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Entry Cost, Financial Friction, and Cross-Country Differences in Income and TFP

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Abstract: This paper develops a model to assess the quantitative effect of entry cost and financial friction on cross-country income and total factor productivity (TFP) differences. The main focus is on the interaction between entry cost and financial friction. The model is calibrated to match establishment-level statistics for the U.S. economy assuming a perfect financial market. The quantitative analysis shows that entry costs and financial frictions together can generate a factor ten of the differences in income per capita and a factor five of the differences in TFP, and a large part of the differences are accounted for by the interaction between entry cost and financial friction. The main mechanism is that financial friction amplifies the effect of entry cost by boosting the effective entry cost.

JEL classification: O11, O43

Key words: entry cost, financial friction, GDP per capita, TFP

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1 Introduction

Income per capita differs by a factor of thirty between rich and poor countries. Research on growth accounting finds out that most of the differences come from the cross-country differences in total factor productivity (TFP). [1] On the other hand, many poor countries have poor developed financial markets as well as large costs to the opening of new businesses. Both of these two factors have been found to be negatively correlated with income per capita across country.[2] The goal of this paper is to quantify the importance of financial frictions and entry costs for cross-country differences in income per capital and TFP.

There are a number of studies that have examined either the effects of financial frictions or the effects of entry costs on cross-country differences. The objective of this paper is to investigate whether there is any interaction between entry costs and financial frictions and how such interaction may affect cross-country income and TFP differences. Intuitively, underdeveloped financial markets may amplify the effect of entry cost since entrepreneurs can not borrow to overcome the high barriers. In contrast, better developed financial market may have little effects on how entry costs affect output and TFP.

To explore this issue, this paper develops a model to incorporate both financial friction and entry cost, and then use the calibrated model to explore how the effect of entry cost on cross-country income and TFP differences change with financial market conditions. We discover that financial friction amplifies the effect of entry cost on economic development. Moreover, the interaction between financial friction and entry cost is quantitatively important in accounting for the cross-country income and TFP differences.

The model developed in this paper builds on the industry model studied by Hopenhayn

[1] See for example Klenow and Rodriguez-Clare (1997), Prescott (1998), Hall and Jones (1999). One exception is Manuelli and Seshadri (2005)

[2] Djankov et. al. (2002) finds a negative correlation between GDP per capita and the ratio of entry cost to GDP per capita. Nicoletti and Scarpetta (2003) and (2006) find that entry cost is negatively related to TFP in OECD countries. Beck, Levine and Loayza (2000) established a negative relationship between financial development and economic growth.

(1992) and Hopenhayn and Rogerson (1993). In the model establishments have different levels of productivity and the technology is subject to decreasing return to scale with a fixed production cost. We assume that capital and labor have to be paid before production takes place. An establishment can save or borrow from the financial market to fulfill the need for working capital. The financial market is imperfect and an establishment can only borrow up to a fraction of its expected discounted life-time profits. The existing establishments may exit if it is hit by a death shock or the value of production is smaller than the savings. In contrast, new establishments can enter after paying an upfront entry cost which can be borrowed from the financial market subject to a similar borrowing constraint facing by the existing establishments.

The model is calibrated to match the establishment level statistics in the U.S. economy assuming a perfect financial market for the U.S. The calibrated model is then used to analyze the cross-country differences in income per capita and TFP. To perform the analysis, we vary entry costs in the range observed in the data and vary the friction in the financial market to obtain variations in external finance to GDP ratios that are comparable to the data. We find that entry costs and financial frictions together can account for a factor ten of the differences in income per capita and a factor five of the differences in TFP across countries. Moreover, a large part of the explanatory power comes from the interaction between entry cost and financial friction.

The intuition for the results consists of three parts. First, higher entry costs lead to less entry and therefore a smaller number of productive establishments. This reduces the competitive pressure in the economy. Hence establishments with a lower productivity can survive and output and TFP decrease. Second, when there are financial frictions, the existing establishment can not borrow enough working capital and has to operate at a scale smaller than the efficient level. Third, financial friction amplifies the effects of entry cost 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 since they can not finance the required upfront entry cost. This reduces the number of establishments in production. The effect is equivalent to an increase in the entry cost. Hence output and TFP fall. Furthermore, as financial market condition deteriorates, the amplification effect becomes larger, so does the drop in output and TFP.

This paper is connected to the literature that studies the relationship between various policies and the cross-country income and TFP differences. For instance, Parente and Prescott (1999) and Herrendorf and Texeira (2010) examines the role of monopoly rights in blocking the use of most efficient technologies. Lagos (2006) examines how labor market institutions affect TFP. Erosa and Hidalgo (2008) investigates the role of poor contract enforcement in explaining the use of inefficient technologies and low TFP in poor countries. Guner et al. (2008) and Restuccia and Rogerson (2008) studies the effects of size-dependent policies on macroeconomic aggregates. D'Erasmo and Moscoso Boedo (2010) explores how the cost to informality and financial market structure affects cross-country TFP differences.

This paper is more closely related to three other papers in the literature that emphasize the importance of entry costs and financial frictions on cross-country income and TFP differences. Barseghyan and DiCecio (2009) quantifies the effect of entry cost on economic development. Amaral and Quintin (2009) and Buera et al. (2009) show that financial frictions can generate sizable differences in output and TFP. We view this paper as a complement to these works. We develop an industry model incorporating both entry cost and financial friction. The model allows us to investigate how the interaction between entry costs and financial frictions affects income and TFP differences. Moreover, the simulations based on the calibrated model show that the interaction is quantitatively important.

The rest of the paper is organized as follows. Section 2 presents the model. Section 3 lays out the agents' maximization problem and defines the steady state equilibrium. Section 4 describes the calibration strategy. Section 5 assesses the quantitative implications of the calibrated model and the robustness of the results. Section 6 concludes.

2 The Economy

We consider a discrete-time model with heterogeneity in establishment level productivity. The model can be best described as embedding borrowing constraints into the industry model studied by Hopenhayn and Rogerson (1993). In the model economy an establishment needs to pay for capital and labor ahead of production. To finance the working capital, the establishment can either use its savings or borrow 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 also needs to be financed.

2.1 Household

There is an infinitely-lived representative household that inelastically supply one unit of labor each period and values a single consumption good c by the utility function:

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

where $0 < \beta < 1$ is the discount factor and u is an increasing and concave function in c_t. The household invests and rents capital to establishments and owns all the establishments in the economy.

2.2 Production

The production unit is the establishment. There are a continuum of existing establishments which differ in their productivity z. Each of them hires labor, rents capital, and produces according to the production function:

$$y = zk^{\alpha}h^{\gamma}. \tag{2.1}$$

To simplify the analysis, we deviate from Hopenhayn and Rogerson (1993) and assume that z is constant over an establishment's life. This assumption does not affect the analysis of the interaction between entry costs and financial market frictions, but saves a lot of computational time.[3] The establishment's production technology is assumed to be decreasing return to scale, i.e., $\alpha + \gamma < 1$. To stay in operation, each establishment needs to pay a fixed production cost f every period, measured in the units of output.

We assume that capital and labor need to be paid before production takes place. An establishment can finance the working capital either through its savings s or through borrowing from the financial market. To save, an establishment must have positive current period profits. If the savings can not cover the capital and labor costs, the establishment can borrow from the financial market at a constant rate r_b and can not default on the debt. We assume that borrowing and capital rental are both within period.

The financial market is imperfect and each establishment can borrow up to a fraction η of its discounted life-time profits. η captures the degree of financial frictions in different countries with the interpretation that a larger η represents a better financial market. Although the credit constraint is not derived from an optimal contract, it imposes an upper bound on borrowing and captures the idea that more profitable establishments can borrow more from the financial market. In fact, an optimal contract often gives rise to a similar credit constraint.[4]

At the beginning of a period, each establishment faces an exogenous probability of death λ. If an establishment is hit by the death shock, it keeps its savings and exits. Moreover, an

[3] See section 5.2 for details.

[4] see for example Chen and Song (2009) and Amaral and Quintin (2009).

establishment can choose to exit endogenously if the continuation value is smaller than its savings.

The timing of decisions within a period is as follows. At the beginning of a period, the death shock realizes. The survival establishment then decides whether to stay or exit. If the establishment decides to stay, it chooses how much labor to hire and how much capital to rent, and therefore how much to borrow from the financial market taking into account the borrowing constraints. At the end of the period, production takes place and the establishment repays the debt and decides how much to save.

There are also a continuum of infinite amount of ex ante identical entrants which can enter each period after paying the entry cost f_e. f_e represents a nominal cost of entry and the revenue will be rebated back to the household in a lump-sum fashion. To pay such costs, the entrant can borrow from the financial market at the rate r_b up to the fraction η of its value of entry. The debt is again within period and has to be repaid at the end of the period. Once the entry cost is paid, each establishment receives a productivity draw z from the distribution $F(z)$. The productivity draws are i.i.d across entering establishments and the distribution $F(z)$ is the same every period. After the productivity draw is realized, the entering establishment with productivity z is in the same position as an incumbent that has the same productivity and savings $-f_e$, and has survived the death shock, and therefore decides to stay or exit first and if it chooses to stay, then decides how much to borrow, how much to produce, and how much to save.

3 Equilibrium

This section focuses on the stationary equilibrium for the economy just described. In such an equilibrium, all the prices are constant and the distribution of establishments over productivity and savings does not change over time.

Household

Normalize the price of the consumption good to be one and let $W(K)$ denote the value function of the household. The problem of the representative household is then given by:

$$\begin{aligned} W(K) &= \max_{c,K'} u(c) + \beta W(K') \\ s.t. \quad & c + K' - (1-\delta)K = w + r_k K + \Pi + T, \end{aligned} \tag{3.1}$$

where δ is the depreciation rate, w is the wage, r_k is the rental rate on capital, T is transfers, and Π is the profits generated by the productive establishments.

A simple manipulation of the first order condition implies that if a stationary equilibrium exists, the following relationship must hold:

$$r_k = \frac{1}{\beta} - (1-\delta). \tag{3.2}$$

Establishment

Let $v(z,s)$ be the value function of an establishment with productivity z and savings s and having decided to stay in operation. $v(z,s)$ is given by:

$$\begin{aligned} v(z,s) &= \max_{k,h,s'} z k^\alpha h^\gamma - (1+r_b)(wh + r_k k - s) - f - s' \\ & \quad + \beta(1-\lambda)\max[v(z,s'), (1+r_b)s'] + \beta\lambda(1+r_b)s' \\ s.t. \quad & wh + r_k k - s \le \eta v(z,s) && (3.3) \\ & s' = 0, \text{if } z k^\alpha h^\gamma - (1+r_b)(wh + r_k k - s) - f \le 0 \\ & 0 \le s' \le z k^\alpha h^\gamma - (1+r_b)(wh + r_k k - s) - f, \text{otherwise} && (3.4) \end{aligned}$$

where $wh + r_k k - s$ is the working capital that the establishment finances externally and s' denotes next period's value of savings. The maximization operator that nested on the right hand side reflects the establishment's decision of staying or exiting at the beginning of the next period. An establishment's value consists of its current period profit, which is given by $zk^\alpha h^\gamma - (1 + r_b)(wh + r_k k - s)$ net of the fixed cost f and savings s', and the next period's value, which reflects the realization of the death shock and the establishment's staying or exiting decision. (3.3) describes the borrowing constraint and (3.4) summarizes the assumption that the establishment's savings must come from nonnegative profits.

Since there is no distortion in the capital market and the labor market, the first order condition for k and h implies that capital-labor ratio $\frac{k}{h}$ is constant across establishments regardless of whether the borrowing constraint binds or not, and it is easy to derive:

$$\frac{k}{h} = \frac{w\alpha}{r_k\gamma}. \tag{3.5}$$

Moreover, if the financial market is perfect, (3.3) will not bind, and all the establishments can operate at their optimal scales. Hence k and h only depend on z and are given by:

$$k^*(z) = z^{\frac{1}{1-\alpha-\gamma}}(\frac{\gamma}{w})^{\frac{\gamma}{1-\alpha-\gamma}}(\frac{r_k}{\alpha})^{\frac{\gamma-1}{1-\alpha-\gamma}}(\frac{1}{1+r_b})^{\frac{1}{1-\alpha-\gamma}} \tag{3.6}$$

$$h^*(z) = z^{\frac{1}{1-\alpha-\gamma}}(\frac{\alpha}{r_k})^{\frac{\alpha}{1-\alpha-\gamma}}(\frac{w}{\gamma})^{\frac{\alpha-1}{1-\alpha-\gamma}}(\frac{1}{1+r_b})^{\frac{1}{1-\alpha-\gamma}} \tag{3.7}$$

However, if the financial market is imperfect, (3.3) may bind, and therefore some, if not all productive establishments can not borrow enough working capital and will operate below their optimal scales. In this case k and h will be increasing in s since more savings not only imply that the establishment has more internal fund to finance working capital, but also imply that the establishment can borrow more from the financial market because v is an increasing function of s. This and several other properties of the value function are established in the following lemma.

Lemma 1 *(i) $v(z, s)$ is strictly increasing in z and s;*

(ii) $v(z,s) - s(1+r_b)$ *is increasing in* s.

Proof: See appendix.

Since v is increasing in z, the decision of staying or exiting is characterized by a cutoff rule for z at a given value of s. In particular, the rule is to exit if z is smaller than the cutoff value and to stay otherwise. Moreover, Lemma 1(*ii*) proves that an increase in s leads to a larger increase in v. This implies that the decision of staying or exiting is also characterized by a cutoff rule for s at a given value of z. Since v is increasing in z, it is easy to see that the cutoff value of s becomes smaller as z increases. In addition, the cutoff rule implies that if an entrant decides to stay in operation in the period of entry, it will choose to stay every period afterwards until the death shock realizes because its productivity z is constant over time and its savings will be larger than that in the period of entry.

Entry

As in Hopenhayn and Rogerson (1993), since there are infinite amount of potential entrants 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 is in the same position as the existing establishment with the same productivity and savings $-f_e$, and therefore when making stay/exit decision, the entrant will compare between $v(z, -f_e)$ and $-f_e(1+r_b)$.[5] Hence the free entry condition can be described as follows:

$$f_e + \int \max(v(z, -f_e), -f_e(1+r_b))dF(z) \le f_e, \tag{3.8}$$

where the f_e on the left hand side is the amount borrowed from the financial market and the f_e on the right hand side denotes the entry cost. The integral is taken over all the possible productivity draws. For future reference, note that the left hand side of (3.8) denotes the value of entry for a new establishment.

[5] If $f_e \ge \eta v(z, -f_e)$, we assume that the entrant can not finance any working capital and therefore can not produce in the period of entry.

If there is no financial friction, the free entry condition (3.8) must hold in the steady state equilibrium. In fact, in such cases (3.8) must holds with equality. This is true because λ fraction of productive establishments exits exogenously every period. Hence if a steady state equilibrium exists, there must be positive entry and exits. In such an equilibrium, if (3.8) does not hold with equality, more establishments will enter and produce. This drives down the value of entry until it is no longer profitable for more establishments to enter.

However when there is financial friction, free entry condition may not hold in the steady state equilibrium. To see this, note that similar to an existing establishment, a new establishment can only borrow up to η fraction of its value of entry. Hence if f_e is less 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 can not exist even when the free entry condition holds, since if a steady state equilibrium exists, there must be a positive amount of entry. This implies that f_e must be less than or equal to the borrowing limit for a new establishment in the steady state equilibrium. Since the left of (3.8) is the value of entry for a new establishment, the borrowing constraint is simply as follows:[6]

$$\eta\{f_e + \int \max(v(z, -f_e), -f_e(1 + r_b))dF(z)\} \geq f_e. \tag{3.9}$$

Simple manipulation gives

$$\{f_e + \int \max(v(z, -f_e), -f_e(1 + r_b))dF(z)\} \geq \frac{f_e}{\eta}. \tag{3.10}$$

If $\eta \geq 1$, there is no contradiction between (3.8) and (3.10), and therefore free entry

[6]Alternatively, the borrowing constraint for a new establishment can be based on the net value of entry. In this case (3.10) changes to $\eta\{\int \max(v(z, -f_e), -f_e(1 + r_b))dF(z)\} \geq f_e$. Hence the free entry condition holds only if $\eta = inf$ or $f_e = 0$. Simple manipulation of this borrowing constraint gives $\{f_e + \int \max(v(z, -f_e), -f_e(1 + r_b))dF(z)\} \geq \frac{f_e(1+\eta)}{\eta}$. Hence the effective entry cost is $\frac{f_e(1+\eta)}{\eta}$, which is larger than the effective entry cost in the case when the borrowing constraint is based on the gross value of entry. This implies that the amplification effects of financial frictions on entry cost will be even larger if the net value of entry is used to form the borrowing constraint.

condition will hold with equality in the 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 can not hold in the equilibrium. In such cases the entrant's borrowing constraint (3.10) binds. This is true since when the free entry condition does not hold, it is profitable for more establishments to enter. In addition, these establishments can acquire the up-front cost f_e from the financial market if the borrowing constraint does not bind. This drives up the wage rate, and therefore drives down the value of entry until (3.10) holds with equality. It follows that if $\eta \geq 1$, financial friction does not distort the entry decision, however if $\eta < 1$, financial friction not only distorts the production scale, but also distorts the entry decision.

For future reference, note that from (3.8) and (3.10), it is easy to see that when $\eta \geq 1$, the value of entry equals to the entry cost f_e, but when $\eta < 1$, the value of entry equals to $\frac{f_e}{\eta}$. Thus, when $\eta < 1$, $\frac{f_e}{\eta}$ can be viewed as the effective entry cost since the entrants make entry decision according to $\frac{f_e}{\eta}$ instead of f_e, and therefore output and TFP also adjust according the effective entry cost. Hence, as long as η is small, even if the entry cost is not large, the effective entry cost could still be large. This implies that financial friction interacts with entry cost and amplifies the effects of entry cost on cross-country incomes and TFP differences by boosting the effective entry cost. Moreover, the severer the friction is, the larger the amplification effect is.

Aggregation

Let $\mu(z, s)$ denote the distribution of productive establishments across productivity and savings. Let $x(z, s)$ denote the decision of staying or exiting with the convention that $x(z, s) = 1$ corresponds to stay and $x(z, s) = 0$ corresponds to exit. Let M be the mass of entrants, S be the aggregate savings, Ω be the total net interest payment, and Y be the aggregate output. Let $k(z, s)$, $h(z, s)$, and $s'(z, s)$ be the optimal decision for capital, labor, and savings. The relation between establishment level variables and aggregate variables can be expressed as follows:

$$K = \int k(z, s) d\mu, \tag{3.11}$$

$$1 = \int h(z, s) d\mu, \tag{3.12}$$

$$S = \int s'(z, s) d\mu, \tag{3.13}$$

$$Y = \int z k(z, s)^{\alpha} h(z, s)^{\gamma} d\mu. \tag{3.14}$$

In the steady state equilibrium, the current period savings also equals to S, which includes savings of productive establishments, exiting establishments, and dead establishments. With the definition for aggregate capital, labor, output, and savings at hand, the total net interest payment and total profit can then be defined as follows:

$$\Omega = r_b(w + r_k K) + r_b M f_e - r_b S, \tag{3.15}$$

$$\Pi = Y - (w + r_k K)(1 + r_b) - \int f d\mu + (1 + r_b)S - \int s'(z, s) d\mu - M f_e(1 + r_b), \tag{3.16}$$

where $(w + r_k K)(1 + r_b)$ is the total cost of working capital and $M f_e(1 + r_b)$ is the total cost of entry. The government balances budgets each period:

$$T = M f_e. \tag{3.17}$$

The goods market clear condition is standard once the financing cost Ω is taken into account:

$$c + \delta K = Y - \int f d\mu - \Omega. \tag{3.18}$$

3.1 Definition of the Steady State Equilibrium

A steady state competitive equilibrium is composed of: prices w and r_k, value functions $W(K)$ and $v(z,s)$, a measure of establishments $\mu(z,s)$, a mass of entry M, consumption c and aggregate capital K, and policy functions $h(z,s)$, $k(z,s)$, $s'(z,s)$, and $x(z,s)$ such that:

(i) Given prices, all agents solve their maximization problems.

(ii) The resource constraints (3.11) to (3.18) hold.

(iii) If $\eta \geq 1$, (3.8) holds with equality and if $\eta < 1$, (3.10) holds with equality.

(iv) μ is time-invariant.

4 Calibration

This section calibrates the parameters in order to match observations in the steady state to the data in the U.S. For this purpose, the U.S 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 target the steady state interest rate r_b to be 4% a year. This implies that $\beta = 0.96$. To calibrate the exogenous exit rate λ, we target the exit rate of 10% for the establishments in the U.S. We follow the literature and set the return to scale in the establishment level to be 0.8, and set capital share to be $\frac{1}{3}$ and labor share to be $\frac{2}{3}$ of the return to scale parameter respectively.[8] This implies that $\alpha = 0.267$ and $\gamma = 0.533$. To calibrate the depreciation rate, we target the capital output ratio in the U.S. economy to be 2.3. In the economy without financial friction, the payment to capital is $r_k(1 + r_b)K = \alpha Y$. This and (3.2) then implies $\delta = 0.0715$.

We assume a lognormal distribution $F(z)$ with support $[0, z_{max}]$ for the initial productiv-

[7] The financial market in the U.S. is certainly not perfect. Hence, the quantitative results in section 5 should be interpreted as the effects of financial frictions on income and TFP relative to the U.S.

[8] The return to scale parameter is found to be between 0.8 and 0.9. See for example Basu (1996), Veracierto (2001), Chang (2008) and Guner et. al. (2008). Section 5.2 reports the results for the return to scale of 0.85 and 0.9.

ity draw of a new establishment. In the economy without financial friction, all establishments operate at their optimal scale and the establishment level employment is uniquely determined by z for any given prices. Hence z_{max} can be pin down by the maximum establishment level employment in the steady state equilibrium, which we assume to be 10,000.

The parameters that remain to be assigned are the entry cost f_e, the fixed production cost f, and the mean a and the variance σ of the distribution F. We calibrate these four parameters jointly to match the ratio of entry cost to income per capita, the average establishment size, and the share of total number of establishments at different size in the U.S. economy. The Doing Business data set of the World Bank provides the data about entry cost in terms of income per capita in 184 countries since 2004. The average value for the U.S. from 2004 to 2010 is 0.73%. This number is used to pin down 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. Specifically, the 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. Table 2 lists the targets and the corresponding statistics generated by the model. Overall, the calibrated model matches the data well.

5 Quantitative Analysis

This section uses the calibrated model to assess the effects of entry cost, financial friction, and the interaction between them on the cross-country income and TFP differences. The strategy is to compare the steady state equilibrium in economies that differ in the entry cost and the ability of acquiring external finance. According to data for entry cost to per capita GDP ratio from the World Bank and data for per capita GDP from the Penn World Table, the maximum amount of entry cost in the data is about 20 times of the U.S. level. Hence for the comparison exercises we increase the entry cost from the benchmark value to twenty times.

When assessing the effects of financial friction, we vary η to obtain a range of external finance to GDP ratios observed in the data. The data we use is the private sector credit to GDP ratio from the World Development Indicators, published by the World Bank. For the analysis, we examine four different levels of external debt to GDP ratios. The four levels correspond to the average external debt to GDP ratios in high income countries, middle income countries, low income countries, and poor countries, where the definition of the four groups follow the definition of the World Bank. The calibrated values for η are listed in table 3.

Following the standard development accounting exercise, total factor productivity in this section is measured as:

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

where H is one since the labor supply is inelastic.

5.1 Results

Figure 2 plots the steady state output and TFP against the entry cost for different values of η. For comparison purpose, all values are relative to the U.S. To isolate the effects of the interaction between entry costs and financial frictions, figure 1 plots similar results for the economy without distortion on business entry. In this economy, borrowing constraints are only imposed on the finance of working capital and not on the finance of entry costs. This implies that free entry condition (3.8) holds with equality regardless of the value for η. For the simulations in figure 1, we choose the same values for f_e and η as in figure 2. Since whether the borrowing constraint is imposed on business entry or not is irrelevant for the economy without financial frictions, the top curves in both figure 1 and figure 2 are identical.

Figure 1 relates to several works in the literature. To begin with, the top curves, which can be related to Barseghyan and DiCecio (2009), shows how output and TFP varies with entry costs in an economy with perfect financial market. As Barseghyan and DiCecio (2009), when the entry cost increases, both output and TFP decreases. The intuition behind this result is simple. When there is no financial friction, free entry condition always needs to be satisfied in the steady state equilibrium. A higher entry cost then necessarily leads to higher expected value of entry through a lower wage rate. This implies a larger v for any pair of (z, s), and therefore establishments with a smaller productivity can survive and the cutoff value for z decreases. Moreover, a larger entry cost also reduces the mass of production establishments. Both of these two reasons lead to lower output and TFP. As figure 1 indicates, varying entry cost from the U.S. level to twenty times can generate about two and a half times of the differences in output and about twice of the differences in TFP.

Figure 1 can also be related to Amaral and Quintin (2009) and Buera et al. (2009) once the entry cost is fixed at the U.S. level. As in these works, tighter borrowing constraints decrease output and TFP since tighter borrowing constraints reduce establishments' production scale and distort the allocation of capital and labor. However the quantitative effects is much smaller here. To understand this, note that Amaral and Quintin (2009) has a three period over-lapping generations model in which the entrepreneurs can only save for one period and can not overcome borrowing constraints through self-financing over time. As a result, the quantitative effects of financial friction is large. Buera et al. (2009) generates a larger effect 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 show that the misallocation of capital and labor with risk neutral establishments can not generate a large quantitative effect of financial friction on output and TFP. This abstraction simplifies the analysis and does not undermine our results since our main focus is on how the interaction between entry cost and financial market friction affects the cross-country income and TFP differences.

Now we turn to the main results. From figure 2, when we take into account the borrowing constraint on business entry, financial friction decreases output and TFP a lot more for any level of entry cost. To understand this, note that η is less than one for all the curves except the top ones in figure 2. Hence the free entry condition (3.8) can not be satisfied in these economies, and instead (3.10) holds with equality. In such cases, the equilibrium wage rate adjusts according to the effective entry cost $\frac{f_e}{\eta}$, so do the output and TFP. Because $\eta < 1$, the reduction in output and TFP will be larger comparing to the economy with the same f_e and η but without borrowing constraint on business entry. This implies that financial friction interacts with entry cost and amplifies the effects of entry cost on output and TFP. Furthermore, as the financial market condition deteriorates, such amplification effect becomes larger, since a smaller η leads to larger effective entry costs.

In the context of this model the interaction between entry cost and financial friction is generated by the borrowing constraints on business entry, which largely exists in reality. When business entry is explicitly modeled, such constraints imply that some of the profitable entrants may not be able to borrow the required up-front entry cost to open their businesses. Hence financial frictions affect output and TFP not only through reducing the existing establishments' production scale, but also through reducing the mass of the entering establishments directly. As a result, the number of production establishments falls. In addition, less entry also decreases the competitive pressure on the existing establishments. Thus, establishments with lower productivity and savings can survive. This all leads to lower output and TFP. As the financial market condition deteriorates, it becomes even harder for new businesses to open, and therefore the distortion becomes larger and output and TFP fall more.

Next we turn to the quantitative magnitude of the effects. Based on figure 2, the maximum differences on output the model can generate is a factor of ten. As in the data, most of the differences are accounted by the differences in TFP. In particular, the model can generate a factor five of the differences in TFP across countries. Once we shut down the interaction between entry costs and financial frictions, the maximum differences the model can generate are a factor of two and a half for output and a factor of two for TFP as shown in figure 1. This implies that the interaction between entry costs and financial frictions accounts for a large part of the quantitative effects and the size of such quantitative effects are comparable to the size of the quantitative effects in the case without the interaction. Hence when analyzing the effects of financial frictions and entry costs on output and TFP, it is important to model business entry explicitly and explore the interaction between them. We did not model the entrepreneur sector and assume that establishments have zero wealth before entry and have to finance the entire entry cost. If allowing part of the entry cost paid through entrepreneurs' savings, the quantitative effects will be smaller than that shown in figure 2 and larger than that shown in figure 1, and the size of the effects depends on financial friction and the part of the entry cost needed to be financed.

It is also worth noting that the shape of the curves in figure 1 does not change much with η. In fact, output and TFP change almost linearly with entry cost in log scale and the slope is about the same for different values of η. Such properties are preserved in the cases with interaction between entry costs and financial frictions, since the effective entry cost is a linear function of the actual entry cost for any given η.

Next we explore how the capital-output ratio changes in the model. Entry cost does not affect the capital accumulation, and therefore has no effects on the capital-output ratio. In contrast, financial friction does affect the capital accumulation and potentially can affect the capital-output ratio. In particular, the capital-output ratio falls by about 3% as we change η from the benchmark level to the level in poor countries. This also contributes to part of the reduction in output, but the effects are small.

In summary, entry costs and financial frictions in the model can generate large cross-country income and TFP differences and a large part of the differences are accounted by the interaction between entry costs and financial frictions. Hence such interaction can not be ignored when analyzing the cross-country income and TFP differences.

5.2 Discussion

5.2.1 Technology Parameters

This section discuss the robustness of the results to various choices of the parameters. We first explore the effects of varying the return to scale parameter, and then investigate the effects of changing the capital share. To do these experiments, we recalibrate the model to match the same targets as before. The calibrated parameters are listed in table 4.

We set the return to scale parameter to be 0.8 in the benchmark calibration. Research in the literature normally finds a value between 0.8 and 0.9. Figure 3 and 4 shows the results for the return to scale of 0.85 and 0.9 respectively. The top panels plots the results for the economy without borrowing constraint on business entry and the the lower panels plots the results for the economy with borrowing constraint on business entry. Although the model generates a smaller effects as the return to scale parameter increases, the quantitative effects is still sizeable. More importantly, a large part of the effects again comes from the interaction between entry cost and financial friction.

Figure 5 and 6 shows the results for capital share of 0.2 and 0.4 holding the return to scale parameter constant. The pictures show clearly that the interaction between entry cost and financial friction is quantitatively important for cross-country differences in income and TFP for reasonable values of capital share.

5.2.2 Evolution of Establishment Level Productivity

The model abstracts from the time-series variation in establishment level productivity and assumes that productivity is constant over time for a given establishment. If we allow the establishment level productivity evolves over time according to a first-order Markov process, the quantitative effects could be even larger since the uncertainty about future productivity distorts the decision of savings and therefore distorts the allocation of capital and labor further in the economy with financial friction. Moreover, if an establishment has to make the finance decision before the realization of its current period productivity, the allocation of capital and labor will be distorted even further. More importantly, the evolution of establishment level productivity does not change the mechanism through which financial frictions amplify the effects of entry costs. Hence the interaction will still be important.

6 Conclusion

This paper has analyzed how the interaction between entry costs and financial frictions affect the cross-country income and TFP differences. To perform such analysis, we developed a model with both entry costs and financial frictions. In the model, entry, production, and exit decisions are all endogenous. To pay for working capital, establishments can save or borrow from the financial market. To enter, new establishments have to pay an upfront entry cost which can also be borrowed from the financial market. The financial market is imperfect and each establishment can only borrow up to a fraction of its expected discounted life-time profits.

The model is calibrated to match the establishment level statistics in the U.S. economy assuming a perfect financial market for the U.S. The simulations show that the model can generate a factor ten of the differences in income per capita and a factor five of the differences in TFP across countries, and a large part of the differences are accounted by the interaction between entry cost and financial friction. The main mechanism is that financial frictions amplify the effects of entry costs by boosting the effective entry costs.

We assume that all new establishments pay the same entry cost, which might not be true in reality. As Buera et al. (2009) has shown, allowing entry costs vary across sectors can generate large quantitative effects on income and TFP. Similarly, the interaction between financial frictions and sectoral or industrial entry costs may also be worth studying. We leave this for future research.

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Table 1: Parameter Values

Parameter	r_b	β	α	γ	δ	λ	z_{max}	f_e	f	a	σ
Value	4%	0.96	0.267	0.533	0.0715	0.1	45.6	0.146	8	0.06	0.8

Table 2: Targets

Statistics	Data	Model
Entry cost (% of GDP)	0.73%	0.73%
Average establishment Size	15.65	15.89
% of establishments with		
1-4 employees	54.45%	55.98%
5-9 employees	18.92%	23.02%
10-19 employees	12.72%	11.08%
20-49 employees	8.63%	6.31%
50-99 employees	2.94%	1.97%
100-249 employees	1.67%	1.08%
250-499 employees	0.42%	0.33%
500-999 employees	0.16%	0.14%
1000+ employees	0.09%	0.09%

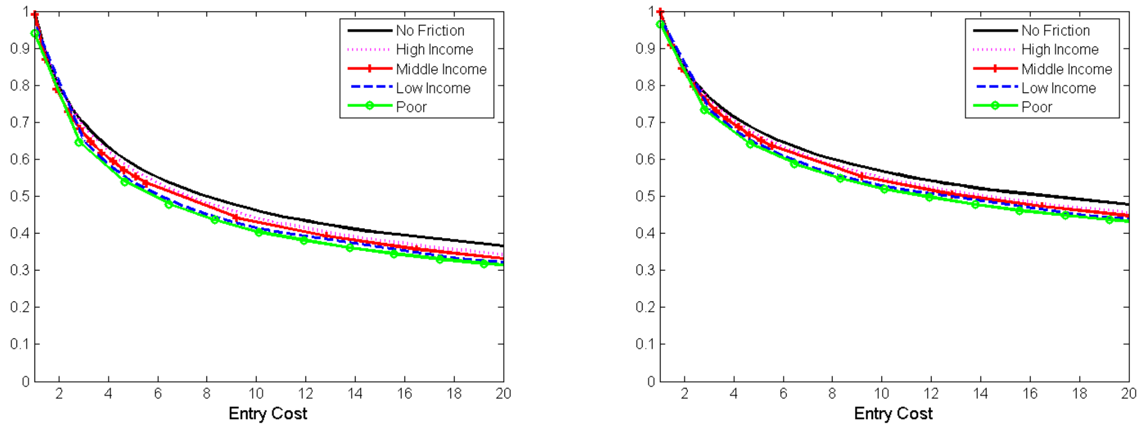
Table 3: Values for η

	High Income	Middle Income	Low Income	Poor
Value of η	0.49	0.18	0.091	0.052

Table 4: Parameter Values for Discussion

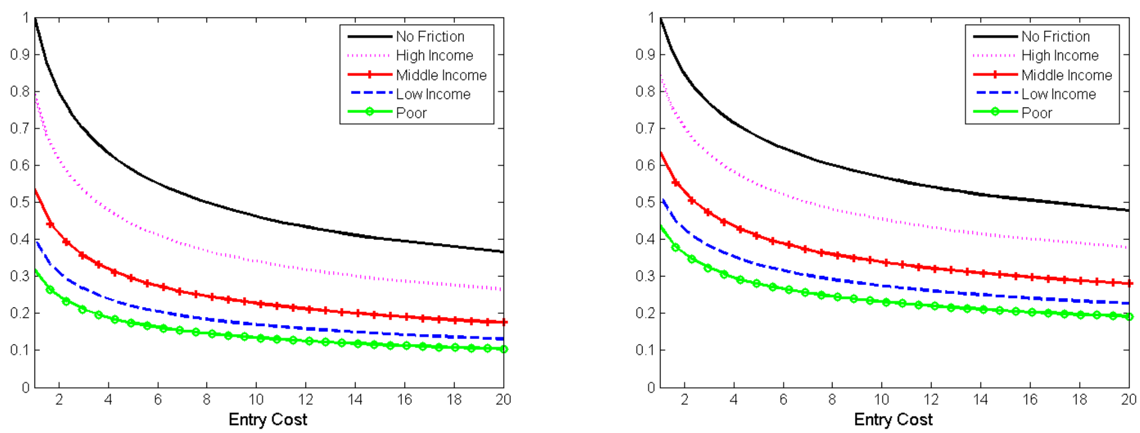
Parameter	α	γ	δ	z_{max}	f_e	f	a	σ
$\alpha + \gamma = 0.85$	0.283	0.567	0.0785	17.91	0.083	4	0.02	0.59
$\alpha + \gamma = 0.9$	0.3	0.6	0.0854	6.21	0.0379	1.04	-0.1	0.385
$\alpha = 0.2$	0.2	0.6	0.0436	45.67	0.106	6	0.06	0.801
$\alpha = 0.4$	0.4	0.4	0.1272	44.76	0.335	20	0.06	0.795

Figure 1: Without Interaction



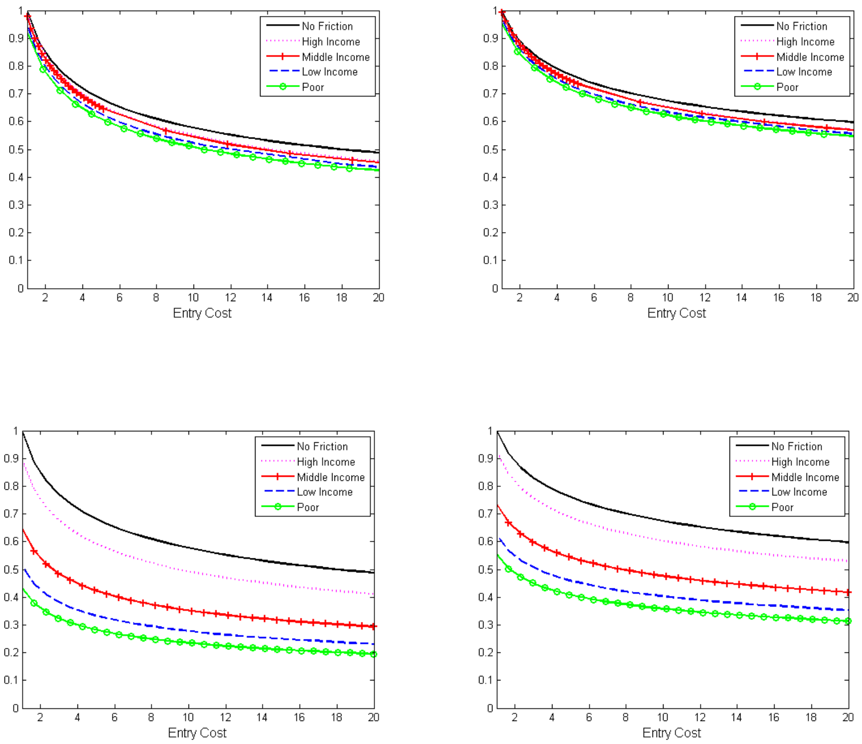
Output TFP

Figure 2: With Interaction



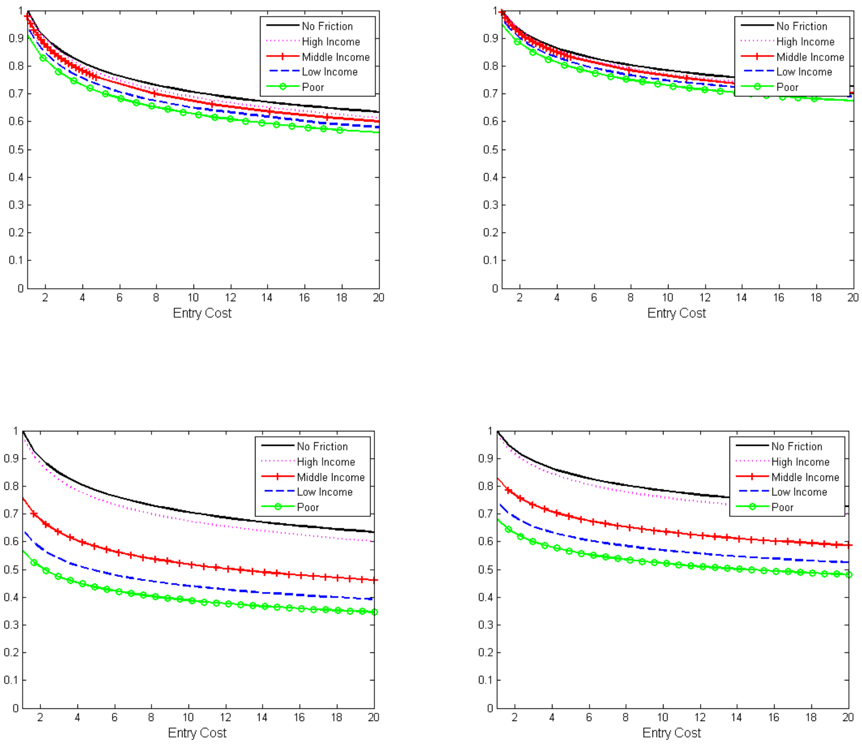
Output TFP

Figure 3: Return to Scale=0.85



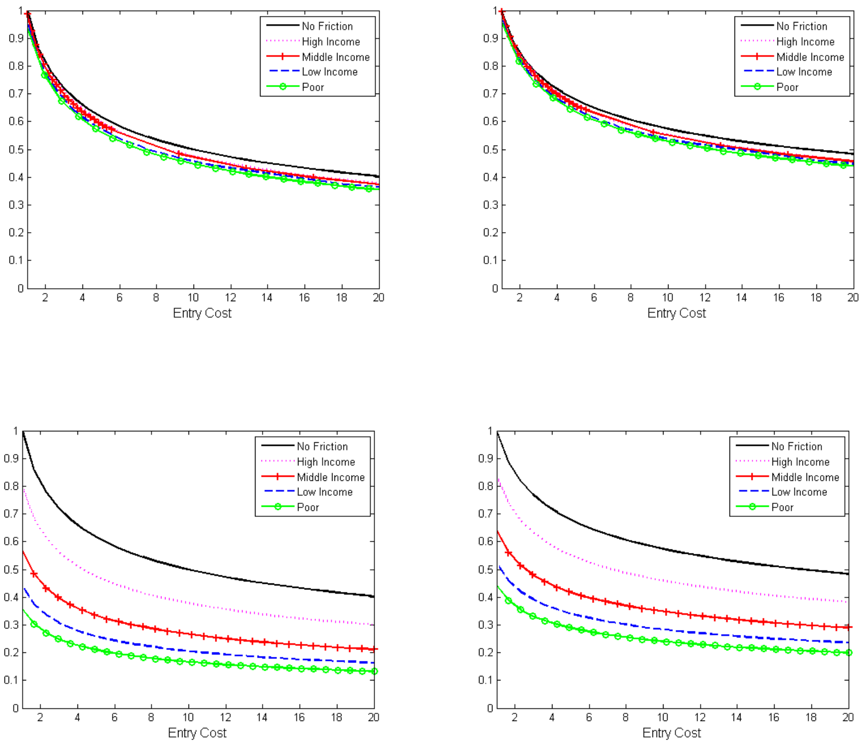
Output TFP

Figure 4: Return to Scale=0.9



Output TFP

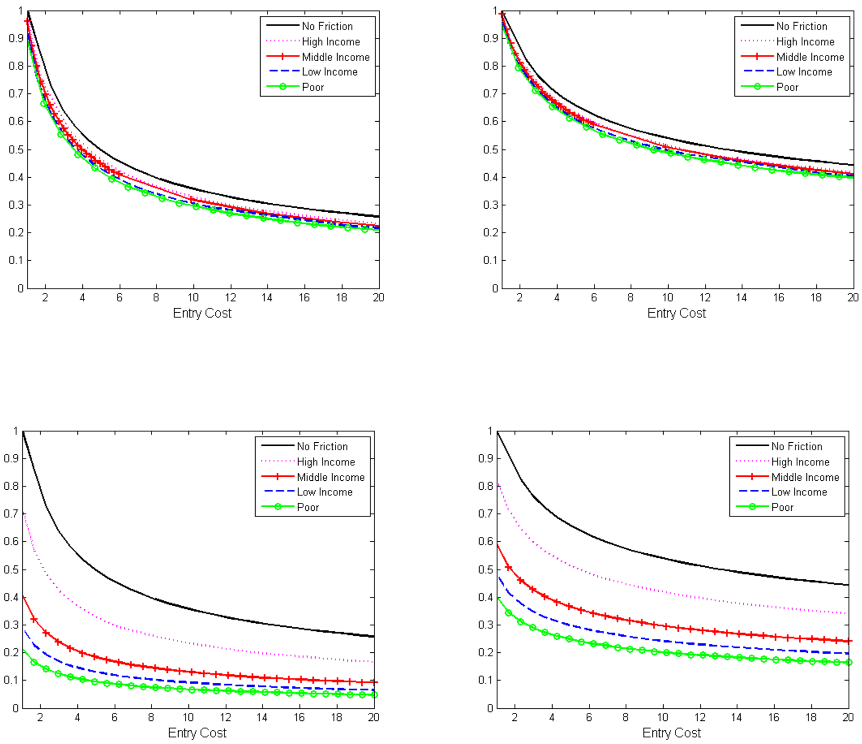
Figure 5: Capital Share=0.2



Output

TFP

Figure 6: Capital Share=0.4



Output

TFP

7 Appendix

Proof of Lemma 1.

(i): Since the per period profits and the choice sets for (k, h, s') are both increasing in z and s, standard dynamic programming argument can easily show that $v(z, s)$ is increasing in z and s.

(ii) Let $g(z, s) = v(z, s) - s(1 + r_b)$. $g(z, s)$ is then defined by:

$$
\begin{aligned}
g(z,s) \quad &= \quad \max_{k,h,s'} zk^\alpha h^\gamma - (1+r_b)(wh + r_k k) - f + (\beta(1+r_b) - 1)s' \\
&\qquad +\beta(1-\lambda)\max[g(z,s'),0] \\
s.t. \quad &\qquad wh + r_k k \leq \eta g(z,s) + (\eta(1+r_b)+1)s \\
&\qquad s' = 0, \text{if } zk^\alpha h^\gamma - (1+r_b)(wh + r_k k - s) - f \leq 0 \\
&\qquad 0 \leq s' \leq zk^\alpha h^\gamma - (1+r_b)(wh + r_k k - s) - f, \text{otherwise.}
\end{aligned}
\tag{7.1}
$$

Since the per period payoff $zk^\alpha h^\gamma - (1+r_b)(wh+r_k k) - f + (\beta(1+r_b)-1)s'$ and the choice sets for (k, h, s') are increasing in s, it is easy to show that $g(z, s)$ is increasing in s by applying the standard dynamic programming analysis to the above problem.