the data. Hence we use data on GDP per capita and GDP per worker from the Penn World Table 7.1 (PWT7.1) to convert the ratio of entry cost to GDP per capita to the ratio of entry cost to GDP per worker. The most recent value of the ratio of entry cost to GDP per worker for the United States is 0.71%. This number is used to calibrate the entry cost f_{e}. The establishment-level statistics are borrowed from the 2007 U.S. Economic Census, which summarizes the establishment-level distributional statistics by size.[12] Specifically, the establishment level targets include 10 moments: the average establishment size and nine statistics related to the distribution of the share of establishments by size.

The calibrated parameters are reported in Table 1, whereas Table 2 lists the targets and the corresponding statistics generated by the model.[13] Overall, the calibrated model matches the data well.

4. QUANTITATIVE ANALYSIS

This section uses the calibrated model to assess the effects of entry costs, financial frictions, and the interaction between these two on the cross-country income and TFP differences. The strategy is to compare the steady state equilibria in economies that differ in entry costs and the ability to acquire external finance. Data on entry costs have been discussed in Section 3. A common measure for a country's level of financial development in the empirical literature is the ratio of external credit to GDP, which has been found to be negatively correlated with economic development.[14] Research works on assessing the effects of financial frictions on cross-country income and TFP differences, such as Amaral and Quintin (2010), Buera et al. (2011), and Midrigan and Xu (2014), use this measure to pin down cross-country variation in financial development. We follow the literature and

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TABLE 2. Targets

Statistics	Data	Model
Entry cost (% of GDP)	0.71%	0.71%
Average establishment size	15.65	15.18
% of establishments with		
1–4 employees	54.45	59.27
5–9 employees	18.92	20.30
10–19 employees	12.72	9.81
20–49 employees	8.63	6.14
50–99 employees	2.94	2.20
100–249 employees	1.67	1.42
250–499 employees	0.42	0.51
500–999 employees	0.16	0.27
1000+ employees	0.09	0.09

Note: The table compares the targeted moments and the corresponding statistics implied by the calibration.

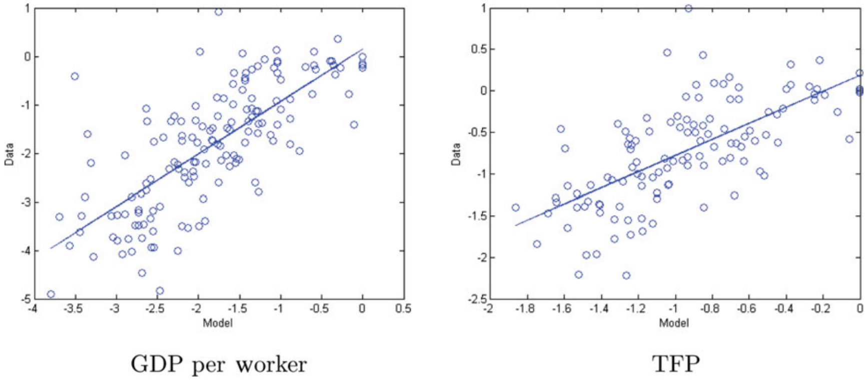

FIGURE 1. The effects of the two frictions. The figure plots GDP per worker and TFP from the data against the model's predictions. Each circle represents one country. The predicted values are obtained from simulations with individual countries' values of entry-cost-to-GDP ratio and debt-to-GDP ratio.

adjust η to match the debt-to-GDP ratio in the model to the ratio of credit to the private sector to GDP in the data.[15] The data also come from the WDI dataset.

4.1. Aggregate Effects of Entry Costs and Financial Frictions

In this section, we adjust f_e and η jointly to match the observed entry-cost-to-GDP ratio and the external-credit-to-GDP ratio in the data for all available countries. Figure 1 plots the log values of output and TFP from the model against the data. Each circle represents one country. Data on GDP per worker come from the

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PWT7.1. TFP in the data is calculated following Hall and Jones (1999):

$$\text{TFP} = \frac{Y}{K^{\alpha} H^{(1-\alpha)}},$$

where Y is the aggregate output; K is the aggregate capital, calculated using the perpetual inventory method with investment data from PWT7.1; and H is the aggregate labor adjusted for human capital, calculated using educational attainment data from Barro and Lee (2012). The reported GDP and TFP series are normalized by the perfect financial market levels in the model and by the U.S. levels in the data.

Output per worker and TFP from the model are highly correlated with the data. The correlation coefficient is 0.74 for the output and 0.68 for TFP. Figure 1 also plots the regression line that regresses data on model values. If the model accounted perfectly for the data, the slope and the R^2 would both be one. Hence the model fits the data better if both the slope and R^2 are closer to one. The regression for the output has an R^2 of 0.55 and a slope of 1.08. The regression for TFP has an R^2 of 0.46 and a slope of 0.97.[16] Moreover, both slopes are significantly different from zero at 1% level. Therefore, we conclude that the model explains 55% of the cross-country variation in output and 46% of the cross-country variation in TFP, as measured by the R^2.[17]

4.2. Understanding the Contributions of the Two Frictions

To illustrate the importance of the two frictions and their interaction, we simulate the model outcomes for three groups of countries: high-income countries (HIC), middle-income countries (MIC), and low-income countries (LIC), where the definitions of the groups follow the Atlas method from the World Bank. For the analysis, we calibrate f_{e} and η jointly to match the observed average values of the entry-cost-to-GDP ratio and the debt-to-GDP ratio for each group. The simulation results are reported in the first column of Table 3. For comparison purposes, we normalize the U.S. values to be one.

The second column of Table 3 reports the results of the model where f_{e} is set to each group's own value and η is set to the U.S. value (f_{e}^{i}, η^{US}, where $i = \text{HIC}$, MIC, LIC). Hence the second column shows the sole effects of the entry cost. As reported, both output and TFP decrease with the entry cost. The intuition goes back to Hopenhayn and Rogerson (1993). When there is no borrowing constraint, the free-entry condition must always be satisfied in the steady state equilibrium. Thus, a higher entry cost necessarily leads to a higher expected value of entry through a lower wage rate. This implies a larger v at each state, and therefore, an establishment with a smaller productivity can survive, and the cutoff value for z decreases. This leads to lower TFP and output. In particular, the cutoff values for z are 91%, 90%, and 79% of the U.S. value for the simulated high income, middle income, and low income countries. These cutoff values are independent of establishments' capital stocks because the experiments performed in the second column assume perfect financial markets.

TABLE 3. Decomposition of the contributions of the two frictions

	Case 1 (f_e^i, η^i)	Case 2 (f_e^i, η^{US})	Case 3 (f_e^{US}, η^i)	Case 4 (f_e^{US}, η^i on K)	Case 5 (f_e^{US}, η^i on f_e)
			Y		
HIC	0.62	0.84	0.72	0.97	0.77
MIC	0.23	0.82	0.28	0.75	0.38
LIC	0.09	0.62	0.14	0.51	0.27
			TFP		
HIC	0.71	0.88	0.79	0.99	0.83
MIC	0.41	0.86	0.47	0.96	0.49
LIC	0.25	0.71	0.36	0.92	0.39
			K/Y		
HIC	0.96	1	0.96	0.96	1
MIC	0.51	1	0.51	0.51	1
LIC	0.22	1	0.22	0.22	1

Notes: The table reports output, TFP, and capital–output ratio in the average high-income countries (HIC), middle-income countries (MIC), and low-income countries (LIC). The values are all relative to the corresponding values in the United States. Case 1 reports the benchmark results with each group's levels of entry cost and financial frictions. Case 2 reports the results with each group's level of entry cost but without financial frictions. Case 3 reports the results with U.S. level entry cost but with each group's levels of financial frictions. Case 4 reports the results with U.S. level entry cost but with financial frictions on capital accumulation only. Case 5 reports the results with U.S. level entry cost but with financial frictions on entry only.

The entry cost in low income countries alone can generate a drop of 38% in output and a drop of 29% in TFP. The quantitative effects generated are similar to that found in Barseghyan and DiCecio (2011) and Moscoso Boedo and Mukoyama (2012). As entry costs do not affect capital accumulation, the capital to output ratio remains constant. Hence, the reduction in output with entry costs is due to the reduction in TFP.

The third column presents the effects of financial frictions by holding η at each group's value and setting f_e to be the same as the U.S. value (f_e^{US}, η^i, where i = HIC, MIC, LIC). Observing that the product of the values from the second and the third column is approximately the same as that in the first column, one may be tempted to conclude that there is no interaction between the two frictions. However, as equation (8) illustrates, when there are financial frictions there will be interaction between the two frictions as long as the entry cost is not zero. In the third column, the entry cost is set to the U.S. value and therefore, the effective entry cost is f_e^{US}/η^i. To isolate the effect of the interaction, we decompose the effect of financial frictions into two parts: the effect of financial frictions on capital accumulation, as reported in the fourth column, and the effect of financial frictions on business entry, as reported in the fifth column. We interpret the latter effect as the contribution of the interaction to the cross-country income and TFP differences. Specifically, the fourth column reports the results when the borrowing constraint is imposed only on the financing of capital and the fixed production cost (f_e^{US}, η^i on K, where i = HIC, MIC, LIC) and the fifth column reports the results when the borrowing constraint is imposed only on the financing of entry costs (f_e^{US}, η^i on f_e, where i = HIC, MIC, LIC).

We now discuss the simulation results in the fourth column. In this case the free entry condition (6) holds with equality because the borrowing constraint is not imposed on the financing of entry costs. As expected, tighter borrowing constraints decrease output and TFP. The intuition is standard. First, financial frictions restrict borrowing and lending and drive down the capital-to-output ratio and hence output. It is also worth noting that the capital share and labor share do not change with financial development despite the sharp decrease in the capital to output ratio. This is because the capital and labor markets are both competitive.

Second, tighter borrowing constraints distort the allocation of capital and labor. Specifically, establishments with high productivity, but small capital stocks, may not raise enough capital and may have to operate on smaller scales, whereas establishments with low productivity but large capital stocks can operate on larger scales. Furthermore, establishments with large capital stocks and low productivity may survive, and establishments with small capital stocks and high productivity may not survive. This misallocation drives down TFP and therefore also contributes to the decline in output. However, such an effect only accounts for a small portion of the decline in output, as the change in TFP is small. Although this is consistent with Gilchrist et al. (2013) and Midrigan and Xu (2014), it differs from the findings of Amaral and Quintin (2010) and Buera et al. (2011). To understand the difference, note that Amaral and Quintin (2010) have a three-period overlapping-generations model in which the entrepreneur can only save for one period and cannot overcome borrowing constraints through self-financing over time. As a result, the misallocation effect of financial frictions on TFP is large. Buera et al. (2011) generate a greater effect on TFP through an industry model with risk-averse entrepreneurs and misallocation of capital and talent. In contrast, we did not model the misallocation of talent, and we show that the misallocation of capital with risk-neutral establishments cannot generate a large quantitative effect of financial frictions on TFP. This abstraction simplifies the analysis and does not undermine our results, as our main focus is on how the interaction between entry costs and financial market frictions affects the cross-country income and TFP differences.

The rest of this section discusses the interaction between entry costs and financial frictions. As reported in the fifth column, the interaction between the two frictions decreases output and TFP significantly. To understand this, note that η is less than one for all three groups. Hence, the free entry condition (6) cannot be satisfied in the case reported in the fifth column; thus (8) holds with equality. In such cases, the equilibrium wage rate adjusts according to the effective entry cost f_e^{US}/η^i; so do output and TFP. Because $\eta^i < 1$, the effective entry cost f_e^{US}/η^i is greater than the entry cost in the United States, f_e^{US}. Hence output and TFP decrease as reported in the fifth column and the effect is equivalent to an increase in the entry cost alone, because the borrowing constraint on capital accumulation

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is eliminated in this case. This implies that financial frictions interact with entry costs and amplify the effect of entry costs on output and TFP. Furthermore, as the financial market conditions deteriorate, such amplification effects increase, as a lower η leads to a higher effective entry cost. This is demonstrated by the larger decline of output and TFP in the fifth column as the income level decreases. Moreover, the interaction between the two frictions decreases TFP substantially while having no effect on the capital–output ratio. This is because the interaction only raises the effective entry cost and has no impact on capital accumulation. Hence, the decline of output in the fifth column is completely driven by the decline in TFP.

We now turn to the quantitative magnitude of each factor. Based on the first column, when both frictions are included, output per worker in the simulated low-income country is 9% of the U.S. level. As in the data, the drop in TFP accounts for a substantial portion of the drop in output. In particular, TFP in the low-income country is 25% of the U.S. level. The entry cost alone can bring down TFP (output per worker) to 71% (62%) and the financial friction on capital accumulation alone can bring down TFP (output per worker) to 92% (51%). Hence, if we eliminated the interaction between entry costs and financial frictions, TFP (output per worker) in the simulated-low income country would be 65% (32%) of the U.S. level, as measured by the product of values in the second column and the fourth column. The fifth column shows that the interaction can bring down TFP (output per worker) to 39% (27%) in the low-income country and therefore accounts for more than half of the drop in TFP (output per worker). Moreover, the interaction accounts for a larger portion of the decline in TFP than in output, because the interaction reduces TFP but not the capital-to-output ratio. Similarly, the interaction accounts for a substantial portion of the decline in output and TFP for the simulated high- and middle-income countries. Hence, in analyzing the effects of financial frictions and entry costs on output and TFP, it is important to explicitly model business entry and to explore the interaction between financial frictions and entry costs. This also suggests that policy makers should remove barriers to entry and mitigate financial frictions to achieve the greatest improvement in economic development.

In summary, although the entry cost and the financial friction in the model generate large declines in output and TFP, a substantial portion of the decline is accounted for by the interaction between the two. Hence, such interaction cannot be ignored when the cross-country income and TFP differences are analyzed.

4.3. Model Evaluation

Section 4.2 has shown that the two frictions affect output and productivity through effects on the capital-to-output ratio and the distribution of establishments. One natural question is whether the model's predictions on these dimensions are consistent with the cross-country data. To address this question, Figure 2 compares the capital-to-output ratio, entry rate, average establishment size as measured by the number of employees, and variance of establishment size from the model to

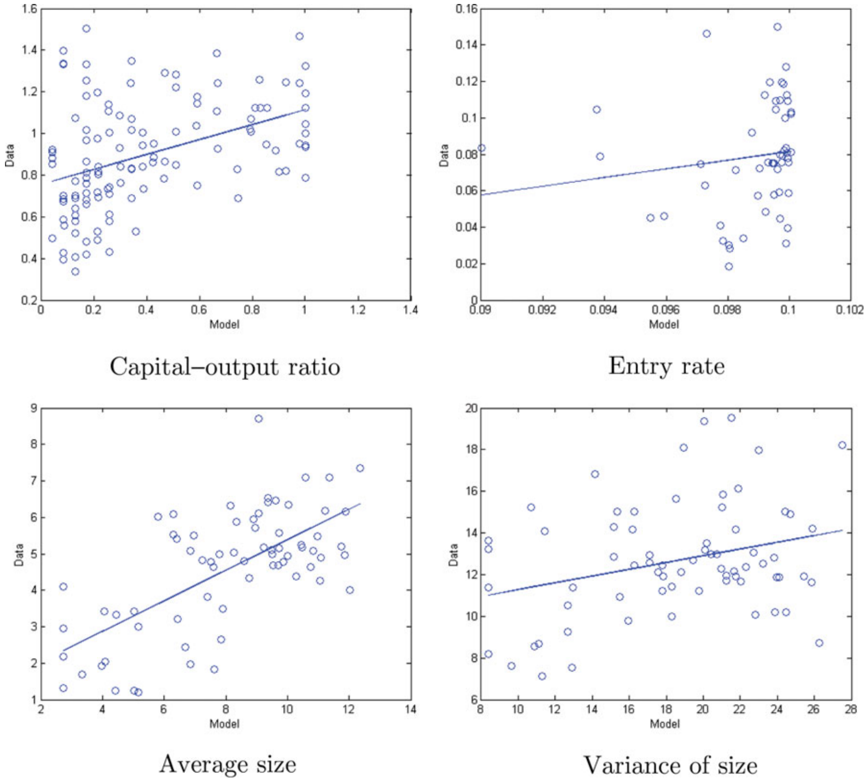

FIGURE 2. Model and data comparison. The figure plots capital–output ratio, entry rate, average establishment size, and the variance of establishment size from the data against the model'a predictions. Each circle represents one country. The predicted values are obtained from simulations with individual country's values of entry-cost-to-GDP ratio and debt-to-GDP ratio.

the data. Data on capital-to-output ratios are constructed when we compute TFP.[18] Data on business entry rates are borrowed from Djankov et al. (2010). Tybout (2000) and Alfaro et al. (2009) both study firm size distributions across countries. But the former studies both formal and informal firms, whereas the latter focuses only on plants in the formal sector. Because we focus on the formal sector, we compare our model predictions with data constructed by Alfaro et al. (2009). In Figure 2, we compare the log values of the average establishment size and variance of establishment size from the model with the data in Alfaro et al. (2009).

Table 4 reports the correlation coefficients and the regression results for these variables. Figure 2 and Table 4 show that the model is consistent with the data in terms of the capital-to-output ratio, average establishment size, and variance of establishment size. This is demonstrated by the positive correlation coefficients, the positiveness and significance of the slopes for the regression lines, and the

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TABLE 4. Model and data comparison

Variable	Correlation	R^2	Slope	t-Statistics on slope
Output	0.74	0.55	1.08	13.41
TFP	0.68	0.46	0.97	9.88
Capital-to-output ratio	0.41	0.17	0.36	4.86
Entry rate	0.15	0.02	2.38	1.07
Average establishment size	0.66	0.44	0.42	7.25
Variance of establishment size	0.30	0.09	0.16	2.57

Notes: The table reports the correlation between the data and the model's predictions on output, TFP, capital–output ratio, entry rate, average establishment size, and variance of establishment size. The predicted values are obtained from simulations with individual country's values of entry cost to GDP ratio and debt to GDP ratio. The R^2, slope and t-Statistics reported are from the fitted OLS regression in Figures 1 and 2.

associated R^2.[19] The model misses the cross-country variation in the entry rate. The next section explores the implications of the model with capital adjustment costs. The model's explanatory power for the entry rate improves substantially with capital adjustment costs.

4.4. Discussion

Capital adjustment cost. So far, we have assumed that establishments can adjust their capital stock freely. However, there are often costs associated with changing the level of production, such as inventory costs, machine setup costs, and hiring and layoff costs. This section explores the model's implications for capital adjustment costs. Specifically, establishments are subject to the capital adjustment cost $\Omega(k, k_{-1})$ and are recovering only the scrap value of capital when exiting. Cooper and Haltiwanger (2006) estimate the capital adjustment cost function using plant-level data and find that both convex and nonconvex capital adjustment costs are important in explaining the investment behavior. We follow their estimates and set $\Omega(k, k_{-1}) = 0.039k + 0.0245(\frac{k-(1-\delta)k_{-1}}{k})^2 k$. The scrap value of capital is a fraction of the original capital stock, and this fraction is set to be 40%, following the estimate of Ramey and Shapiro (2001).

We simulate the model with capital adjustment costs for each country, as in Section 4.1. In the simulation, the capital adjustment cost is also subject to the borrowing constraint. The simulation results are reported in Figure 3 and Table 5. Including capital adjustment costs improves the fit of the model for the entry rate significantly, with no major changes in the other variables. The correlation coefficient for the entry rate between the model and the data is more than doubled, the regression coefficient of the data on the model is now significantly different from zero, and R^2 increases from the benchmark case.

Technology parameters. We first examine the effect of a larger capital share. We set the capital share to be 0.3 and recalibrate the model. The quantitative effects are slightly larger for output and almost unchanged for TFP. We set the

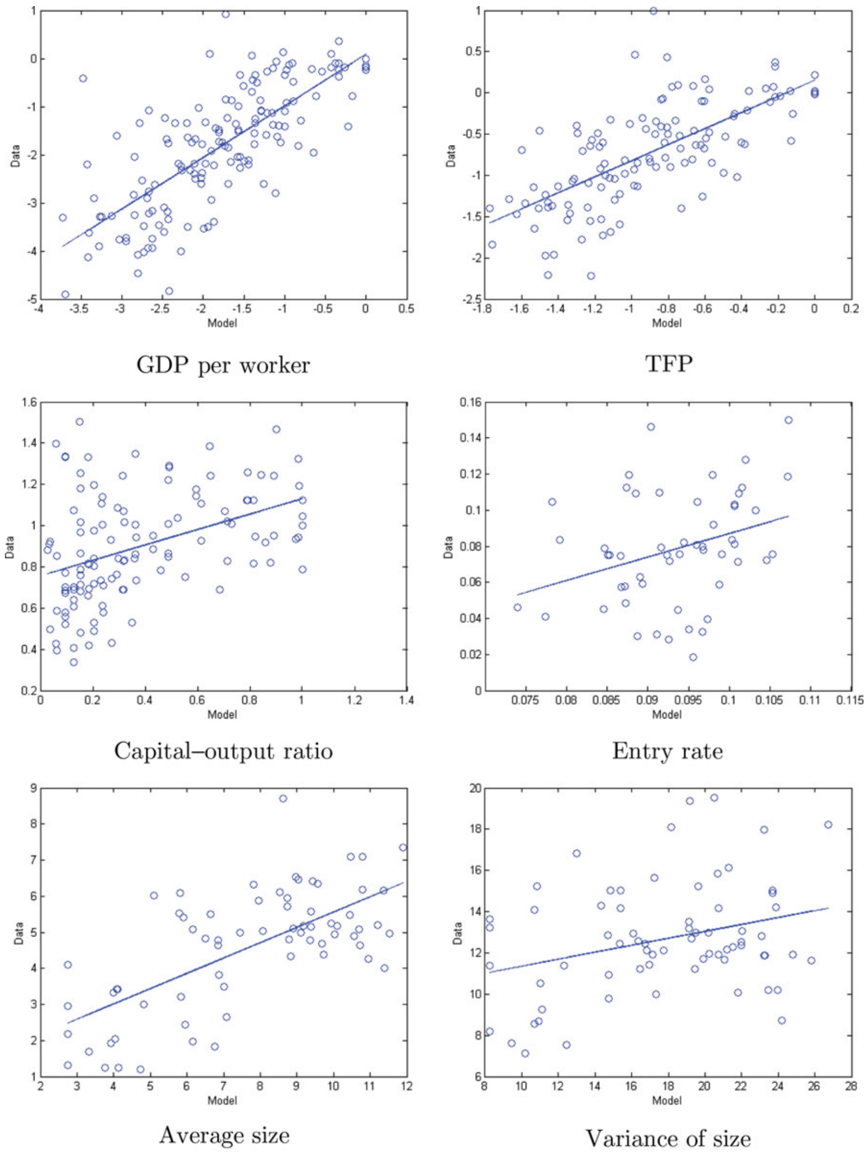

FIGURE 3. Model implications with capital adjustment costs. The figure plots output, TFP, capital–output ratio, entry rate, average establishment size, and the variance of establishment size from the data against the predictions from the model with capital adjustment costs. Each circle represents one country. The predicted values are obtained from simulations with individual countries' values of entry-cost-to-GDP ratio and debt-to-GDP ratio.

TABLE 5. Model and data comparison with capital adjustment costs

Variable	Correlation	R^2	Slope	t-Statistics on slope
Output	0.74	0.55	1.07	13.42
TFP	0.68	0.46	0.97	10.02
Capital-to-output ratio	0.41	0.17	0.37	4.88
Entry rate	0.33	0.11	1.30	2.48
Average establishment size	0.67	0.45	0.42	7.37
Variance of establishment size	0.31	0.09	0.17	2.64

Notes: The table reports the correlation between data and predictions on output, TFP, capital–output ratio, entry rate, average establishment size, and variance of establishment size from the model with capital adjustment costs. The predicted values are obtained from simulations with individual countries' values of entry-cost-to-GDP ratio and debt-to-GDP ratio. The R^2, slope, and t-statistics reported are from the fitted OLS regression in Figure 3.

returns-to-scale parameter to be 0.8 in the benchmark calibration. The literature normally indicates a value between 0.8 and 0.9. Recalibrating the model with an upper bound of 0.9 generates smaller but still sizable effects. In particular, entry costs and financial frictions together can bring TFP down to 53% and output to 19% in the simulated low-income country. Importantly, a substantial portion of the quantitative effect is again derived from the interaction for the alternative values of the capital share and returns-to-scale parameter.

Internal and external financing. In this paper, we did not explicitly allow establishments to finance capital using retained earnings. However, excluding self-financing is not an issue for incumbents in our model, because in our formulation, the collateral of borrowing is the value of the establishment, which includes present and future net profits. Because an establishment's value increases in profits, an establishment with higher profits or cash flow is less financially constrained. This is similar to what one would obtain by specifically modeling self-financing.

For new entrants, as we did not model the entrepreneurial sector, we assume that establishments have zero wealth before entry and must finance the entire entry cost. In reality, entrepreneurs use some of their assets to start businesses. However, external financing is still important for startups. Berger and Udell (1998) use data from the National Survey of Small Business Finances (NSSBF) to analyze the financial structure of small businesses. They find that the upper bound of internal financing (principal owner and other equity) is 56.8% for small business startups in the United States. Cassar (2004) finds that 40% of the startup funds in Australia come from outside sources. Huyghebaert and Van de Gucht (2007) report, for a sample of 244 manufacturing startups in Belgium, that 77.75% of their initial funding is from external debts (bank debt and trade credit).

To illustrate the model's prediction when entrepreneurs finance part of the entry cost through their savings, we recalibrate the model assuming that only half of the entry cost is financed by debt and the other half is paid through household savings. The partition is in the middle range, as reported by the referenced studies. The simulation results show that all the qualitative predictions are the same as in the benchmark case, and the quantitative results are smaller but close to the benchmark case. For example, output and TFP in the simulated low-income country are now 10% and 28%, respectively. The entry cost alone can reduce TFP (output) to 71% (62%), the borrowing constraint on capital accumulation alone can reduce TFP (output) to 91% (45%), and the interaction can reduce TFP (output) to 43% (32%).

The informal sector. There is a large informal sector in many poor countries. This paper focuses exclusively on the formal sector, not because we think the informal sector is not important, but because we view the analysis as a benchmark in assessing the effects of the interaction between entry costs and financial frictions on output and TFP. In this paper, financial frictions amplify the effect of entry costs by increasing the effective entry cost. This channel will still operate if the informal sector is modeled. D'Erasmo and Boedo (2012) take the existence of the informal sector seriously and explore how the financial market structure and the costs of informality, including the entry cost, affect cross-country TFP differences. However, they do not focus on the interaction between entry costs and financial frictions. They find that the model with an informal sector generates a larger decline in TFP than the model without an informal sector, because in countries with high entry costs, a large fraction of total output is produced by the informal sector, which consists of low-productivity firms compared to the formal sector. This intuition is also valid in our model. Moreover, because the borrowing constraint on business entry raises the effective entry cost, an even larger share of the output would be produced by the low-productivity informal firms if we were to include an informal sector. Hence TFP and output would be even lower.

5. CONCLUSION

This paper analyzed how the interaction between entry costs and financial frictions affects cross-country income and TFP differences. To perform such an analysis, we developed a model that incorporates both entry costs and financial frictions. In the model, entry, production, and exit decisions are all endogenous. To raise capital, establishments can borrow from the financial market. To enter the market, new establishments must borrow from the financial market to pay an upfront entry cost. Because the financial market is imperfect, each establishment can only borrow up to a fraction of its expected discounted lifetime profits.

The model is calibrated to match the establishment level statistics in the U.S. economy, assuming a perfect financial market for the United States. We simulate the model to jointly match the entry-cost-to-GDP-per-worker ratio and the debt-to-GDP ratio for a large set of countries. The regression of the data on the model results show that the model accounts for 55% and 46% of the cross-country variation in output and TFP, respectively, as measured by R^2. Moreover, a large portion of the model's explanatory power comes from the interaction between entry costs and financial frictions. The main mechanism is that financial frictions amplify the effect of entry cost by boosting the effective entry cost. This finding implies that financial frictions and business entry costs must be addressed together to improve overall productivity.

We assume that all new establishments pay the same entry cost, which may not be true in reality. As Buera et al. (2011) have shown, allowing entry costs to vary across sectors can generate significant quantitative effects on income and TFP. Similarly, the interaction between financial frictions and sectoral or industrial entry costs may be worth studying. We leave this for future research.

NOTES

1. See, for example, Klenow and Rodriguez-Clare (1997); Prescott (1998); Hall and Jones (1999). One exception is Manuelli and Seshadri (2010).
2. Modeling financial frictions as access to financial markets, Trew (2014) finds that the economics growth rate is positively related to the size of the financial industry.
3. This paper also connects with the literature on endogenous growth and convergence. Recent examples include Angyridis (2014) and Neto (2014).
4. Amaral and Quintin (2010) and Buera et al. (2011) derive the borrowing constraint endogenously through contractual enforcement and their borrowing constraints have the same properties.
5. As the borrowing and lending rates are the same, this is equivalent to the following: The downsizing establishment sells the extra capital and uses the proceeds to pay for the fixed production cost. If the fixed production cost is high, the establishment finances the difference, and if the proceeds are large, the establishment deposits the extra proceeds.
6. This equilibrium exists for all the simulations in Section 5.
7. The financial market in the United States is certainly not perfect. Hence, the quantitative results in Section 4 should be interpreted as the effects of financial frictions on income and TFP relative to the United States.
8. The returns-to=scale parameter is found to be between 0.8 and 0.9. See, for example, Basu (1996), Chang (2000), Veracierto (2001), Atkeson and Kehoe (2005), and Guner et al. (2008). Section 4.4 discusses the results for returns to scale of 0.9.
9. The data can be found in the table "Economy Wide" at the following Web page: http://www.census.gov/ces/dataproducts/bds/data_estab.html.
10. As noted by Hopenhayn and Rogerson (1993), one cannot disentangle the effect of a high wage from that of a high mean of the productivity shock on the establishment's objective function. This problem is dealt with by normalizing the wage rate in the calibrated model to be one and choosing the remaining parameters to be consistent with the data.
11. The data can be found at the following Web page: http://databank.worldbank.org/data/views/variableSelection/selectvariables.aspx?source=world-development-indicators.
12. The establishment statistics can be found in the table "U.S. & States, Totals" at the following Web page: http://www.census.gov/econ/susb/data/susb2007.html.
13. Note that the fixed production cost is 42 times that of the entry cost; thus, it implies that f is 30% of GDP per worker in the United States and is a small fraction of the total GDP.
14. See Levine (2005) for a comprehensive literature review.
15. The debt-to-GDP ratios are normalized by the perfect financial market levels in the model and by the U.S. levels in the data.
16. The correlation coefficient and the regression results are very similar for TFP computed without human capital adjustment.

17. The simulations with entry cost data from Djankov et al. (2002) deliver similar results.

18. The values are normalized by the U.S. values in both the model and the data.

19. The R^2 for the variance of establishment size is small. This may be due to the fact that there is no selection of establishments at the point of entry. D'Erasmo and Boedo (2012) model selection upon entry. They assume that an establishment receives the productivity draw before entering the formal sector and find that the implied variance is close to the data.

REFERENCES

Alfaro, Laura, Andrew Charlton, and Fabio Kanczuk (2009) Plant-size distribution and cross-country income differences. In *NBER International Seminar on Macroeconomics 2008*, National Bureau of Economic Research, Inc., NBER Chapters, pp. 243–272.

Amaral, Pedro and Erwan Quintin (2010) Limited enforcement, financial intermediation and economic development: A quantitative assessment. *International Economic Review* 51, 785–811.

Angyridis, Constantine (2014) Endogenous growth with public capital and progressive taxation. *Macroeconomic Dynamics*, http://dx.doi.org/10.1017/S1365100513000801.

Atkeson, Andrew and Patrick J. Kehoe (2005) Modeling and measuring organization capital. *Journal of Political Economy* 113, 1026–1053.

Azariadis, Costas and Leo Kaas (2014) Capital misallocation and aggregate factor productivity. *Macroeconomic Dynamics*, http://dx.doi.org/10.1017/S1365100514000236.

Banerjee, Abhijit and Esther Dufflo (2005) Growth theory through the lens of development economics. In Philippe Aghion and Steven N. Durlauf (eds.), *Handbook of Economic Growth*, 1st ed., Chap. 7, pp. 473–552. Elsevier B.V.

Barro, Robert J. and Jong-Wha Lee (2012) A new data set of educational attainment in the world, 1950–2010. *Journal of Development Economics* 104(C), 184–198.

Barseghyan, Levon and Riccardo DiCecio (2011) Entry costs, industry structure, and cross-country income and TFP differences, *Journal of Economic Theory* 146, 1828–1851.

Basu, Susanto (1996) Procyclical productivity: Increasing returns or cyclical utilization? *Quarterly Journal of Economics* 111, 719–751.

Beck, Thorsten, Ross Levine and Norman Loayza (2000) Finance and the sources of growth. *Journal of Financial Economics* 58, 261–300.

Berger, Allen N. and Gregory F. Udell (1998) The economics of small business finance: The roles of private equity and debt markets in the financial growth cycle. *Journal of Banking and Finance* 22, 613–673.

Buera, Francisco J., Joseph P. Kaboski, and Yongseok Shin (2011) Finance and development: A tale of two sectors. *American Economic Review* 101, 1964–2002.

Cassar, Gavin (2004) The financing of business start-ups. *Journal of Business Venturing* 19, 261–283.

Chakraborty, Shankha and Amartya Lahiri (2007) Costly intermediation and the poverty of nations. *International Economic Review* 48, 155–183.

Chang, Yongsung (2000) Wages, business cycles, and comparative advantage. *Journal of Monetary Economics* 46, 143–171.

Cooper, Russell W. and John C. Haltiwanger (2006) On the nature of capital adjustment costs. *Review of Economic Studies* 73, 611–633.

D'Erasmo, Pablo N. and Hernan J. Moscoso Boedo (2012) Financial structure, informality and development. *Journal of Monetary Economics* 59, 286–302.

Djankov, Simeon, Tim Ganser, Caralee McLiesh, Rita Ramalho, and Andrei Shleifer (2002) The regulation of entry. *Quarterly Journal of Economics* 117, 1–37.

Djankov, Simeon, Rafael La Porta, Florencio Lopez de Silanes, and Andrei Shleifer (2010) The effect of corporate taxes on investment and entrepreneurship. *American Economic Journal: Macroeconomics* 2, 31–64.

Erosa, Andrés and Ana Hidalgo Cabrillana (2008) On finance as a theory of TFP, cross-industry productivity differences, and economic rents. *International Economic Review* 49, 437–473.

Gilchrist, Simon, Jae W. Sim, and Egon Zakrajsek (2013) Misallocation and financial market frictions: Some direct evidence from the dispersion in borrowing costs. *Review of Economic Dynamics* 16, 159–176.

Guner, Nezih, Gustavo Ventura, and Yi Xu (2008) Macroeconomic implications of size dependent policies. *Review of Economic Dynamics* 11, 721–744.

Hall, Robert E. and Charles I. Jones (1999) Why do some countries produce so much more output per worker than others. *Quaterly Journal of Economics* 114, 83–116.

Herrendorf, Berthold and Arilton Teixeira (2011) Barriers to entry and development. *International Economic Review* 52, 573–602.

Hopenhayn, Hugo A. (1992) Entry, exit, and firm dynamics in long run equilibrium. *Econometrica* 60, 1127–1150.

Hopenhayn, Hugo A. and Richard Rogerson (1993) Job turnover and policy evaluation: A general equilibrium analysis. *Journal of Political Economy* 101, 1127–1150.

Huyghebaert, Nancy and Linda Van de Gucht (2007) The determinants of financial structure: New insights from business start-ups. *European Financial Management* 13, 101–133.

Klenow, Peter J. and Andres Rodriguez-Clare (1997) The neoclassical revival in growth economics: Has it gone too far? In Ben Bernanke and Julio J. Rotemberg (eds.), *NBER Macroeconomics Annual*, pp. 73–103. Cambridge, MA: MIT Press.

Lagos, Ricardo (2006) A model of TFP. *Review of Economic Studies* 73, 983–1007.

Levine, Ross (2005) Finance and growth: Theory and evidence. In Philippe Aghion and Steven N. Durlauf (eds.), *Handbook of Economic Growth*, Vol. 1A, Chap. 12, pp. 865–934. Elsevier.

Manuelli, Rodolfo E. and Ananth Seshadri (2010) Human Capital and the Wealth of Nations. Working paper, University of Wisconsin–Madison.

Midrigan, Virgiliu and Daniel Yi Xu (2014) Finance and misallocation: Evidence from plant-level data. *American Economic Review* 104, 422–458.

Moscoso Boedo, Hernan J. and Toshihiko Mukoyama (2012) Evaluating the effects of entry regulations and firing costs on international income differences. *Journal of Economic Growth* 17, 143–170.

Neto, Delfim Gomes (2014) Financial globalization and economic growth. *Macroeconomic Dynamics* 18, 526–547.

Nicoletti, Giuseppe and Stefano Scarpetta (2003) Regulation, productivity and growth: OECD evidence. *Economic Policy* 18, 9–72.

Nicoletti, Giuseppe and Stefano Scarpetta (2006) Regulation and economic performance:product market reforms and productivity in the OECD. In T. Eicher and C. García-Peñalosa, *Institutions, Development and Growth*, pp. 81–120. Cambridge, MA: MIT Press.

Parente, Stephen L. and Edward C. Prescott (1999) Monopoly rights: A barrier to riches. *American Economic Review* 89, 1216–1233.

Prescott, Edward C. (1998) Needed: A theory of total factor productivity. *International Economic Review* 39, 525–551.

Ramey, Valerie A. and Matthew D. Shapiro (2001) Displaced capital: A study of aerospace plant closings. *Journal of Political Economy* 109, 958–992.

Restuccia, Diego and Richard Rogerson (2008) Policy distortions and aggregate productivity with heterogenous establishments. *Review of Economic Dynamics* 11, 707–720.

Trew, Alex (2014) Finance and balanced growth. *Macroeconomic Dynamics* 18, 883–898.

Tybout, James R. (2000) Manufacturing firms in developing countries: How well do they do and why? *Journal of Economic Literature* 38, 11–44.

Veracierto, Marcelo (2001) Employment flows, capital mobility, and policy analysis. *International Economic Review* 42, 571–595.

APPENDIX: PROOF OF LEMMA 1

(i) Because the per-period profits and the choice set for k are both increasing in z and k_{-1}, standard dynamic programming argument can easily show that $v(z, k_{-1})$ is increasing in z and k_{-1}.

(ii) Let $g(z, k_{-1}) = v(z, k_{-1}) - (1 + r)(1 - \delta)k_{-1}$. $g(z, k_{-1})$ is then defined by

$$
\begin{aligned}
g(z, k_{-1}) = \max_{k,h} & \; zk^{\alpha}h^{\gamma} - wh - (1 + r)(k + f) \\
& + \beta(1 - \lambda) \int \max[g(z', k), 0] dF(z') + \beta\lambda \max[g(z, k), 0] \\
\text{s.t.} \quad & k + f \leq \eta g(z, k_{-1}) + [\eta(1 + r) + 1](1 - \delta)k_{-1}.
\end{aligned} \qquad \textbf{(A.1)}
$$

Because the per-period payoff and the choice set for k are increasing in k_{-1}, it is easy to show that $g(z, s)$ is increasing in k_{-1} by applying the standard dynamic programming analysis to this problem.