Entry Barriers, Financial Frictions, and Cross-Country Differences in Income and TFP*

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Abstract

This paper develops a model to assess the quantitative effects of barriers to entry and financial frictions on cross-country income and TFP differences. The main focus is on the interaction between barriers to entry and financial frictions. The model is calibrated to match the firm level statistics for the U.S. economy assuming a perfect financial market. The quantitative analysis shows that barriers to entry and financial frictions together can explain a factor nine of the differences in income per capita and a factor five of the differences in TFP across countries, and half of the differences are accounted by the interaction between barriers to entry and financial frictions. The main mechanism is that financial frictions amplify the effects of barriers to entry by boosting the effective entry costs.

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1 Introduction

Income per capita differs by a factor 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] At the same time, many poor countries have poor developed financial markets as well as large barriers to the opening of new businesses. Both of these two factors are 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 barriers to entry for cross-country differences in income per capital and TFP.

There are a number of studies that have investigated either the effects of financial friction or the effects of barriers to entry on economic development. However, to our knowledge, there is no work which studies the importance of the interaction between them for cross-country income and TFP differences. Intuitively, underdeveloped financial markets may amplify the effects of barriers to entry on economic development since entrepreneurs can not borrow to overcome the high barriers. In contrast, better developed financial market may have little effects on how barriers to entry affect economic development.

The goal of this paper is to develop a model to incorporate both financial frictions and barriers to entry, and then use the calibrated model to explore how the effects of barriers to entry on cross-country income and TFP differences change with financial market conditions. We discover that financial frictions amplify the effects of barriers to entry on economic development. Moreover, the interaction between financial frictions and barriers to entry is quantitatively important in explaining 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 barrier 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 firms 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. A firm can save or borrow from the financial market to fulfill the need for working capital. The financial market is imperfect and a firm can only borrow up to a fraction of its expected discounted life-time profits. The existing firms may exit if it is hit by a death shock or the value of production is smaller than the savings. In contrast, new firms 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 firms.

The model is calibrated to match the firm 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 cost 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 barriers to entry and financial frictions can explain a factor nine of the differences in income per capita and a factor five of the differences in TFP across countries. Moreover, half of the explanatory power comes from the interaction between barriers to entry and financial frictions.

The intuition for the results consists of three parts. First, higher entry costs lead to less entry and therefore a smaller number of productive firms. This reduces the competitive pressure in the economy. Hence firms with a lower productivity can survive and output and TFP decreases. Second, when there is financial friction, the existing firm can not borrow enough working capital and has to operate at a scale smaller than the efficient scale. In the model with endogenous entry and exits, this implies that firm distribution is distorted, so does the allocation of capital and labor. Third, financial friction amplifies the effects of barriers to entry 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 lowers the number of firms 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 effects becomes larger, so does the drop in output and TFP.

This paper is connected to the literature that studies the relationship between institutions 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, big dispersion in productivity, 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.

This paper is more closely related to three other papers in the literature that emphasize the importance of barriers to entry and financial frictions on cross-country income and TFP differences. Barseghyan and DiCecio (2009) quantifies the effects of barriers to entry on economic development. Amaral and Quintin (2009) and Buera et al. (2009) shows that financial friction 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 barriers to entry and financial frictions. The three papers mentioned can then be viewed as special cases in our analysis. The model allows us to investigate how the interaction between barriers to entry 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. Section 6 assesses the robustness of the results. Section 7 concludes.

2 The Economy

We consider a discrete-time model with heterogeneity in firm 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 a firm needs to pay for capital and labor ahead of production. To finance the working capital, the firm 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 setup 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 firms and owns all the firms in the economy.

2.2 Production

There are a continuum of existing firms 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 a firm's life. This assumption does not affect the analysis of the interaction between barriers to entry and financial market frictions, but saves a lot of computational time.[3] The firm's production technology is assumed to be decreasing return to scale, i.e., $\alpha + \gamma < 1$. To stay in operation, each firm 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. A firm can finance the working capital either through its savings s or through borrowing from the financial market. To save, a firm must have positive current period profits. If the savings can not cover the capital and labor costs, the firm 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 firm 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 firms 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, a firm can choose to exit if the continuation value is smaller than its savings. Moreover, each firm faces an exogenous probability of death λ every period. If a firm hits by the death shock, it keeps its savings and exits.

The timing of decisions within a period is as follows. At the beginning of a period, the death shock realizes. The survival firm then decides whether to stay or exit. If the firm decides to stay, it chooses how much labor to hire and how much capital to rent, and

[3]See section 6 for details.

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

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 firm repays the debt and decides how much to save.

There are 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.[5] To pay such costs, the entrant can borrow from the financial market at the rate r_b up to the fraction η of its expected life-time discounted profits. The debt is again within period and has to be repaid at the end of the period. Once the entry cost is paid, each firm receives a productivity draw z from the distribution $F(z)$. The productivity draws are i.i.d across entering firms and the distribution $F(z)$ is the same every period. The entering firm with productivity z is in the same position as an incumbent with the same productivity and $-f_e$ savings in the period of entry, 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 firms 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

[5]Since labor supply is inelastic, how the revenue from the entry fee is used and whether the entry cost involves real resource cost or not has no effects on output and productivity in the context of this model.

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 is the rental rate on capital, T is transfers, and Π is the profits generated by the production firms.

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

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

Firm

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

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

where $wh + r_k k - s$ is the working capital that the firm finances externally and s' denotes next period's value of savings. Note that a firm's current period profit 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 choices of inputs are constrained by the borrowing constraint (3.3). The maximization operator that nested on the right hand side reflects the firm's decision of staying or exiting at the beginning of the next period. (3.4) reflects the assumption that the firm'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 firms 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 firms can operate in 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) will bind, and therefore some, if not all productive firms 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 larger savings not only imply that the firm has more internal fund to finance working capital, but also imply that the firm has a higher discounted life-time profits, and therefore can borrow more from the financial market.

The following Lemma states some properties of the value function v. These properties provide information about the staying or exiting decision made by a firm.

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.

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 characterized by a cutoff rule for s at a given value of z.

In particular, the rule is to exit if s is smaller than the cutoff value and to stay otherwise. 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 become larger. Moreover, because v is increasing in z, there exists a cutoff value of z for the new entrants such that if the firm's productivity draw is larger than the cutoff, it will stay, and otherwise exit.

Entry

As in Hopenhayn and Rogerson (1993), since there are infinite amount of potential entrants each period, the expected value of an entering firm should not exceed the entry cost in the equilibrium. In this economy the entrant is in the same position as the existing firm 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 $-f_e(1+r_b)$.[6] Hence the free entry condition can be described as follows:

$$f_e - f_e + \int \max(v(z,-f_e), -f_e(1+r_b))dF(z) \leq 0, \tag{3.8}$$

where the first f_e is the amount borrowed from the financial market and the second f_e denotes the entry cost. Rearranging terms gives:

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

where the right hand side is the cost of entry and the left hand side is the value of entry.

If there is no borrowing constraint on business entry, the free entry condition (3.9) must

[6]if $f_e \geq \eta v(z,-f_e)$, the entrant can not finance any working capital and therefore can not produce in the period of entry.

hold in the steady state equilibrium. In fact, in such cases (3.9) must holds with equality. This is true because λ fraction of productive firms exits exogenously every period. Hence if a steady state equilibrium exists, there must be positive entry and exits. If (3.9) does not hold with equality, more firms will enter and produce. This drives down the value of entry until it is no longer profitable for firms to enter.

However when there is borrowing constraint on business entry, free entry condition may not hold in the steady state equilibrium. To see this, note that similar to an existing firm, a new firm can only borrow up to η fraction of its expected discounted life time profits. Hence if f_e is less than the borrowing limit for a potential entrant, no firm 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. Because if a steady state equilibrium exists, there must have a positive amount of entry. This implies that f_e must be less than or equal to the borrowing limit for a new firm in the steady state equilibrium. Since the left of (3.9) is the value of entry for a new firm, the borrowing constraint is simply as follows:[7]

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

Simple manipulation gives

$$\{f_e + \int \max(v(z, -f_e), -f_e(1 + r_b))dF(z)\} \geq \frac{f_e}{\eta}. \tag{3.11}$$

If $\eta \geq 1$, there is no contradiction between (3.9) and (3.11), and therefore free entry condition will hold with equality in the equilibrium. This implies that if the friction in

[7] Alternatively, the borrowing constraint for a new firm can be based on the net value of entry. In this case (3.11) 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 amplification factor is $\frac{1}{\eta} + 1$, which is larger than the amplification factor 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 barriers to entry will be even larger if the net value of entry is used to form the borrowing constraint.

the financial market is moderate, all the profitable new firms 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 does not hold in the equilibrium. In such cases the entrant's borrowing constraint (3.11) binds. This is true because when the free entry condition does not hold, it is profitable for more firms to enter. Moreover these firms 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 (3.11) 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 when $\eta < 1$, (3.11) implies that the value of entry must be the same as $\frac{f_e}{\eta}$ in the steady state equilibrium. In this case, we call $\frac{f_e}{\eta}$ the effective entry cost since the entrant makes entry decision according to $\frac{f_e}{\eta}$ instead of f_e. This implies that financial friction interacts with barriers to entry and amplifies the effects of barriers to entry on cross-country incomes and TFP differences by boosting the effective entry cost. Moreover, the severer the friction is, the larger the amplification is.

Aggregation

Let $\mu(z, s)$ denote the distribution of productive firms 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 firm level variables and aggregate variables can be expressed as follows:

$$K = \int k(z, s) d\mu, \tag{3.12}$$

$$1 = \int h(z, s) d\mu, \tag{3.13}$$

$$S = \int s'(z,s)d\mu, \tag{3.14}$$

$$Y = \int zk(z,s)^{\alpha}h(z,s)^{\gamma}d\mu. \tag{3.15}$$

With the definition for total savings and aggregate capital, labor, and output at hand, the total net interest payment and total profit can then be defined as follows:

$$\Omega = r_b(w + r_k K) + r_b M f_e - r_b S, \tag{3.16}$$

$$\Pi = Y - \int f d\mu - (w + r_k K)(1 + r_b) - M f_e(1 + r_b) + (1 + r_b)S - \int s'(z,s)d\mu, \tag{3.17}$$

where $(w+r_k K)(1+r_b)$ is the total cost of working capital and $Mf_e(1+r_b)$ is the total cost of entry. S is the current period savings, which include savings of productive firms, exiting firms, and dead firms. The government balances budgets each period:

$$T = M f_e. \tag{3.18}$$

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

$$c + K' - (1-\delta)K = Y - \int f d\mu - \Omega. \tag{3.19}$$

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 firms $\mu(z,s)$, 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 (3.12) to (3.19) hold.

(iii) If $\eta \geq 1$, (3.9) holds with equality and if $\eta < 1$, (3.11) 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 with no distortion in the financial market. 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 annual job destruction rate of 15.1% for the U.S. reported by Davis et al. (2008). We follow the literature and set the return to scale in the firm 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 productivity draw of a new firm. In the economy without financial friction the firm level employment is uniquely determined by z for any given prices. Hence z_{max} can be pin down by the maximum firm 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 firm size, the share of total labor employed by firms at different sizes, and the share of total number of firms at different size in the U.S. economy. The Doing Business data set of the

[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 6 reports the results for the return to scale of 0.85 and 0.9.

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. is 0.73%. This number is used to pin down the entry cost f_e. The firm level statistics for the U.S. are borrowed from Helfand et al. (2007) which summarizes the firm distributional statistics by size using the firm level data from the Business Employment Dynamics program of the U.S. Bureau of Labor statistics. Helfand et al. (2007) reports the distribution of firms and employment by size from 1990 to 2005. In the calibration, we take the average over these 16 years as the target. Specifically, the targets include 19 moments: the average firm size, nine statistics related to the distribution of firms by size, and nine statistics related to the distribution of employment 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. In particular, the calibrated model replicates one of the most important feature of the data: small firms constitute a large share of total number of firms, but they only account for a small fraction of total employment, whereas large firms constitute a small fraction of total number of firms, but they account for a large share of total employment.

5 Quantitative Analysis

5.1 Methodology

This section uses the calibrated model to assess the effects of barriers to entry, borrowing constraints, 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. In these comparison, we increase the entry cost from the benchmark value to 15 times. This is the range in which most of the data falls.

When assessing the effects of financial friction on cross-country income and TFP differences, 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. This statistic includes all private sector credits such as business credits and consumer credits. Since consumer credits are not modeled, we assume that the ease of acquiring credits is similar for the consumer sector and the business sector in a country. Hence, the ratio of a country's business credit to the U.S. is the same as the ratio of this country's total private credit to the U.S. This implies that the relative value of the domestic credits to the U.S. can be used to calibrate η. Moreover, we use the average of such relative value from 2000 to 2008 as targets to get rid of the idiosyncratic component of the data. 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. For future references, note that the equilibrium external fiance to GDP ratio is increasing in η.

Before presenting the results, it is worth noting that the change in entry cost almost has no effects on the debt to GDP ratio. To see this, note that the total debt consists of two parts in this economy: the debt used to finance production and the debt used to finance entry. Moreover, the debt used to finance entry is a small fraction of the total debt and have little effects on the debt to GDP ratio. When there is no financial friction, there is no need to save and all firms can borrow enough working capital to operate at their efficient scale. The economy-wide competitive factor markets then imply that the payment to working capital is a constant fraction of the total output. This constant fraction is determined by the return to scale parameter and does not vary with the entry cost. If there exists financial friction, the production scale will be determined by how much working capital a firm can acquire, which is determined by a firm' ability of acquiring external finance, governing by the parameter η. When the entry cost varies, such ability does not change. Hence the entry cost has little effects on the debt to GDP ratio.

5.2 Results

Normalizing the output of the benchmark economy to be 1, figure 2 plots the steady state output and TFP against the entry cost for different values of η. Since the entry cost has little effects on the debt to GDP ratio, each curve shows how the output or TFP varies across countries with different levels of entry costs but with similar levels of financial frictions. For comparison purpose, figure 1 plots the same results for the economy with borrowing constraints only imposed on the finance of working capital and not on the finance of entry costs. This implies that free entry condition (3.9) holds with equality regardless of the value for η. In the simulation, we vary f_e in the same range and fix η for the curves in the two figures respectively. Figure 1 can then be viewed as the case in which there is no interaction between barriers to entry and financial frictions.

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 cost in a 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 profits of entry through a lower wage rate. This implies a larger v for any combination of (z, s), and therefore firms with a smaller productivity can survive and the cutoff value of z decreases. Moreover, a larger entry cost also reduces the mass of production firms. Hence output and TFP decreases. As figure 1 indicates, varying entry cost from the U.S. level to 15 times can generate 2.6 times of the differences in output and 2.2 times of the differences in TFP. The magnitude is similar to what Barseghyan and DiCecio (2009) has found.

Figure 1 can also be related to Amaral and Quintin (2009) and Buera et al. (2009). In fact, they can be viewed as a special case in the current setting, which is to fix the entry cost at the benchmark level and vary the debt to GDP ratio, representing by the vertical axis in figure 1. As in these works, tighter borrowing constraints decrease output and TFP. Since tighter borrowing constraints reduce firms' 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. This exaggerates the quantitative effects of financial frictions. Buera et al. (2009) generates a larger effect through an industry model with misallocation of capital and talent. In contrast, we only model the misallocation of capital and show that the misallocation of capital alone can not generate a large quantitative effect. This abstraction simplifies the analysis and does not undermine our results since our main focus is on how the interaction between barriers to entry and financial market frictions 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 one in figure 2. Hence the free entry condition (3.9) can not be satisfied, and instead (3.11) holds with equality. In this case, 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 entry cost and debt to GDP ratio but without borrowing constraints on business entry. This implies that financial friction interacts with entry costs and amplifies the effects of entry costs on output and TFP. Furthermore, as the financial market condition deteriorates, such amplification effects becomes larger, since a decrease in η leads to an increase in the effective entry cost. Hence financial friction affects output and TFP not only through reducing firms' production scale, but also through reducing the mass of production firms directly by augmenting the effective entry cost.

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 the number of production firms falls. Moreover, less entry decreases the competitive pressure on the existing firms. Thus, firms with lower productivity and savings can survive. As a result, output and TFP fall. As the financial market condition deteriorates, it becomes even harder for new businesses to open, and therefore the distortions become larger and output and TFP decrease more.

Next we turn to the quantitative magnitude of these effects. The maximum differences on output the model can generate is nine times. As in the data, most of the differences are accounted by the differences in TFP. In particular, the model can generate five times of differences in TFP. It is easy to see from figure 1 and figure 2, a large part of these quantitative effects are accounted by the interaction between financial frictions and entry costs. Hence when analyzing the effects of financial friction on output and TFP, it is important to model business entry explicitly and explore the effects of financial friction on business entry.

To isolate the effects of the interaction between barriers to entry and financial frictions, table 4 and 5 decompose the quantitative effects on output and TFP in figure 1 and figure 2 respectively. The largest cost and worst friction represent the largest value for entry cost and the worst level for financial friction. From the two tables, when there is no borrowing constraints on business entry and therefore no interaction between barriers to entry and financial frictions, the largest differences in output and TFP the model can generate are 3 times and 2.2 times. In contrast, when there is interaction, the largest differences are 9 times and 5 times. This implies that the interaction between barriers to entry and financial frictions accounts for about half of the quantitative effects.

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 6% as we change the debt to GDP ratio from the benchmark level to the level in poor countries. This contributes to part of the reduction in output.

It is also worth noting that output and TFP change almost linearly with entry cost in log scale and the slope is about the same for any debt to GDP ratio. It follows that the elasticity between entry cost and output and TFP is constant. Hence countries with higher entry barriers have to decrease their barriers more to achieve the same percentage increase in output and TFP as in countries with lower barriers. Moreover, the shape of the curves in figure 2 and 1 does not change with the debt to GDP ratio. This implies that changes in financial market condition does not change the elasticity between entry cost and output and TFP.

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

6 Discussion

6.1 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 capital share. To do these experiments, we recalibrate the model to match the same targets as before. The calibrated parameters are listed in table 3.

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. 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 barriers to entry and financial frictions.

Figure 5 and 6 shows the results for capital share of 0.2 and 0.4 holding the return to scale parameter constant. It is easy to see that capital share has little effects on TFP both qualitatively and quantitatively. The intuition behind this is simple. In the current setting, firms borrow to finance the payment to both capital and labor. Hence the importance of capital in production does not change the effects of finance on TFP, and therefore has little effects on output.

6.2 Evolution of Firm Level Productivity

The model abstracts from the time-series variation in firm level productivity and assumes that productivity is constant over time for a given firm. If we allow the firm 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. Moreover, if a firm has to make the finance decision before the realization of its current period productivity, the allocation of capital and labor will be further distorted.

7 Conclusion

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

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

Although the model is used to study the effects of barriers to entry and financial frictions, it can be easily extended to study the effects of minimum capital requirement on income and TFP differences across countries. In this case, new firms need to have some amount of capital in hand before entry occurs, which they can borrow from the financial market. Higher capital requirement works similarly in the model as higher entry costs and therefore reduces the number of production firms. Hence output and TFP fall. Financial frictions again amplify such effects.

We assume that all new firms 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 entry costs may also generate a larger effects than what we have found. 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	0.151	91.48	0.375	18	0.4	0.96

Table 2: Targets

Statistics	Data	Model
Entry cost (% of GDP)	0.73%	0.72%
Job Destruction Rate	0.151	0.151
Average Firm Size	21.6	21.9
% of firms with		
1-4 employees	53.54%	57.09%
5-9 employees	20.91%	19.30%
10-19 employees	12.53%	10.89%
20-49 employees	8%	7.78%
50-99 employees	2.65%	2.4%
100-249 employees	1.51%	1.30%
250-499 employees	0.46%	0.64%
500-999 employees	0.2%	0.33%
1000+ employees	0.2%	0.28%
% of employment at firms with		
1-4 employees	5.27%	6.84%
5-9 employees	6.36%	5.53%
10-19 employees	7.79%	6.40%
20-49 employees	11.16%	10.99%
50-99 employees	8.41%	8.41%
100-249 employees	10.53%	9.49%
250-499 employees	7.19%	9.52%
500-999 employees	6.78%	9.78%
1000+ employees	36.51%	33.04%

Table 3: Parameter Values for Discussion

Parameter	α	γ	δ	z_{max}	f_e	f	a	σ
$\alpha+\gamma=0.85$	0.283	0.567	0.0783	109.8	1.015	28	1.5	0.716
$\alpha+\gamma=0.9$	0.3	0.6	0.0854	44.9126	0.64	14	1.65	0.465
$\alpha=0.2$	0.2	0.65	0.0436	108.9575	0.56	21	1.5	0.716
$\alpha=0.4$	0.4	0.45	0.1272	120.3612	3.75	108	1.6	0.715

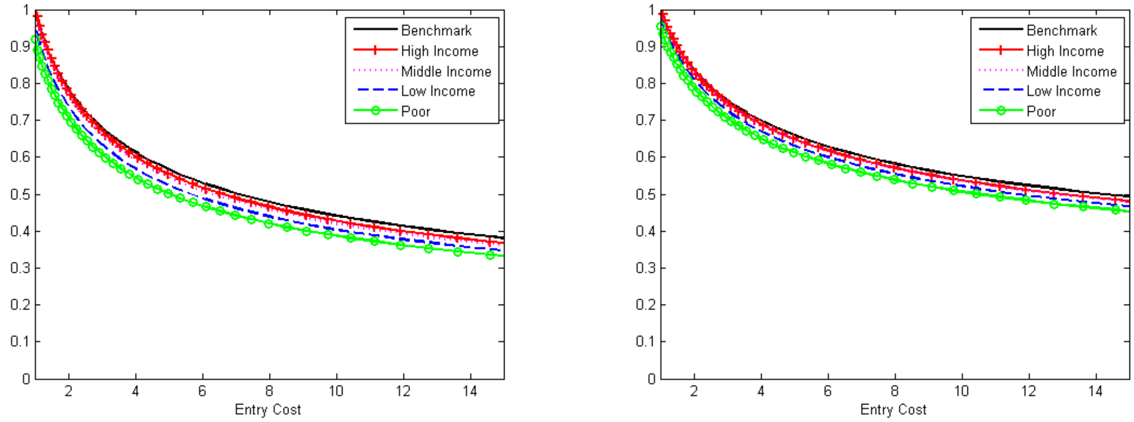
Table 4: Decomposition of the Reduction in Output

	Largest Cost No Friction	Benchmark Cost Worst Friction	Largest Cost Worst Friction
Without Interaction	0.38	0.92	0.34
With Interaction	0.38	0.3	0.11

Table 5: Decomposition of the Reduction in TFP

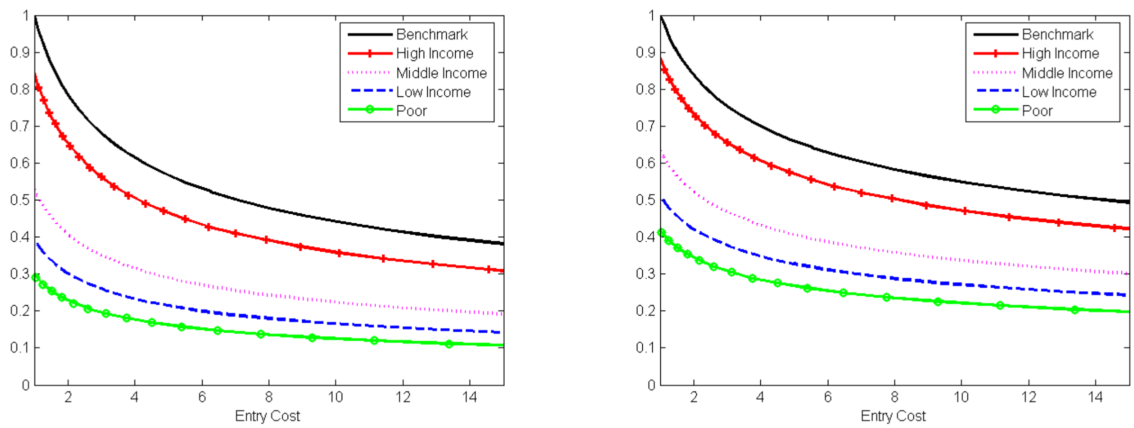
	Largest Cost No Friction	Benchmark Cost Worst Friction	Largest Cost Worst Friction
Without Interaction	0.49	0.95	0.46
With Interaction	0.49	0.42	0.2

Figure 1: Without Interaction



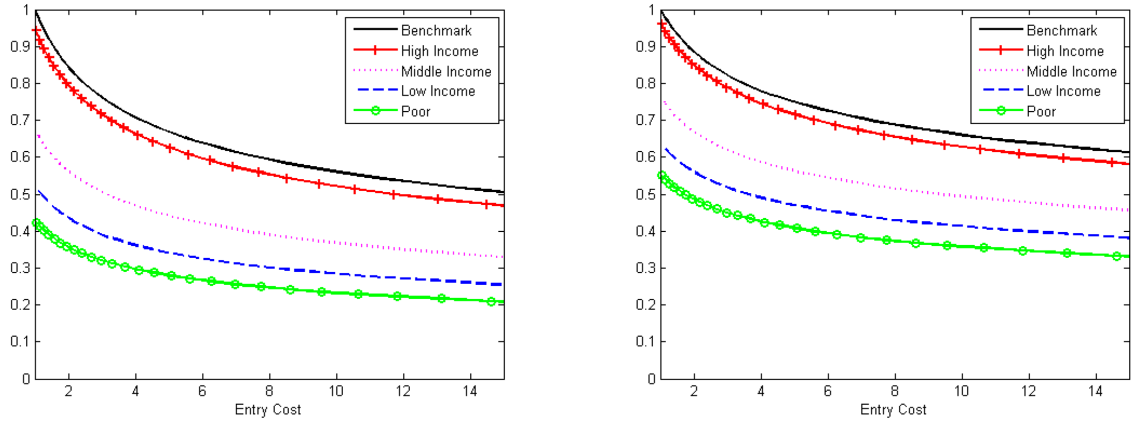
Output TFP

Figure 2: With Interaction



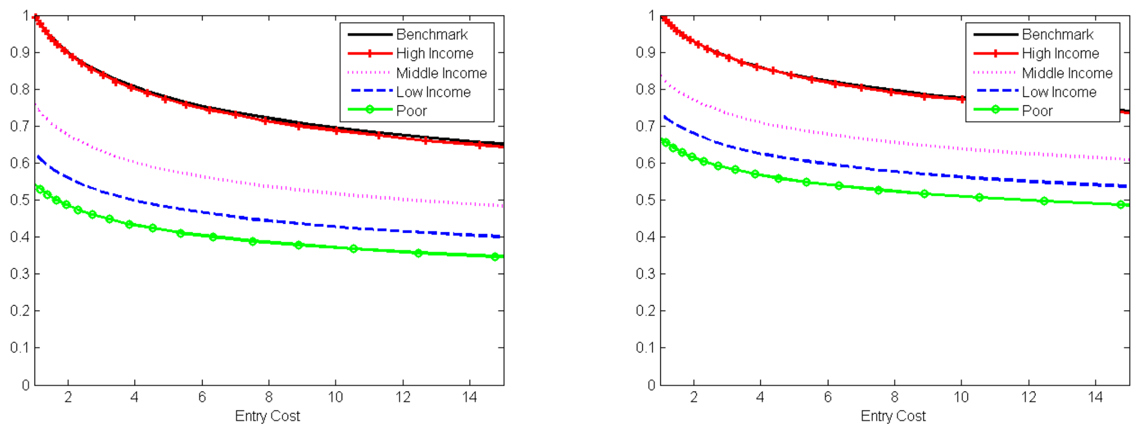
Output TFP

Figure 3: Return to Scale=0.85



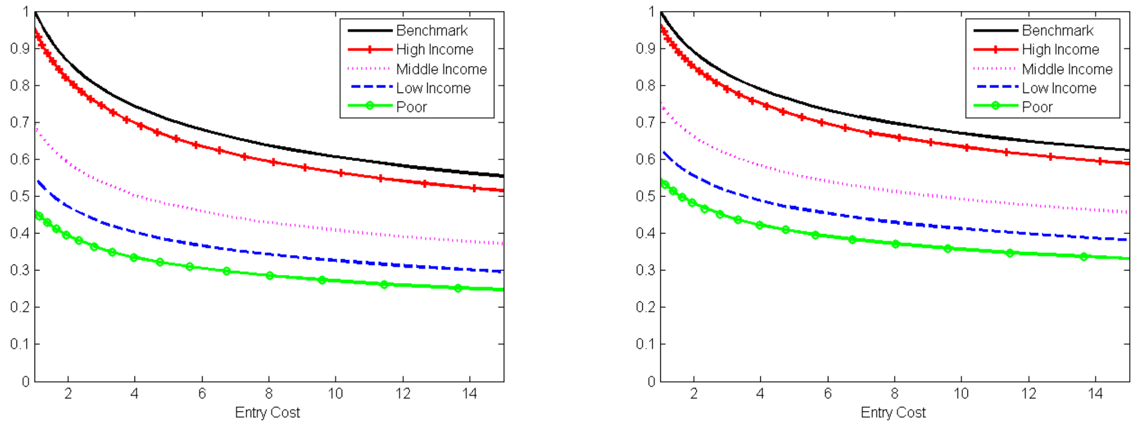
Output TFP

Figure 4: Return to Scale=0.9



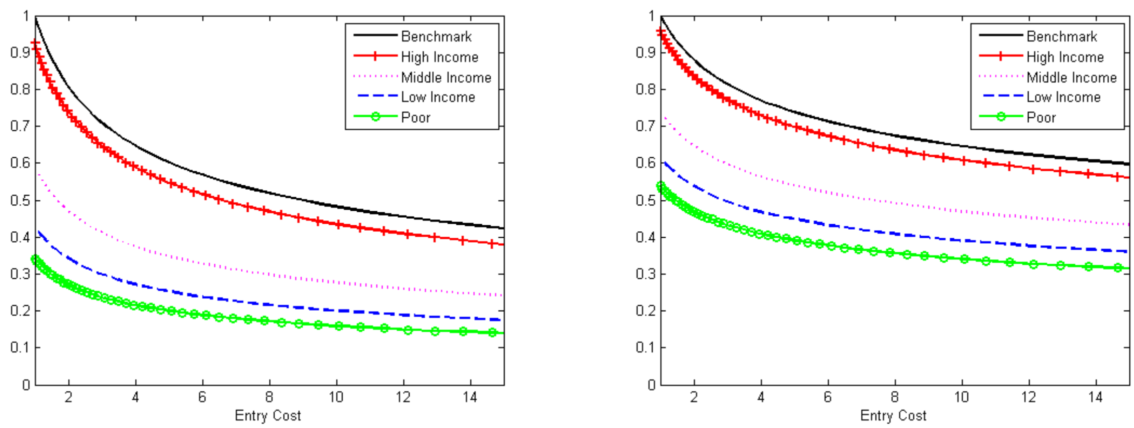
Output TFP

Figure 5: Capital Share=0.2



Output TFP

Figure 6: Capital Share=0.4



Output TFP

8 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:

$$\begin{aligned} g(z,s) \quad &= \quad \max_{k,h,s'} zk^{\alpha}h^{\gamma} - (1+r_b)(wh + r_k k) - f + (\beta(1+r_b) - 1)s' \\ & \qquad +\beta(1-\lambda)\max[g(z,s'), 0] \\ s.t. \quad & \qquad wh + r_k k \leq \eta g(z,s) + (\eta(1+r_b)+1)s \\ & \qquad s' = 0, \text{if } zk^{\alpha}h^{\gamma} - (1+r_b)(wh + r_k k - s) - f \leq 0 \\ & \qquad 0 \leq s' \leq zk^{\alpha}h^{\gamma} - (1+r_b)(wh + r_k k - s) - f, \text{otherwise.} \end{aligned} \tag{8.1}$$

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.