Financial Intermediation, Costly Information Production, and Small Industry Growth*

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Abstract

This paper studies the mechanism of financial intermediaries' information production and its impact on industry-level growth, especially its difference between industries that differ in the technological composition of small firms. We build a growth model in which (i) both loan contracts and production of information on borrowing firms' productivities are endogenously determined, and (ii) the smaller firm's productivity is more costly to assess. Analytic results show that the smaller firm's innately greater degree of informational opaqueness hinders its growth, especially in the early stage of a country's financial development. We provide some evidence supporting the key mechanism.

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Keywords: Economics Growth, Financial intermediation, Capital Allocation, Firm Size, Financial development.

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1 Introduction

Financial systems can greatly affect the allocative efficiency and hence economic development (King and Levine; 1993; Buera et al.; 2011). However, less is known about the mechanism of financial intermediaries' information production and its implications for the cross-section of capital allocation and economic growth (Greenwood and Jovanovic; 1990; Giannetti and Yu; 2014). This paper examines the mechanism of the effect of the financial intermediaries' improved efficiency on firm-level growth via increased information production, especially its disproportionate growth impact on the industry that has a greater share of small firms (*small industry*), and provides some evidence (Beck, Demirguc-kunt, Laeven and Levine; 2008; Beck, Demirguc-kunt and Maksimovic; 2008).

The key contribution of this paper to the literature is that we develop and integrate the theory of financial intermediaries' information production more tightly with extant empirical findings about financial development and firm growth as well as with new facts documented in this paper. Our model is featured that both information production in the financial sector and production of goods and services in the real sector are fully flexible, which enables us to clarify the conditions under which the model's predictions about the relative firm growth between the small and large industries are consistent with extant and new empirical findings.

We are motivated by the fact that the financial-intermediation cost is negatively correlated with the borrowing firm's size—more costly to assess creditworthiness of a small firm than that of a large firm—(Petersen and Rajan; 2002). This indicates that technological determinants of the firm size (e.g., productivity) are highly correlated with the firm's informational opaqueness.[1] We study how such a heterogeneity component of the cost of financial

[1]As discussed in Beck, Demirguc-kunt, Laeven and Levine (2008), we need to identify technologically small industry, i.e., the industry of which average firm size is small due to technological factors. The reason is that in reality, many non-technological factors (i.e., all sorts of frictions relevant to the capital market)

intermediation affects the sensitivity of a small industry's growth to financial development.

Consider the case in which the financial intermediary's marginal cost curve of information production is steeper for the smaller firm. In this case, the greater the industry's technological composition of small firms, the smaller the sensitivity of firm growth in this industry to the financial intermediaries' improved efficiency (e.g., adoption of new information technologies). The reason is that given the uniform downward shift of the financial intermediary's cost curve of information production, the increase in information production is determined, up to a first-order approximation, by the inverse of the slope of the cost curve, which differs across industries. We provide the theoretical mechanism with some empirical evidence.

We develop a parsimonious growth model in which both the real sector's production of goods/services and the financial sector's information production are fully flexible (e.g., continuous and concave in inputs) and endogenously determined. We consider a small open economy in which (domestic) firms transform capital into the single final good by using the decreasing-returns-to-scale technology. The firm-level (realized) productivity is stochastic (i.i.d. over time) and, importantly, a private information known to the firm itself but not to others (Arellano et al.; 2012). Firms belong to one of two industries— "Small" vs. "Large"— that differ in the (publicly known) distribution of firms' productivities, which would determine the *technological* firm-size distribution if there were no distortions. For simplicity, we use the industry's productivity distribution as a proxy of all fundamental factors that determine the industry's "technological" composition of small firms.[2]

In the model, firms finance investment via one-period loan contracts in every period.[3]

are likely to affect the industrys average firm size. Thus, it is challenging to identify the industrys average firm size that is solely determined by the technological factors.

[2]Productivity is one, even though not all, of determinants of the industry's technological firm-size distribution. For analytical tractability, we consider this one factor model. Otherwise, the model would become too complicated to answer the main research question addressed in this paper.

[3]Long-term loan contracts are ruled out for the purpose of tractability. Our goal is to build a simple

There is a representative financier that is the most efficient in production of information on productivities of domestic borrowing firms. As such, we assume that the financier engages in, prior to designing loan contracts, costly production of information on borrowing firms' productivities and providing the intermediation service on behalf of (international) lenders.[4] In doing so, the financier reduces the conflict of interests between borrowers and lenders.

In our model, the financier can raise any amount of capital at the risk-free rate in the international capital market, due to the assumed commitment to repayment. That is, sovereign default is not a key friction studied in this paper. The main source of distortions is the informational friction (i.e., borrowers' private information) but not the country-level "capital endowment" constraint (Giannetti and Yu; 2014). The financier assesses the borrowing firm's productivity, which is, in reality, likely strongly related to the firm's creditworthiness, and then optimally designs loan contracts by taking into consideration the borrowing firm's expected productivity, incentive compatibility and participation constraints. Importantly, the smaller firm's productivity is more difficult for the financier to assess.[5] Using the truth-revealling mechanism, we solve for equilibrium: the level of information production, and the terms of loan contracts. Prior to information production, the financier is lack of information on the borrower's productivity. Thus, the level of information production is the same for all firms belonging to a given industry, i.e., within-industry pooling, but differs across industries. By information production, the lender is enable to separate the different types of firms by offering larger capital to higher types and making them pay for the privilege (by increasing their debt repayment). [6] The financier's information production is in equilibrium deter-

model so that we can confront the model's predictions about firm-level capital growth with data.

[4]Ultimately, lenders can be either international or domestic. For the purpose of simplicity, we consider the case of the international lender, because both are identical in the model.

[5]For a given borrowing firm, the information-production cost is stochastic and not observed by the financier so that it can not signal the borrowing firm's productivity prior to designing the loan contracts.

[6]For a given industry, loan and capital allocation is in equilibrium monotonic to the borrowing firms'

mined by the trade-off between the industry-level expected benefit and cost of information production, which then determines the variation in capital growth across industries.

Consider the two industries that differ in the *technological* composition of small firms, labelled *small and large industry*, respectively: the large industry's productivity distribution first-order stochastically dominates the small industry's. On the one hand, the small industry is prone to the asymmetric information problem to the greater extent and hence has the advantage in terms of the greater marginal benefit of information production—the greater growth potential that would have been realized if the current financial constraint had been relaxed. On the other hand, the small industry also has the disadvantage: the financier's greater marginal cost—more costly to assess the smaller firm's productivity—i.e., the steeper marginal-cost curve. These two opposing forces determine the relative level of information production, and hence capital growth, between the small and large industries.

Main analytic results are as follows: Consider two countries that differ in the financier's efficiency of assessing borrowers' productivities, where the financier's efficiency is the model-side measure of a country's financial development. Under the condition that ensures both the absolute level difference and the relative ratio difference between marginal costs and marginal benefits between the two industries, the model predicts that in the more financially developed country, the disproportionate impact of growth in the financier's information-production efficiency on the small industry's capital growth is of magnitude greater than in the less financially developed country. In doing so, we present sufficient conditions which generate the equilibrium outcome which can be replicated by empirical findings.

The economic mechanism is as follows: Consider the financier's marginal cost curve of information production, especially its difference between the small and large industries. In

productivities although the level of information production is the same across these firms.

a financially advanced country, such a cost difference between these two industries is negligible. By contrast, in a financially underdeveloped country, it is substantial: the financier's marginal cost curve is substantially steeper for the small industry than for the large industry. Note that the marginal increase in information production equals, up to a first-order approximation, the *inverse* of the cost-curve slope: the steeper the marginal cost curve, the smaller the increase in information production. This implies that in a financially underdeveloped country, the disproportionate effect of the financier's improved efficiency on the small industry's capital growth is of magnitude smaller than in a financially advanced country.

We empirically examine main results of the model. First, we provide evidence supporting a hypothesis that (i) the cost of financial intermediation is disproportionately greater for the small industry than for the large industry and (ii) the spread in such a cost for the small industry (relative to that for the large industry) is decreasing in the degree of a country's financial market development. We use a sample of 8,366 syndicated loans during the period from January 1, 1987 to December 31, 2014, provided by Reuter/Loan Pricing Corporation's DealScan database. This database provides detailed information on loan tranche-level characteristics (including its size, spread, upfront fee, maturity, signing date, etc.) and has been employed in many empirical syndicated loan studies.[7] The cost of financial intermediation is measured as the cost for lenders to certify a borrower's creditworthiness, for which we consider many different proxies such as commitment fee, letter of credit fee, annual fee, and loan spread. As in Beck, Demirguc-kunt, Laeven and Levine (2008), we consider the industry's technological composition of small firms that is not constrained by the financial obstacles and measured as the corresponding U.S. industry's small firm share in employment.[8] The

[7]Syndicated loans are especially promising as an empirical laboratory for studying information asymmetry: Sufi (2007), Hainz and Kleimeier (2012) and Gatti et al. (2013).

[8]Plehn-Dujowich (2009) also takes the share in employment of small firms empirically as agents' hidden types.

results indicate that the cost spread of financial intermediaries between the small and large industries is decreasing in the level of a country's financial market development.

Second, we test the main results of the model that the effect of improvements in the financial intermediary's capability of information production disproportionately benefits the the small industry's firm growth, especially to magnitude greater in the more financial developed country. To measure the industry-level firm growth, we use the *United Nations Industrial Statistics* database, which provides industry-level aggregated information on performance of all firms. Our sample covers firms in the 20 NACE two-digit manufacturing industries and in 28 countries over the world, during the period 2004-2012 annually. We take the annual growth rate of a given country's credit bureau index during the sample period, as for the proxy of growth in the capability of information production of the given country's financial intermediaries.[9] The credit bureau index measures, for a given country, the percentage of individuals and companies of which past repayment history is provided, labelled *credit bureau coverage rate*. Borrowers' repayment history is likely to provide valuable information on the likelihood of the *comparable* borrower's future repayment, and hence to reduce the overall cost of production of information on borrowers' creditworthiness (Djankov et al.; 2007; Arellano et al.; 2012). Here, we assume that the borrowing firm's creditworthiness (the data counterpart) is closely related to the firm's profitability/productivity (the model counterpart). To avoid the endogeneity problem of explanatory variables, we use a system GMM estimator. Our regression results show that growth in the provision of information on borrowers' creditworthiness is associated with disproportionate firm growth in the small industry, especially to the greater extent in a more financially developed country.

[9]The sample period is restricted since Credit bureau index from the World Bank is available since 2004. To overcome it, we employ a system GMM estimator. For example, Arellano and Bond (1991) and Blundell and Bond (1998) tested for the sample period is 1979-1984.

Taken together, our empirical findings suggest evidence supporting the model's results that the smaller firm's innately greater degree of informational opaqueness hinders its growth, especially in the early stage of a country's financial development.

This paper contributes to the literature that studies financial intermediaries' information production (Leland and Pyle; 1977; Campbell and Kracaw; 1980; Boyd and Prescott; 1986; Chemmanur and Fulghieri; 1994; Fulghieri and Lukin; 2001; Stein; 2002; Araujo and Minetti; 2007; Giannetti and Yu; 2014) and, more broadly, the evolution of both technological and financial innovations (Greenwood et al.; 2010; Laeven et al.; 2015). While these aforementioned papers focus mainly on the demand-side determinants of financial intermediation, we emphasise the trade-off between the demand- and supply-side determinants.[10]

This paper is also related to the literature that studies financial development and economic development. Many papers have studied *consequences* of improved financial intermediation by leaving the mechanism of financial intermediation itself as a black box (Buera et al.; 2011), while this paper focuses on studying the mechanism of financial intermediation.

The empirical analysis of this paper is closely related to Beck et al. (2005), Beck, Demirguc-kunt and Maksimovic (2008), Beck, Demirguc-kunt, Laeven and Levine (2008) and Beck et al. (2012); these papers document the effect of the *cross-country difference* in financial development on relative firm growth between small- and large-sized firms/industries, which this paper complements both empirically and theoretically. In particular, we identify the effect of *within-country growth* in the financial intermediaries' efficiency on relative firm growth between small- and large-sized industries. King and Levine (1993), Levine et al. (2000) and Aghion et al. (2005) document that aggregate measures of development in

[10]One exception is Giannetti and Yu (2014) who study how the cost of financial intermediaries' information production determines the formal vs. relationship-based financing depending on the country's development stages in terms of the size of financial intermediaries' capital endowment.

credit/financial markets are significantly associated with per-capita GDP across countries, which this paper examines by using more disaggregated industry-level data.[11]

The rest of the paper is organized as follows: Section 2 develops the model, and Section 3 discusses its analytic results. Section 4 discusses empirical evidence. Section 5 concludes.

2 Model

This section develops a growth model in which (i) both information production in the financial sector and production of goods in the real sector are fully flexible, and (ii) a financial intermediary's production of information on a borrowing firm's profitability (which is likely, in reality, to be highly related to the borrowing firm's creditworthiness) is a key to determining firm-level capital growth and the allocative efficiency of capital. More specifically, the model is a small open economy with access to the international capital market and has features as follows: domestic firms need to raise external funds and have private information on their own productivities, where such private information is a key source of distortions in the capital allocation in this economy. A representative financier, which can commit its repayment and hence is able to borrow any amount of capital at a low cost (i.e., at the risk-free rate) in the international capital market, intermediates the international lenders and domestic borrowers/firms. The financier produces information on a borrowing firm's productivity, which mitigates the allocative inefficiency but is costly. Importantly, production of information on productivity of a small firm is more costly than that of a large firm is. The trade-off between benefit and cost of the financier's information production determines the degree of distortions in the capital allocation, especially relative firm growth between

[11] For discussion of the feedback effect between financial and economic development, see, e.g., Greenwood and Jovanovic (1990) and Fuente and Marin (1996).

the two industries that differ in their technological composition of small firms.

2.1 Environment

We consider a small open economy with access to the international capital market in which a risk-free asset of the (real) return $r_f \geq 0$ is traded.

Technology There is a continuum of (domestic) firms indexed by i. Firm i can operate the decreasing-return-to-scale technology producing the single final good $y_t(i)$. The production function of firm i is written as:

$$y_t(i) = [z_t(i)]^{1-\alpha}[k_t(i)]^{\alpha}, \quad \alpha \in (0,1) \tag{1}$$

where $z_t(i) > 0$ refers to firm i's (exogenous) idiosyncratic productivity, $k_t(i) \geq 0$ capital used in production by firm i, and α the returns to scale.

Firm i owns no capital and its outside-option value is normalized to zero (Giannetti and Yu; 2014). Thus, firm i finances, at the beginning of a period t, capital $k_t(i)$ via the one-period loan contract provided by the financier. For simplicity, we assume that capital, if used in production, depreciates fully at the end of each period.[12]

Idiosyncratic productivity shocks $z_t(i) \in [\underline{z}, \overline{z}]$ are drawn from the distribution $F(\cdot)$ independently across individual firms i where $0 < \underline{z} < \overline{z}$ and $F(\cdot)$ is constant over time. For analytic tractability, we assume that idiosyncratic productivity shocks $z_t(i)$ are independent over time.[13]

[12]The assumption of 100 percent depreciation of capital does not hurt the generality of our analytic results and helps to simplify the notation.

[13]The main reason for the assumed i.i.d. process of the idiosyncratic productivity shocks $z_t(i)$ is to keep the model tractable so that we can obtain analytic results of the equilibrium outcome. An alternative case of $z_t(i)$ being serially correlated would raise the issue of dynamic contracting, which would greatly sacrifice

Firms are grouped by the (ex-ante publicly known) distribution of idiosyncratic productivity shocks. There are two groups of firms, and these two groups differ in their cumulative distribution functions $F(z;j)$ defined over $z \in [\underline{z}, \overline{z}]$, which is indexed by $j \in \{S, L\}$; group $j = S$ stands for the technologically small-sized industry, and group $j = L$ the technologically large-sized industry, where an industry's technological size refers to how large the industry's average firm size would be if there were no distortions. For each of two groups/industries, there is a continuum of firms of measure one. In this paper, 'group of firms' and 'industry' will be used interchangeably. It is public information whether firm i belongs to group/industry $j = S$ or $j = L$, which is thus incorporated into the terms of borrowing in the credit market. And the firm i's realised idiosyncratic productivity shock $z(i)$ is private information known to only firm i itself, indicating that the asymmetric information problem is inherent.

More specifically, each distribution $F(\cdot;j)$ has finite mean and standard deviation, and its probability density function is denoted by $f(\cdot;j)$. Let $F_j \equiv F(\cdot;j)$ denote the distribution $j \in \{S, L\}$. Without loss of generality, we assume that the average productivity is higher in industry $j = L$ than in industry $j = S$: $E[z|F_L] > E[z|F_S]$, essentially so that in industry $j = L$, the average *technological* firm size is larger than in industry $j = S$.

For a technical reason related to the optimal design of loan contracts, we also assume that each distribution $F(\cdot;j)$ has a log-concave density as in the mechanism design literature

the model's tractability without gaining much insight for the research question addressed in this paper. The key in our model is the component of a borrowing firm's productivity that is unpredictable in the absence of information production in financial markets. Thus, idiosyncratic productivity shocks $z_t(i)$ in our model are intended to capture the component of a borrowing firm's profitability that can not be assessed correctly by using only publicly available information.

(Bagnoli and Bergstrom; 1997).[14] Let $\phi(z;j)$ denote the inverse of the hazard rate:

$$\phi(z;j) \equiv \frac{1 - F(z;j)}{f(z;j)}. \tag{2}$$

We assume that the inverse hazard rate $\phi(z;j)$ satisfies two properties as follows:

$$\text{Assumption } (\mathbf{A1}) : \phi'(z;j) \leq 0, \forall z \in [\underline{z}, \overline{z}], \text{ and } \phi(\underline{z};j) < \frac{\underline{z}}{1-\alpha}, \forall j \in \{S, L\}.$$

The first part of the assumption (A1) says that for both two distributions F_S and F_L, the inverse hazard rate $\phi(z;j)$ is non-increasing in z, which essentially guarantees that for a given group j, the capital allocation is in equilibrium non-decreasing in the firm's productivity z (as commonly assumed in the literature). The second part of the assumption (A1) essentially states that for both two distributions F_S and F_L, the inverse hazard rate $\phi(z;j)$ is bounded above by $\underline{z}/[1-\alpha]$ so that it is profitable for the financial intermediary to serve every firm in need of external finance.

Market Structure and Tradability of Final Good The market of the final good is perfectly competitive. Without loss of generality, we assume that in every period, the price of the final good is normalised to one. The final good, which can be consumed by domestic household, is tradable with no delivery costs (i.e., zero iceberg cost): one unit of the final good can be converted into one unit of capital and delivered to international lenders.

Private Information and Financial Intermediation Firm i observes its own ex-post realised idiosyncratic productivity shock $z_t(i)$, while others do not. As a result, the alloca-

[14] Bagnoli and Bergstrom (1997) discuss merits of the log-concave density with numerous examples including the uniform, normal, exponential, logistic, Beta, and Gamma distributions.

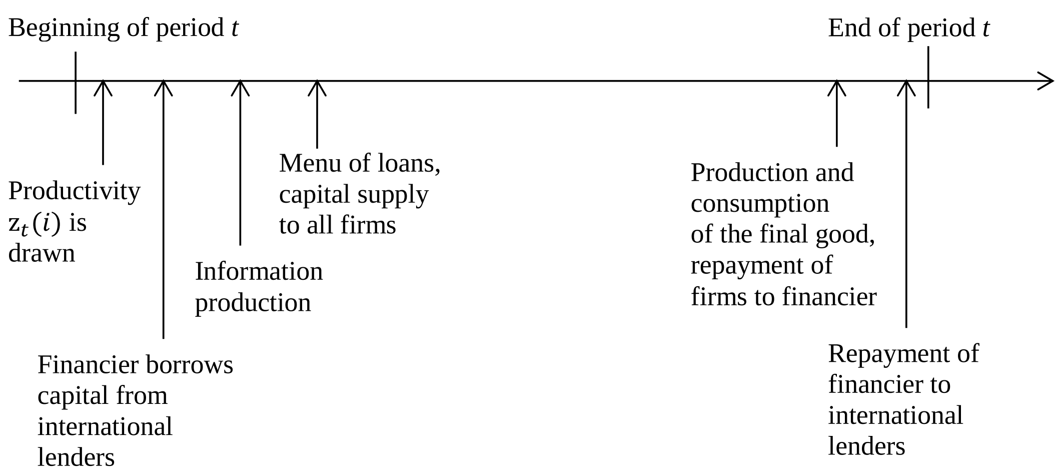
tion of capital via the capital market might be inefficient due to the asymmetric information problem between lenders and borrowers, calling for information production so as to alleviate such a problem. The domestic financial intermediary, labelled *financier*, which is the best capable of acquiring and processing information on the domestic industrial firms' productivities $z_t(i)$, does the job of intermediating borrowers/firms and lenders so that the conflict of interests between them is reduced. The financier can commit to repayment without default risk so that the financier can raise capital at a low cost (i.e., at the risk-free rate) in the international capital market and provide all (domestic) firms with as much amount of capital as demanded. Thus, we abstract from the issue of sovereign default (related to the issue of the limited total amount of capital), as we focus on the informational friction that distorts the capital allocation. Each firm faces the terms of borrowing that depends, of course, on the level of borrowing (i.e., the larger the loan amount, the higher the cost of borrowing). Last, we assume that long-term international borrowing is not available (due to some frictions in the international capital market).

The financier is the monopolist in the domestic market of intermediation services. It turns out that in this setting, the financier behaves in equilibrium as if the social planner that maximizes the small open economy's output subject to the same informational constraint.

Note that the financier itself has no default risk. Thus, this economy suffers only from the informational friction but not from the limited total amount of capital that can be raised. This feature of our model enables us to clarify the mechanism that determines the financial intermediaries' equilibrium production of information on borrowers' productivities/profitabilities, which would mitigate the informational friction and hence improve the allocative efficiency. By contrast, Giannetti and Yu (2014) study the setup in which the total amount of capital available to financial intermediaries is limited and hence a key factor, beyond the informational friction, in determining formal vs. relationship-based financing.[15]

Timing At the beginning of a period t, idiosyncratic productivity shocks $z_t(i)$ are realized; the financier learns $z_t(i)$ stochastically by paying the stochastic information-production costs that are realised but not observed by the financier; the financier borrows the aggregate level of capital from the international lenders, designs a menu of loan contracts and provides firms with capital. At the end of a period t, production and consumption of the final good takes place; firms pay back to the financier, who then pays the international lender(s) capital plus interests. Figure 1 illustrates graphically the timing of events.

Figure 1: Timing of Events



Information Production Cost Consider borrowing firm i that belongs to group j. The financier can learn firm i's productivity $z_t(i;j)$ with probability $\mu_t(i;j) \in [0,1]$ by paying the information-production cost. If the financier fails to learn $z_t(i;j)$, then the financier simply

[15]Thus, the mechanism explored in our setup is related to, but different from, the mechanism in Giannetti and Yu (2014) regarding determinants of efficiency-enhancing formal financing.

uses the group j's distribution $F(\cdot; j)$ in designing the loan contract for firm i; in such a case, the financier would optimally design the loan contract such that in equilibrium, firm i is willing to voluntarily reveal $z_t(i; j)$ due to the "informational rent" paid by the financier.

Consider group j of firms. The financier's information production takes place simultaneously across such firms. Note that prior to information production, the financier can not distinguish individual borrowing firms who differ only in productivities, which are unknown to the financier. Thus, the financier chooses the same level of information production $\mu_t(i; j) = \mu_t(j)$ across firms i that belong to the same group j, i.e., within-group pooling.

For group j, the financier chooses $\mu_t(j)$, the probability of success in learning productivities of group j's firms (i.e., the measure of information production), subject to the cost function of information production $c(\mu_t(j); z_t(i; j), a_t)$ that is increasing and convex in $\mu_t(j)$. More specifically, the cost function $c(\mu_t(j); z_t(i; j), a_t)$ is stochastic and negatively correlated with the borrowing/assessed firm i's productivity $z_t(i; j)$ and written as:

$$c(\mu_t(j); z_t(i; j), a_t) = \frac{1}{a_t}\left[c \cdot z_t(i; j)^{-\gamma} \cdot \mu_t(j) + \frac{1}{2}[\mu_t(j)]^2\right], \quad \forall \mu_t(j) \in [0, 1], \quad \gamma > 0 \qquad (3)$$

where $c > 0$ refers to the scale parameter for the information-production cost component that is linear in $\mu_t(j)$ relative to the (normalized) quadratic component of the cost $[\mu_t(j)]^2/2$, and $a_t > 0$ is the financier's efficiency of information production such that an increase in a_t shifts down the information-production cost curves for borrowing firms in all industries.[16] Thus, a_t is interpreted as the level of this economy's financial development.

[16]There is ample evidence about the improvement of the efficiency in the financial sector. The financial sector in the U.S. has grown steadily over the post-war period. In particular, the financial sector has benefited greatly from innovation in computers and information technologies. For instance, from the early 1980s onward, the value added per employee has increased much faster in the financial sector than in the rest of the U.S. economy, see, e.g., Philippon and Reshef (2007).

Loan Contracts Let $k_t(z_t(i))$ denote capital supplied to firm i at the beginning of a period t and $d_t(z_t(i))$ the firm i's repayment at the end of the period t. The financier offers, at the beginning of t, firm i the loan contract $(k_t(z_t(i)), d_t(z_t(i)))$ depending on whether or not the financier has learned $z_t(i)$. Given the choice of information production μ_t for group j of firms, the financier succeeds in learning $z_t(i)$ for μ_t fraction of these firms and fails for $(1-\mu_t)$ fraction (due to the law of large numbers). For a given group j, suppressing group index j, we let $(k_t^N(z_t(i)), d_t^N(z_t(i)))$ denote the loan contract for firm i conditional on that the financier has succeeded in learning $z_t(i)$, and $(k_t^O(z_t(i)), d_t^O(z_t(i)))$ does the same conditional on that the financier has failed to learn $z_t(i)$; similarly, let $y_t^N(z_t(i)) \equiv [z_t(i)]^{1-\alpha}[k_t^N(z_t(i))]^\alpha$ and $y_t^O(z_t(i)) \equiv [z_t(i)]^{1-\alpha}[k_t^O(z_t(i))]^\alpha$ denote firm i's end-of-period output conditional on whether the financier has learned $z_t(i)$ or not, respectively.

Discussion: Model Specification We discuss implications of the model specifications, especially the information-production cost function specified above. We consider group j of firms in what follows and suppress the group index j unless otherwise mentioned. Consider the cost component $c \cdot z_t(i)^{-\gamma} \cdot \mu_t$ that is linear in μ_t: it is negatively correlated with the borrower's productivity $z_t(i)$ given $\gamma > 0$. That is, for a given level of information produced μ_t, production of information on a low-productivity firm is more costly than that on a high-productivity firm is.[17] This assumption essentially captures the fact that information on a small firm is "soft" and difficult to obtain and assess (Petersen and Rajan; 2002).[18] This fea-

[17]The cost of production of information on an individual borrower is not observed by the financier until the loan contract is designed, and hence can not be used as the signal of the borrower's productivity in designing the loan contract.

[18]This assumption can be also thought of as a reduced-form approach to the fact that relative to an entrant, an incumbent surviving firm tends to have higher productivity, e.g., the selection effect, and also has a greater advantage in access to external funds, e.g., reputation effect. More generally, we could model the case of a positive serial correlation for a firm's productivity process and derive endogenously the property of information-production cost function being decreasing in the borrowing firm's productivity, which would,

ture of the information-production cost is intended to capture the supply-side determinants of financial intermediation. There is ample evidence supporting that the spread of credit availability or credit costs (proxied by the lending rate or required collateral) are negatively correlated with a borrowing firm's productivity and loan size (Cressy and Toivanen; 2001; Hanley and Girma; 2006).[19] The perfect correlation between the borrower's productivity $z_t(i)$ and the information-production cost is assumed for simplicity and does not hurt the generality of the main results given the fact that we focus on the industry-level equilibrium outcome (i.e., the law of large numbers).

We discuss how we model the industry's technological firm-size distribution. Note that as discussed above, the financier's cost function of information production is negatively correlated with the technological firm size, which is a critical component of our main hypothesis. In this paper, the industry's productivity distribution is used as a proxy of all fundamental factors that determine the industry's "technological" composition of small firms. Productivity is one, even though not all, of determinants of the industry's technological firm-size distribution. We consider this one-factor model mainly to keep the model analytically tractable. Alternatively, we could consider multiple-factor model, which would then become too complicated to answer the main research question addressed in this paper.

Domestic Household Consumption, Ownership, and Resource Constraint We assume that the representative domestic household is the owner of all the domestic firms and the financier. Note that we abstract from labour input in production, implying that the domestic household income equals the profits earned and paid by the firms and financier.

as discussed earlier, sacrifice the model's tractability without gaining much insight.

[19] In addition, it seems also plausible that the magnitude of the heterogeneity component of information-production cost is decreasing in the financial sector's efficiency; for instance, Liberti and Mian (2010) estimate the collateral spread of financing across riskiness and show that it is decreasing in the level of financial market development.

Given the simplifying assumption that capital is supplied by international lenders, all of the domestic household income is used to consumption (i.e., no domestic investment). Given no aggregate uncertainty (i.e., no business cycle fluctuations), we assume that international borrowing/saving is not used by domestic household (where long-term international borrowing is already ruled out). That is, in this economy, consumption equals income, which is, as mentioned above, profits of domestic firms and financier.

Let $\tilde{c}_t$ denote domestic household consumption at the end of period t. Let $u(\tilde{c})$ denote the per-period utility function of domestic household, which satisfies the usual Inada conditions.[20] We skip to discuss the domestic household problem, as it has no implications for our main issue of relative firm growth between the two industries.

The resource constraint in this small open economy is written as:

$$\underbrace{\sum_{j\in\{S,L\}}\int_{\underline{z}}^{\overline{z}} y_t(z;j)dF(z;j)}_{\text{aggregate output}} = \tilde{c}_t + [1+r_f]\cdot \underbrace{\sum_{j\in\{S,L\}}\int_{\underline{z}}^{\overline{z}} \Big[k_t(z;j) + c(\mu_t(j);z,j,a_t)\Big]dF(z;j)}_{\text{aggregae level of international borrowing}} \quad (4)$$

which says that output $\sum_{j\in\{S,L\}}\int_{\underline{z}}^{\overline{z}} y_t(z;j)dF(z;j)$ is used either to domestic consumption $\tilde{c}_t$ or to repayment to international lenders $\sum_{j\in\{S,L\}}[1+r_f]\cdot\int_{\underline{z}}^{\overline{z}}[k_t(z;j) + c(\mu_t(j);z,j,a_t)]dF(z;j)$. Here, the repayment to international lenders consists of the two components. First, given a depreciation rate of capital $\delta \in (0,1]$, the financier's repayment (to international lenders) for capital used in production is written as: $\sum_{j\in\{S,L\}}[\delta + r_f]\int_{\underline{z}}^{\overline{z}} k_t(z;j)dF(z;j)$. In our model, δ equals one: $\delta = 1$ (i.e., full depreciation), as discussed earlier. Second, the financier uses, at the beginning of period, some funds to pay the cost of information production $\sum_{j\in\{S,L\}}\int_{\underline{z}}^{\overline{z}} c(\mu_t(j);z,j,a_t)dF(z;j)$, which is, together with interest, paid to international lenders at the end of period.

[20]That is, we assume that: $u'(\cdot) > 0$, $\lim_{\tilde{c}\to 0} u'(\tilde{c}) = \infty$, and $\lim_{\tilde{c}\to\infty} u'(\tilde{c}) = 0$.

In short, output $y_t(z;j)$, which is produced by a domestic firm with productivity z in industry j, is paid either to the financier $d_t(z;j)$ or to the firm's owner (i.e., domestic household). Meanwhile, the financier's profit, i.e., $d_t(z;j)$ net the repayment to international lenders for capital $[1+r_f]k_t(z;j)$ and for funds used to information production $[1+r_f]c(\mu_t(j);z,j,a_t)$, is also paid to domestic household who is the financier's owner. As such, domestic household income, which also equals domestic household consumption $\tilde{c}_t$, equals aggregate output net the aggregate repayment to international lenders[21]: $\tilde{c}_t = \sum_{j\in\{S,L\}}\int_{\underline{z}}^{\overline{z}} y_t(z;j)dF(z;j) - \sum_{j\in\{S,L\}}[1+r_f]\cdot\int_{\underline{z}}^{\overline{z}}\Big[k_t(z;j)+c(\mu_t(j);z,j,a_t)\Big]dF(z;j)$.

The Financier's Problem Consider group j of firms. Given the choice of information production $\mu_t(j)$ for group j, which is analysed soon, the financier designs optimal loan contracts to maximise its own end-of-period profit from intermediation services $V(\mu_t(j);j)$:

$$V(\mu_t(j);j) = \max_{\Phi(\mu_t(j))}\Bigg\{\mu_t(j)\int_{\underline{z}}^{\overline{z}}[d_t^N(z;j)-(1+r_f)k_t^N(z;j)]dF(z;j)$$

$$+[1-\mu_t(j)]\int_{\underline{z}}^{\overline{z}}[d_t^O(z;j)-(1+r_f)k_t^O(z;j)]dF(z;j)\Bigg\} \tag{5}$$

subject to the usual rationality and incentive-compatibility, if needed, conditions as follows: For the case of the firm's productivity z being successfully learned, labelled *informed* case and denoted by the superscript 'N,' the rationality condition is written as:

$$[z]^{1-\alpha}[k_t^N(z;j)]^\alpha - d_t^N(z;j) \geq 0, \quad \forall z\in[\underline{z},\overline{z}] \tag{6}$$

[21]In this economy, output is not equal to income mainly because we are not interpreting the aggregate repayment for capital (i.e., output used for formation of capital that is fully depreciated) as aggregate domestic investment.

where the firm's outside-option value is normalized to zero (Giannetti and Yu; 2014). For the other case in which the financier has failed to learn z, labelled *uninformed* case and denoted by the superscript 'O,' the rationality and incentive-compatibility conditions are written as:

$$[z]^{1-\alpha}[k_t^O(z;j)]^\alpha - d_t^O(z;j) \geq 0, \quad \forall z \in [\underline{z}, \overline{z}], \tag{7}$$

$$[z]^{1-\alpha}[k_t^O(z;j)]^\alpha - d_t^O(z;j) \geq [z]^{1-\alpha}[k_t^O(z';j)]^\alpha - d_t^O(z';j), \quad \forall z \in [\underline{z}, \overline{z}], \forall z' \neq z. \tag{8}$$

and the non-negativity constraint $k_t^I \geq 0$, the non-negative profit condition $D_t^I - (1+r_f)k_t^I \geq 0$ for $I \in \{O, N\}$. Note that for this case in which the given firm's productivity z is unknown to the financier, the financier needs to provide such a firm with an incentive so that the firm voluntarily reveals the firm's productivity z, captured by the incentive-compatibility constraint (8). That is, the firm in equilibrium reports its true productivity z despite the available choice of lying and reporting $z' \neq z$ because the financier (principal) has designed the loan contract menu so that truth reporting does maximise the payoff to the borrowing firm (agent). Under the truth-telling mechanism, low-types will not mimic high types as debt repayments increase in z. The function $\Phi(\mu_t(j)) \equiv \{(k_t^N(z;j), d_t^N(z;j)), (k_t^O(z;j), d_t^O(z;j))\}$ denotes the loan contracts optimal to the financier's problem above for a given level of information production $\mu_t(j)$.

The financier, in turn, chooses the optimal level of information production $\mu_t(j)$ so as to maximise its own beginning-of-period expected profit, i.e., the present value of the intermediation profit $V(\mu_t(j);j)/(1+r_f)$ net the current information-production costs:

$$W(a_t;j) = \max_{\mu_t(j)\in[0,1]} \left\{ \left(\frac{1}{1+r_f}\right) V(\mu_t(j);j) - \int_{\underline{z}}^{\overline{z}} c(\mu_t(j);z,a_t)dF(z;j) \right\} \tag{9}$$

where $W(a_t; j)$ refers to the financier's beginning-of-period profit function from producing information and providing group j of firms with loan services.

2.2 Equilibrium

The equilibrium in this economy is a list of the policy and value functions of the loan contracts that satisfy the condition that for each group/industry $j \in \{S, L\}$, both loan contracts $(k_t^N(z;j), d_t^N(z;j)), (k_t^O(z;j), d_t^O(z;j))$ for $z \in [\underline{z}, \overline{z}]$ and information production $\mu_t(j)$ are optimal decision rules for solving the financier's problem.

3 Results

This section presents analytic results of the model. First, the financier's problem is analysed, and the equilibrium allocation of capital across firms is discussed. Second, the equilibrium level of information production is characterised. Third, we discuss how growth in the financier's efficiency of information production affects relative firm growth between two industries that differ in the technological composition of small firms. In doing so, we discuss sufficient conditions under which the model's predictions are consistent with well-known facts about financial development and firm growth (e.g., financial development leading to increased information production disproportionately benefits the small firms/industries).

3.1 Allocation of Capital for Given Information Production

This section analyses the industry-level equilibrium allocation of capital as a function of the level of information production. We begin by characterising the solution to the financier's problem of designing (constrained) optimal loan contracts for a given group of firms. We suppress the group/industry index j unless otherwise mentioned.

LEMMA 1. *Consider a firm of which realized ex-post productivity is z. The financier's problem of designing optimal loan contracts for such a firm (5) is equivalent to maximising the "virtual surplus" of the intermediation profit that is written as:*

$$\max_{\{k_t^h(z)\}} \left\{ [z]^{1-\alpha}[k_t^h(z)]^\alpha - 1_{\{h=O\}} \cdot (1-\alpha)\frac{\phi(z)}{z}[z]^{1-\alpha}[k_t^h(z)]^\alpha - (1+r_f)k_t^h(z) \right\} \tag{10}$$

where the superscript 'h' indicates whether the financier has failed to learn z for $h = O$, in which case the indicator function $1_{\{h=O\}}$ equals one, or not for $h = N$, in which case the indicator function $1_{\{h=O\}}$ equals zero.[22] *The solution to the problem above is characterized as follows:*

1. *Capital allocated to the firm of productivity z is written as:*

$$k_t^N(z) = \left(\frac{\alpha}{1+r_f}\right)^{\frac{1}{1-\alpha}} \cdot z, \quad k_t^O(z) = \left(\frac{\alpha}{1+r_f}\right)^{\frac{1}{1-\alpha}} \cdot z \cdot \left\{1-(1-\alpha)\frac{\phi(z)}{z}\right\}^{\frac{1}{1-\alpha}}. \tag{11}$$

2. *The financier's end-of-period profit is is written as:*

$$\pi_t^N(z) = (1-\alpha)\left(\frac{\alpha}{1+r_f}\right)^{\frac{\alpha}{1-\alpha}} \cdot z, \quad \pi_t^O(z) = (1-\alpha)\left(\frac{\alpha}{1+r_f}\right)^{\frac{\alpha}{1-\alpha}} \cdot z \cdot \left\{1-(1-\alpha)\frac{\phi(z)}{z}\right\}^{\frac{\alpha}{1-\alpha}}. \tag{12}$$

3. *The participation constraint binds for the firm of the lowest productivity $z = \underline{z}$.*

k_t^i is non-decreasing in z and the FOC of (10) yields the associated debt repayment. The expected value of the firm is increasing in z, the debt payment is also increasing in z. Note

[22] It is obvious that the financier's reformulated problem of designing optimal loan contracts (10) is identical to the planner's problem of the optimal allocation of capital subject to the same informational constraints.

that the term $(1-\alpha)[\phi(z)/z] \cdot [z]^{1-\alpha}[k^h(z)]^\alpha$ in equation (10) quantifies the degree of the capital-allocation distortion due to the asymmetric information problem, essentially caused by the incentive compatibility constraint, compared to the first best case of no asymmetric information. More specifically, it is the "informational rent" received by the borrowing firm so that such a firm voluntarily reveals its private information on z. For every firm of productivity z which the financier has failed to learn, such a degree of the capital-allocation distortion should not be too large such that the amount of "informational rent" is smaller than the borrowing firm's output so that the financier receives a positive profit from providing the firm with the intermediation service. Indeed, this is the case guaranteed by the second part of the assumption (A1), so that the financier has an incentive to provide every firm with the intermediation service. Otherwise, the financier would not provide such a firm with the intermediation service, which is uninteresting and ruled out.[23]

As shown in Lemma 1, the solution to the financier's problem of designing the optimal loan contracts is independent of time t. From now on, the time index t is suppressed for the solution to the financier's problem, e.g., $k^h(z)$ stands for $k_t^h(z)$.

Discussion: Marginal Product of Capital We discuss how the (equilibrium) marginal product of capital is different across firms, which has an important implication for the efficiency of capital allocation. Let $MPK^h(z) \equiv dy^h(z)/dk^h(z)$ denote the marginal product of capital of a firm with the productivity of z, depending on the indicator h denoting whether

[23]The second part of the assumption (A1) that $\phi(z)$ is bounded above kicks in here: for a firm of productivity $z \in [\underline{z}, \overline{z}]$, the degree of the capital-allocation distortion $(1-\alpha)[\phi(z)/z] \cdot [z]^{1-\alpha}[k^h(z)]^\alpha$ is smaller than the firm's output $[z]^{1-\alpha}[k^h(z)]^\alpha$ essentially because $(1-\alpha)[\phi(z)/z] < 1$. More specifically, consider a firm of productivity z that the financier has failed to learn. For such a firm, the ratio of the degree of the distortion $(1-\alpha)[\phi(z)/z] \cdot [z]^{1-\alpha}[k^h(z)]^\alpha$ to the firm's output $[z]^{1-\alpha}[k^h(z)]^\alpha$ is simply given by $(1-\alpha)[\phi(z)/z]$. Below we show that $(1-\alpha)[\phi(z)/z] < 1$ for every $z \in [\underline{z}, \overline{z}]$. We start by rewriting the second part of the assumption (A1) as: $[1-\alpha]\phi(\underline{z})/\underline{z} < 1$. Note that $\phi(z)/z \le \phi(z)/\underline{z} \le \phi(\underline{z})/\underline{z}$ where the last inequality follows from the first part of the assumption (A1) that $\phi(z)$ is non-increasing in z. Thus, we have shown that $[1-\alpha]\phi(z)/z < 1, \forall z \in [\underline{z}, \overline{z}]$.

the financier has learned such a productivity $h = N$ or not $h = O$. Given production function $y^h(z) = [z]^{1-\alpha}[k^h(z)]^\alpha$, $MPK^h(z)$ is in equilibrium written as:

$$MPK^h(z) = \alpha \cdot [z]^{1-\alpha}[k^h(z)]^{\alpha-1}, \text{ for } h \in \{N, O\}. \tag{13}$$

Using the results in Lemma 1 for the equilibrium allocation of capital $k^h(z)$, we can rewrite the equilibrium marginal product of capital as follows:

$$MPK^N(z) = 1 + r_f, \tag{14}$$

$$MPK^O(z) = [1 + r_f] \cdot \left\{1 - (1-\alpha)\frac{\phi(z)}{z}\right\}^{-1}. \tag{15}$$

LEMMA 2. *Consider firms of which productivities the financier fails to learn: for such firms, a firm's marginal product of capital is strictly decreasing in the firm's productivity:* $dMPK^O(z)/dz < 0$. *By contrast, for firms of which productivities the financier succeeds to learn, the marginal product of capital is the same across firms:* $dMPK^N(z)/dz = 0$.

Results in Lemma 2 imply that capital allocation is efficient for firms of which productivities the financier succeeds to learn, which is straightforward given that there is no informational friction for these firms. By contrast, for firms of which productivities are unknown to the financier, capital allocation is distorted in the classical sense: the small firm's MPK is higher than the large firm's MPK, which is driven by the informational friction. Put differently, distortion in the capital allocation is mainly driven by the degree of informational friction $[1 - \mu_t(j)]$, the fraction of firms' whose productivities are unknown to the financier. This key informational friction can be mitigated by the financier's information production $\mu_t(j)$, which is, in equilibrium, determined by the financier who balances, as will be discussed soon, its marginal benefit and cost.

3.2 Information Production

This section characterises the equilibrium level of information production. For group j of firms, the first-order condition for equilibrium information production $\mu_t(j)$ is, if satisfied, written as:

$$\int_{\underline{z}}^{\overline{z}} MR(z)dF(z;j) - \int_{\underline{z}}^{\overline{z}} \frac{1}{a_t}[HMC(z) + \mu_t(j)]dF(z;j) = 0 \tag{16}$$

$$where\ MR(z) \equiv \frac{\pi^N(z) - \pi^O(z)}{1+r_f} = \frac{1-\alpha}{1+r_f} \cdot \left(\frac{\alpha}{1+r_f}\right)^{\frac{\alpha}{1-\alpha}} \cdot z \cdot \left[1 - \left\{1 - (1-\alpha)\frac{\phi(z)}{z}\right\}^{\frac{\alpha}{1-\alpha}}\right] \tag{17}$$

$$and\ HMC(z) \equiv c[z^{-\gamma}]. \tag{18}$$

Rearranging terms, we can simplify the first-order condition for $\mu_t(j)$ as:

$$\mu_t(j) = a_t E[MR(z);j] - E[HMC(z);j] \quad \text{ if } 0 < a_t E[MR(z);j] - E[HMC(z);j] < 1 \tag{19}$$

where $E[MR(z);j] = \int_{\underline{z}}^{\overline{z}} MR(z)dF(z;j)$ refers to the average $MR(z)$, labelled *marginal revenue* of information production for group j, and $E[HMC(z);j] = \int_{\underline{z}}^{\overline{z}} HMC(z)dF(z;j)$ the average $HMC(z)$, labelled *marginal cost* of information production for group j. These two quantities, i.e., the industry-specific marginal revenue and cost of information production $E[MR(z);j]$ and $E[HMC(z);j]$, will be used later in explaining the mechanism of the relative level of information production between the small and large industries $\mu_t(S) - \mu_t(L)$.

From now on, the financier's efficiency a_t is assumed to be of a moderate level such that the first-order condition for equilibrium information production $\mu_t(j)$ is satisfied.

$$\text{Assumption } (\mathbf{A2}) : \Big[a_t E[MR(z);j] - E[HMC(z);j]\Big] \in (0,1), \quad \forall j \in \{S, L\}.$$

3.3 Relative Firm Growth between Two Industries

This section discusses the effect of a marginal improvement in the financier's efficiency of information production on industry-level firm growth where 'industry' refers to 'group of firms' as mentioned earlier. In particular, we focus on relative firm growth between two industries that differ in the technological composition of small firms. More specifically, we assume that the technologically large industry $j = L$'s productivity distribution F_L first-order stochastically dominates (FOSD) the technologically small industry $j = S$'s distribution F_S.

Assumption (**A3**): F_L first-order stochastically dominates F_S such that:

$$F_L(z) < F_S(z), \quad \forall z \in [\underline{z}, \overline{z}]. \tag{20}$$

The assumption (**A3**) says that for any given level of productivity z, the cumulative probability $F_S(z)$ of the small industry is greater than that of the large industry. Note that for a given threshold level of productivity $\widetilde{z}$ for a firm to be *small*, the industry j's technological composition of small firms is equal to $F_j(\widetilde{z}) \equiv Prob[z(i,j) \leq \widetilde{z}]$ given the aforementioned result that the within-industry capital allocation is non-decreasing in the firm-level productivity z. Thus, the assumption (**A3**) implies that in the small industry, the technological composition of small firms is greater than in the large industry.

We present results for the two key equilibrium quantities: the industry-level marginal revenue and cost of information production $E[MR(z)|F_j]$ and $E[HMC(z)|F_j]$, especially relative magnitude of each of these two quantities between the two industries.

LEMMA 3. *Consider that assumptions (A1)-(A3) hold. In this case, the two results follow:*

1. $E[HMC(z)|F_S] \geq E[HMC(z)|F_L]$.

2. *If* $\alpha[\phi(z)/z - \phi'(z)] > 1$ *and* $\alpha < 0.5$, *then* $E[MR(z)|F_S] \geq E[MR(z)|F_L]$.

The first part of results in Lemma 3 say that in the technologically small industry, the industry-specific marginal cost of information production $E[HMC(z)|F_j]$ is, by construction, also greater than in the technologically large industry. More interesting part is the second part of results in Lemma 3, which provides sufficient conditions under which in the technologically small industry $j = S$, the industry-specific marginal revenue of information production $E[MR(z)|F_j]$ is greater than in the technologically large industry $j = L$. Taken together, the two results in Lemma 3 the relative industry-specific level of information production between the two industries is in equilibrium determined by which one of these two opposing forces dominates the other.

We discuss the economic mechanism about the marginal benefit of information production $E[MR(z)|F_j]$, especially its difference between the small and large industries. The marginal revenue of information production for industry j's firms $E[MR(z)|F_j] \propto E[\pi^N(z) - \pi^O(z)|F_j]$ $= E[y^N(z) - y^O(z)|F_j]/[1 - \alpha]$ is essentially determined by the degree to which output is distorted due to private information on productivity $E[y^N(z) - y^O(z)|F_j]$. If such a degree of distortion is decreasing in the firm's productivity z (i.e., the greater degree of distortion for the smaller firm), then the marginal benefit of information production in terms of reducing such a degree of output distortion is of magnitude disproportionately greater for the small industry than for the large industry.

Consider the degree of output distortion curve $[y^N(z) - y^O(z)]$ as a function of productivity z. The slope of such a degree of output distortion curve is determined by the difference in the slope between the non-distorted output curve $y^N(z)$ and distorted output curve $y^O(z)$, where the slope of $y^N(z)$ is constant, and $-\alpha[\phi(z)/z - \phi'(z)]$ is one of determinants of the slope of $y^O(z)$ relative to the slope of $y^N(z)$. Thus, the condition above $\alpha[\phi(z)/z - \phi'(z)] > 1$ essentially says that the slope of the distorted output curve $y^O(z)$ is much steeper than the slope between the non-distorted output curve $y^N(z)$ so that the slope of the degree of output distortion curve $[y^N(z) - y^O(z)]$ is negative, i.e., the degree of output distortion is greater for the smaller firm than for the larger firm.

Another condition $\alpha < 0.5$ in Lemma 3 is mainly about the curvature of the degree of output distortion curve $[y^N(z) - y^O(z)]$. The non-distorted output curve $y^N(z)$ is flat (i.e., zero curvature, or constant slope), while the distorted output curve $y^O(z)]$ has a curvature that is essentially determined by $\alpha/(1-\alpha)$. As such, $\alpha < 0.5$ makes sure that the degree of output distortion curve $[y^N(z) - y^O(z)]$ is strictly concave.

From now on, we assume the two conditions as follows[24]:

$$\text{Assumption } (\mathbf{A4}): \; \left[\frac{\phi(z)}{z} - \phi'(z)\right] > \frac{1}{\alpha} \text{ and } \alpha < 0.5.$$

The assumption (A4) implies, as discussed for the results in Lemma 3, the two key features of the model that for the small industry, both marginal cost and revenue of the financier's information production are of magnitude greater than for the large industry.

[24] The condition that $[\phi(z)/z - \phi'(z)]$ is bounded below holds for numerous examples of log-concave density with reasonable parametrization. The condition of $\alpha < 0.5$ seems also plausible. Note that the production function specified in this paper can be thought of as the usual Cobb-Douglas function of the variable amount of capital powered by α and fixed level of labour input (powered by $1-\alpha$); in this case, α would correspond to the capital income share in national income account and is typically smaller than 0.5 in most countries.

Industry-Specific Output Growth This section discusses how growth in the financier's efficiency of information production is propagated to firm growth in terms of output growth. (Results for firm growth in terms of capital growth are presented in section A.2 in the Online Appendix and quite similar to those in terms of output growth.) In particular, we discuss how the output growth rates of the technologically small and large industries responds differently to an increase in the financier's efficiency growth. We begin by discussing the relative *level* of output between these two industries conditional on whether the financier has learned the borrower's productivity z or not.

COROLLARY 1. *Consider that four assumptions (A1)- (A4) hold. In this case, two results follow: (1)* $E[y^h(z)|F_L] \geq E[y^h(z)|F_S]$ *for* $\forall h \in \{N, O\}$ *, and (2)* $E[y^N(z) - y^O(z)|F_S] \geq E[y^N(z) - y^O(z)|F_L]$.

The first part of results in Corollary 1 says that industry-level average output conditional on whether the firm's productivity z is learned by the financier $h = N$ or not $h = O$ is in equilibrium higher in the large-sized industry than in the small-sized industry, which is not surprising. Interestingly, the second part of result in Corollary 1 shows that in the (technologically) small industry, the industry-specific marginal benefit of information production $E[y^N(z) - y^O(z)|F_j]$ is of magnitude greater than in the large industry. That is, consider two firms that (i) belong to the same industry and (ii) have the same productivity but (iii) are different in terms of whether or not the financier has succeeded in learning the firm's productivity. Then, the difference in expected output between these two firms $E[y^N(z) - y^O(z)|F_j]$ would have been zero if there were no informational friction, and hence represents the degree of the capital-allocation distortion due to the informational friction. This distortion can be reduced by increasing the level of information production $\mu_t(j)$. Thus, $E[y^N(z) - y^O(z)|F_j]$ measures the industry-specific marginal benefit of information production, which is greater in the small industry than in the large industry, consistent with the consensus in the literature that the smaller industry/firm has the greater growth potential that would be realised if financial obstacles are removed.

We turn to discussing how the industry-specific *growth rate* of output is in equilibrium related with the financier's efficiency growth. Let $g(y_t(j)) \equiv dlog(E[y_t(z)|F_j])/dt$ denote the (spontaneous) growth rate of industry j's average output.[25] Note that industry j's average output can be written as: $E[y_t(z)|F_j] = \mu_t(j)E[y^N(z)|F_j] + (1 - \mu_t(j))E[y^O(z)|F_j]$, for $j \in \{S, L\}$. Thus, we can simplify industry j's output growth rate $g(y_t(j))$ as:

$$g(y_t(j)) = \frac{\mu_t(j)\Big[E[y^N|F_j] - E[y^O|F_j]\Big]}{\mu_t(j)E[y^N|F_j] + (1 - \mu_t(j))E[y^O|F_j]} \cdot g(\mu_t(j)). \tag{21}$$

As can be seen in equation (21), industry j's average firm growth $g(y_t(j))$ is driven by growth in the financier's information production specific to the corresponding industry $g(\mu_t(j))$. Given that it is of our main interest to study the relative response of firm growth between the small and large industries to growth in the financier's efficiency of information production, we proceed to discussing how the financier's information production responds to an increase in the financier's efficiency of information production, especially its difference between the small and large industry.

We define the relative equilibrium *growth rate* of information production between two industries. Let $g(\mu_t(j)) \equiv dlog(\mu_t(j))/dt$ denote the (spontaneous) growth rate of information

[25] We consider the change in a variable x_t over a short time interval $[t, t + \Delta]$ where $\Delta > 0$ is small. In this case, the growth rate in $x_{t+\Delta}$ would be approximated well by $x_{t+\Delta}/x_t - 1 \approx \Delta \cdot [dx_t/dt]/x_t = \Delta \cdot dlog(x_t)/dt$. The short length of the time interval Δ is constant and suppressed.

production for industry j.[26] Note that $g(\mu_t(j))$ is in equilibrium rewritten as:

$$g(\mu_t(j)) = g(a_t)\frac{a_t E[MR(z)|F_j]}{a_t E[MR(z)|F_j] - E[HMC(z)|F_j]}, \quad g(a_t) \equiv dlog(a_t)/dt \tag{22}$$

where $g(a_t)$ denotes (spontaneous) growth in the financier's information-production efficiency a_t. As shown by equation (22), industry j-specific information growth $g(\mu_t(j))$ is in equilibrium proportional to the financier's efficiency growth $g(a_t)$, which is common to every industry, with the industry-specific sensitivity that is increasing in the equilibrium quantity $E[HMC(z)|F_j]/[a_t E[MR(z)|F_j]]$. That is, if $E[HMC(z)|F_j]/[a_t E[MR(z)|F_j]]$ is greater for the small industry $j = S$ than for the large industry $j = L$, then a given increase in $g(a_t)$ would increase information growth disproportionately for the small industry than for the large industry. This is important for the relative output growth between these two industries, as output growth is driven by changes in the allocative efficiency, which are in turn tightly related to information growth. Therefore, we introduce one assumption as follows:

$$\text{Assumption } (\mathbf{A5})\text{: } \frac{E[HMC(z)|F_S]}{E[HMC(z)|F_L]} > \frac{E[MR(z)|F_S]}{E[MR(z)|F_L]}$$

from which it immediately follows that:

$$\frac{E[HMC(z)|F_S]}{a_t E[MR(z)|F_S]} > \frac{E[HMC(z)|F_L]}{a_t E[MR(z)|F_L]}. \tag{23}$$

Simply put, assumption (**A5**) guarantees that in response to an increase in the financier's efficiency, information production for the small industry increases to magnitude greater than

[26] Here we consider the change in a variable x_t over a short time interval $[t, t + \Delta]$ where $\Delta > 0$ is small. In this case, the growth rate of $x_{t+\Delta}$ is approximated as: $x_{t+\Delta}/x_t - 1 \approx \Delta \cdot [dx_t/dt]/x_t = \Delta \cdot dlog(x_t)/dt$. The short length of the time interval Δ is constant and can be suppressed in discussion of main results.

that for the large industry.

Using results in (21)–(22), we can rewrite the response of industry j-specific output growth to one unit increase in the financier's efficiency growth $\partial g(y_t(j))/\partial g(a_t)$ as:

$$\frac{\partial g(y_t(j))}{\partial g(a_t)} = a_t \cdot \Psi_t(j), \tag{24}$$

$$\Psi_t(j) \equiv 1 \Big/ \left[\left(a_t - \frac{E[HMC(z)|F_j]}{E[MR(z)|F_j]} \right) + \left(\frac{1}{E[MR(z)|F_j]} \cdot \frac{E[y^O(z)|F_j]}{E[y^N(z)|F_j] - E[y^O(z)|F_j]} \right) \right]. \tag{25}$$

This result says that the effect of the financier's efficiency growth on industry j-specific output growth is determined by the two components: (i) the level of the financier's efficiency a_t that is a common factor affecting the given country's all industries, and (ii) the industry-specific growth sensitivity the financier's efficiency growth $\Psi_t(j)$. We discuss the implications of this result. Suppose that the financier's efficiency growth increases by one unit. Consider the disproportionate firm growth for the small industry $[\partial g(y_t(S))/\partial g(a_t) - \partial g(y_t(L))/\partial g(a_t)]$. According to the results in (24), $[\partial g(y_t(S))/\partial g(a_t) - \partial g(y_t(L))/\partial g(a_t)]$ is given by $a_t[\Psi_t(S) - \Psi_t(L)]$, which is determined by the small industry's disproportionate growth sensitivity $[\Psi_t(S) - \Psi_t(L)]$ and increasing in the level of the financier's efficiency a_t.

One caveat is that these results, seemingly quite intuitive, can not be directly used for the purpose of comparing $[\partial g(y_t(S))/\partial g(a_t) - \partial g(y_t(L))/\partial g(a_t)]$ across different level of a_t as the industry-specific growth sensitivity term $\Psi_t(j)$ is also a function of a_t. That is, the variation of $[\partial g(y_t(S))/\partial g(a_t) - \partial g(y_t(L))/\partial g(a_t)]$ over a_t has two components: (i) linear variation mainly driven by the variation of a_t holding the industry-specific growth sensitivity term $\Psi_t(j)$ constant, and (ii) non-linear variation due to the effect of a_t on $\Psi_t(j)$.

We turn to discussing the differential firm growth between the small and large industries.

More specifically, we define the relative effect of the (one-percentage) improvement of the financial intermediary's efficiency (REIFIE) on industry-level output growth between the two industries $REIFIE(y_t)$ as:

$$REIFIE(y_t) \equiv \partial\Big[g(y_t(S)) - g(y_t(L))\Big]/\partial g(a_t) \tag{26}$$

$$= a_t\Big[\Psi_t(S) - \Psi_t(L)\Big]. \tag{27}$$

As discussed earlier, the effect of a_t on $REIFIE(y_t)$ has two components: linear and non-linear effects as follows:

$$\begin{aligned} \frac{\partial REIFIE(y_t)}{\partial a_t} &= \underbrace{\Big[\Psi_t(S) - \Psi_t(L)\Big]}_{\text{linear effect}} + \underbrace{a_t\Big[-[\Psi_t(S)]^2 + [\Psi_t(L)]^2\Big]}_{\text{non-linear effect}} \\ &= \Big[\Psi_t(S) - \Psi_t(L)\Big]\Big[1 - a_t\Big(\Psi_t(S) + \Psi_t(L)\Big)\Big] \\ &= \underbrace{\Big[\frac{REIFIE(y_t)}{a_t}\Big]}_{\text{linear effect}}\Big[1 - a_t\Big(\Psi_t(S) + \Psi_t(L)\Big)\Big]. \end{aligned} \tag{28}$$

From this result, it immediately follows if the non-linear effect is of magnitude sufficiently small relative to the linear effect $a_t[\Psi_t(S) + \Psi_t(L)] < 1$, that the total effect of a_t on $REIFIE(y_t)$ is dominated and determined by its linear effect $REIFIE(y_t)/a_t$. We discuss sufficient conditions under which such a linear effect is positive $REIFIE(y_t)/a_t > 0$.

Proposition 1. *If five assumptions (A1)- (A5) hold, then the "linear" variation in $REIFIE(y_t)$ over a country's financial development a_t is positive: $REIFIE(y_t)/a_t > 0$.*

Results of Proposition 1 say that in the more financially developed country (in which a_t is higher), the disproportionate effect of the financier's efficiency growth on the small industry's output growth is of magnitude greater than in the less financially developed country.

Here, the key assumption is assumption (A5), which, as discussed earlier, guarantees that in response an increase in the financier's efficiency growth $g(a_t)$, growth in information production for the small industry is greater than that for the large industry. Note that in the model, information growth is the key in generating output growth via the improved allocative efficiency, which is the reason why the assumption (A5) is a critical condition to derive results of Proposition 1. Meanwhile, the assumption (A4) implies the key feature (rather than results) of the model such that for the small industry, both cost and benefit of information production are magnitude greater than for the large industry, whereas assumptions (A1)- (A3) are technical ones related to the mechanism design theory (due to the existence of private information).

The economic mechanism is as follows: Consider the effect of one unit parallel shift down in the financier's marginal cost curve on the industry-specific level of information production. In this case, the induced marginal increase in information production equals, up to a first-order approximation, the inverse of the cost-curve slope, and hence is of magnitude smaller for the case of the steeper marginal cost curve. Thus, the relative effects of the financier's increased efficiency on information production and capital growth between the small and large industries are essentially determined by how steeper the financier's marginal cost curve is for the small industry than for the large industry.

Note that in a financially underdeveloped country, the difference in the slope of the financier's marginal cost curve between the small and large industries is greater than in a financially advanced country. For instance, in a financially advanced country, the difference in the cost of information production between these two industries is negligible such that the financier's marginal cost curve is almost identical between the two industries. By contrast, in a financially underdeveloped country, the financier's marginal cost curve is substantially steeper for the small industry than for the large industry. Therefore, in a financially underdeveloped country, the disproportionate effect of the financier's improved efficiency on the small industry's output growth would be of magnitude smaller than in a financially advanced country. Importantly, this effect is driven by the tightly related differential growth in information production between the two industries.[27]

Note that results of Proposition 1 are limited to the "linear" relationship between the small industry's disproportionate output growth $REIFIE(y_t)$ and a country's financial development a_t. The general relationship (i.e., including linear and nonlinear ones) would be analysed by examining the derivative of $REIFIE(y_t)$ with respect to a_t (i.e., $\partial REIFIE(y_t)/\partial a_t$) rather than the slope of $REIFIE(k_t)$ to a_t as in Proposition 1.[28]

LEMMA 4. *If five assumptions (A1)- (A5) hold and* $a_t[\Psi(S) + \Psi(L)] < 1$*, then the small industry's disproportionate output growth* $REIFIE(y_t)$ *is increasing in a country's financial development* a_t*:* $\partial REIFIE(y_t)/\partial a_t > 0$.

Proof. Results immediately follow from the results in (28) and those of Proposition 1. □

Results of Lemma 4 essentially say if the industry-specific growth sensitivity terms $\Psi(S)$ and $\Psi(L)$ are of magnitude sufficiently small, that the linear relationship between $REIFIE(y_t)$ and a_t determines the over effect of a_t on $REIFIE(y_t)$. The reason is that the non-linear effect of a_t on $REIFIE(y_t)$ is mainly due to the effects of a_t on the industry-specific growth sensitivity terms $\Psi(S)$ and $\Psi(L)$.[29]

[27]Indeed, the "linear" relationship between a country's financial development a_t and the small industry's sensitivity of information growth to the financier's efficiency growth (relative to that of the large industry) $REIFIE(\mu_t) \equiv [\partial g(\mu_t(S)) - g(\mu_t(L))]/\partial g(a_t)$ and a_t is also positive (i.e., $REIFIE(\mu_t)/a_t > 0$) under the assumption (A5), as discussed in section A.1 in the Online Appendix.

[28]Such a relationship is what is actually examined in our empirical analysis, as is in most of empirical works. In this sense, under $a_t[\Psi(S) + \Psi(L)] < 1$, our analytic results about this linear relationship, though limited, shed some lights on mapping the theory of the financial intermediary's information production to empirical facts.

[29]The non-linear effect of (28) arises because the term $a_t - E[HMC(z)|F_j]/E[MR(z)|F_j]$ of (25) increases in

4 Some Evidence

This section discusses empirical evidence supporting the model's key mechanism. First, we test the hypothesis that the cost of financial intermediation to screen out potential borrowers is disproportionately larger for firms in the small industry. Importantly, we also test whether or not such a cost spread between firms in the small industry and firms in the large industry is decreasing in the level of a country's financial development.

Mores specifically, we use syndicated loan data to measure the cost of financial intermediaries to certify borrowers' creditworthiness. Syndicated loan data is widely used in the literature that studies the empirical relationship between the cost of borrowing and information asymmetry as bank loans are one of the most widely used means of finance. Using this data, we provide evidence supporting one of the key features of the model: i.e., the cost of information production specified earlier in equation (3) and the overall adverse relationship between the cost spread of financial intermediaries and the country's financial market development.[30]

Second, we test the hypothesis about the relative firm growth between the small and large industries (i.e., the results in Proposition 1). This hypothesis states that the effect of improvement in the financial intermediary's capability of information production on the disproportionate growth in the small industry (relative to that in the large industry) is of magnitude greater in the more financially developed country than in the less financially

both the country's level of financial development and output distortion($E[y^N(z)|F_j] - E[y^O(z)|F_j]$) while the term $[1/E[MR(z)|F_j]] \cdot [E[y^O(z)|F_j]/[E[y^N(z)|F_j] - E[y^O(z)|F_j]]]$ decreases in output distortion. The adverse relationship with output distortion arises because the sensitivity of industry-specific percentage growth to one percentage growth in the financier's efficiency decreases in the level of financial development. By such a non-linear relationship, when output distortion is reduced much faster than improvement in financial development, the effect on growth weakens and may even turn negative. The condition $a_t[\Psi(S) + \Psi(L)] < 1$ ensures a balanced (opposite) change in output distortion and financial development.

[30]The features of the cost function of information production used in our model are also broadly consistent with previous findings in the literature— Philippon and Reshef (2007) and Liberti and Mian (2010).

developed country. We use industry-country data from *United Nations Industrial Statistics* and *World Bank*. Together with the evidence on the syndicated loans, the evidence suggests that the trade-off between the cost and benefit of financial intermediaries' production of information on the borrowing firm's profitability (related to the firm's creditworthiness), especially the evolution of such a trade-off over a country's level of financial development, has an important implications for the disproportionate firm growth in the small industry relative to that in the large industry.

4.1 Determinants of Costs of Financial Intermediation

Data Source We employ a sample of 8,366 syndicated loans, signed January 1, 1987 and December 31, 2014 which is drawn from the Reuter/Loan Pricing Corporation (LPC)'s DealScan database. The sample uses a single loan tranche as a unit of observation. Since many projects are financed with more than one loan tranches, multiple tranches appear as separate observations in our sample. We collect detailed information about each loan tranche: loan size, fees paid by the borrowers, maturity, signing date, and so on.

We use the borrower's fees as proxies for the cost of financial intermediation, the borrower's fees include loan spread, commitment fee, letter of credit (LC) fee, annual fee, and utilization fee. The fee information generally captures the costly process of lenders to certify the borrowers' inside information and relieve information asymmetry. Table 1 presents summary statistics of the variables of the syndicated loan.

As in Beck, Demirguc-kunt, Laeven and Levine (2008), we are interested in whether industries that have a larger share of small firms for technical reasons grow faster in economies with well-developed financial systems. We consider the industry's technological composition of small firms that is not constrained by the financial obstacles and measured as the corresponding U.S. industry's small firm share in employment.[31] The reason why we avoid using the actual country-industry's average firm size is that as discussed in Beck, Demirguc-kunt, Laeven and Levine (2008), a given country's financial obstacles could affect the country-industry's actual firm size, which would raise the endogeneity problem in identifying the the small industry's disproportionate firm growth.

[Insert Table 1.]

Methodology and Results Let $c_{i,k,c,t}$ denote the cost of borrowing in terms of loan spread for the observation of tranche i, industry k, borrowing country c and year t. The regression equation for the cost of borrowing $c_{i,k,c,t}$ is written as:

$$Ln(1+c_{i,k,c,t}) = \Big[\alpha_1+\alpha_2 FD_{c,t}\Big]\cdot Small_k+\mathbf{\Psi}\cdot\mathbf{X}_k\cdot FD_{c,t}+\mathbf{\Omega}\cdot\mathbf{Z}_{i,k,c,t}+\gamma_k+\gamma_c+\gamma_t+\epsilon_{i,k,c,t} \quad (29)$$

where $Small_k$ is the log of industry k's technological composition of small firms; FD_c refers to country c's private credit-to-GDP ratio that is widely used, in the literature studying finance and economic development, as a proxy for the country's level of financial development. FD_c corresponds to the model-side measure of the level of financial intermediaries' efficiency a_t.[32] The parameter vector $\mathbf{\Psi}$ measures the effects of of the interaction terms between financial development $FD_{c,t}$ and industry-level characteristics $\mathbf{X}_k$ (that is discussed in more detail later), while industry-specific fixed effects are also controlled for by the term γ_k. $\mathbf{\Omega}$ refers to the coefficients on the loan-specific characteristics vector $\mathbf{Z}_{i,k,c,t}$ that includes loan size,

[31] We use the share in employment of small firms (as of 1997) that have hired less than 20 employees in 1997, constructed by Beck, Demirguc-kunt, Laeven and Levine (2008). There is previous literature which takes the share in employment of small firms empirically as agents' hidden types — Plehn-Dujowich (2009)

[32] To measure the easiness of the business firm's access to external finance, we would use a country's enterprise credit-to-GDP ratio, if available, constructed by Beck et al. (2012). Unfortunately, panel data on the enterprise credit-to-GDP ratio is not available during the sample period of syndicated loan data, where closing dates of the syndicated loans are various over the years.

maturity, the active dummy (set to one if the loan is active as of the time of observation t), the refinancing dummy (set to one if the loan tranche is used to refinancing an existing project), and the currency risk dummy (set to one if the loan denomination currency differs from the currency of the local currency of the borrower's country). We also control for the country- and year-specific fixed effects via γ_c and γ_t dummies, respectively. And $\epsilon_{i,k,c,t}$ is the error term.

Industry k's characteristics, which are interacted to the country's level of financial development, are as follows: (i) dependence on intangible assets $Intangibility_k$ (Claessens and Laeven; 2003), (ii) the four-firm concentration ratio $Concentration_k$ (Beck, Demirguc-kunt, Laeven and Levine; 2008), and (iii) dependence on external finance $Ext\ Dep_k$ (Rajan and Zingales; 1998). The industry's firm size is already controlled for by the industry's small firm share $Small$. (See appendix, section A, for their definitions.) Industry-specific characteristics are specific to industry k (independent of sample countries c) and measured for the corresponding U.S. industry, where U.S. is taken as the country with the highest level of financial development and hence the least likely to be affected by financial obstacles (Beck, Demirguc-kunt, Laeven and Levine; 2008). In measuring these industry-specific characteristics, we either use the readily available data provided by the cited authors above or construct them by following the methodology in the cited papers.

The coefficient α_1 on the industry's small firm share $Small_k$ (i.e., inverse measure of the industry's technological firm size) measures how larger the cost of financial intermediation for the small industry is than that for the large industry, which is, by conventional wisdom in the literature, expected positive. Importantly, the coefficient α_2 on the interaction term between $Small_k$ and $FD_{c,t}$ is intended to capture the (marginal) effects of (within-country and within-industry) differences in financial development on the disproportionate cost of financial intermediation $c_{i,k,c,t}$ for the small industry (relative to that for the large industry). The null hypothesis is that α_2 is zero. If α_2 is negative, then it indicates that the cost spread (of financial intermediation) between the small and large industries is decreasing in the level of a country's financial development: i.e., in the more financially developed country, the disproportionate cost of financial intermediation for the small industry is smaller than in the less financially developed country.

Table 2 presents the estimation results of the regression equation, where the dependent variables are various proxies for the cost of financial intermediation, measured as borrowers' fees, and include (i) commitment fee, (ii) letter of credit (LC) fee, (iii) annual fee, (iv) utilization fee, and (v) loan spread. The estimated coefficient α_1 is, as expected, positive and significant at the five percent level for three measures: (i) commitment fee, (ii) letter of credit (LC) fee, and (v) loan spread, while it is either insignificant for the case of (iii) annual fee or significantly negative for the case of (iv) utilization fee. That is, the aforementione three measures of the financial-intermediation cost are consistent with the consensus in the literature that for the small industry, the cost of financial intermediation is larger than for the large industry. Moreover, estimation results for the coefficient α_2 on the interaction term between $Small_k$ and $FD_{c,t}$ show that α_2 is, as expected, negative for most of cases except for the case of (iv) utilization fee, for which α_2 is positive but insignificant and importantly, α_1 is, differently from the consensus, negative. In particular, for the three cases for which α_1 is positive (i.e., (i) commitment fee, (ii) letter of credit (LC) fee, and (v) loan spread), α_2 is negative for all of the three cases and significant at the one percent level in the two cases: (ii) letter of credit (LC) fee, and (v) loan spread. Taken together, our regression results for the cost of financial intermediation

For robustness check, we examine how the regression results for the standard control variables are affected by the existence of the control variables of our main interest. That is, we drop the interaction terms $Small_k \times FD_{c,t}$ and $\mathbf{X}_k \times FD_{c,t}$ from the list of the control variables, and estimate again the regression equation of the cost of financial intermediation (29). Estimation results in this case are presented in Table 3 and are consistent with the baseline results in Table 2. For instance, the coefficient α_1 on the industry's small firm share $Small_k$ is still positive for all five measures of the cost of financial intermediation and significant (at the five percent level) for three measures of the cost of financial intermediation.

[Insert Table 2.]

[Insert Table 3.]

These findings suggest some evidence the key features of the model that the cost of financial intermediation—likely to be transferred to borrowers ultimately— is greater for the small industry than for the large industry, and that such a disproportionate cost for the small industry would be reduced as the country's level of financial development (i.e., the efficiency of financial intermediation) increases.

4.2 Determinants of Industry-level Growth

Data Source We proceed to test the hypothesis about the model's main results (i.e., those in Propostion 1) that in response to an increase in the financial intermediary's efficiency growth, disproportionate firm growth in the small industry (relative to that in the large industry) is of magnitude greater in the more financially developed country. For this purpose, we use the *United Nations Industrial Statistics* database (Beck, Demirguc-kunt, Laeven and Levine; 2008), which is a industry-country panel and provides industry-level aggregated information on performance of all firms by industry and country. (See section B in Online Appendix for a list of sample industries and countries.)

Our sample covers firms in the 20 NACE two-digit manufacturing industries and in 28 countries over the world, during the period 2004-2012 annually.[33] Note that these countries vary substantially in levels of economic and financial development. Throughout this section, all monetary variables are in terms of the real 2013 U.S. dollars, and hence their growth rates are also in real terms. Given the industry-level aggregated information, we delete observations in the bottom- and top-tails as in Beck, Demirguc-kunt, Laeven and Levine (2008). As such, the sample includes 2,209 number of year-industry-country observations.

Methodology: Regression Framework and Construction of Variables We use the system GMM estimator of Arellano and Bond (1991) and Blundell and Bond (1998) to avoid the problem of serial correlation, heteroskedasticity and endogeneity of explanatory variables. One period is one calendar year. Let $g_{k,c,t} \equiv \log(y_{k,c,t+1}) - \log(y_{k,c,t})$ denote annual firm growth in industry k and country c at time $t+1$ (i.e., the dependent variable is one period later than the control variables), where $y_{k,c,t}$ is real value added (or real investment) per worker. The dynamic panel regression equation of $g_{k,c,t}$ is written as:

$$g_{k,c,t} = \lambda y_{k,c,t-1} + \left(\left[\beta_1 + \beta_2 FD_c \right] \cdot Small_k + \mathbf{\Psi} \cdot \mathbf{X}_k \right) \cdot CBG_{c,t}$$
$$+ GDP_{c,t} \cdot Small_k + ValueAddedShare_{k,c,t} + \epsilon_{i,k,c,t} \qquad (30)$$

[33]The sample period is restricted because data on credit bureau index, which is used in measuring the financial intermediary's efficiency growth, is available since 2004. To overcome sample restriction, we use the system GMM estimator of Arellano and Bond (1991) and Blundell and Bond (1998). It can improve dramatically on the performance of the usual first-differenced GMM estimator when the autoregressive parameter is moderately high and the number of time-series observations is moderately small.Blundell and Bond (1998) tested the finite sample properties of the system GMM estimator even when the sample period is 1979-1984. See online appendix for discussion of industries and countries included in the sample.

where FD_c refers to country c's time-invariant *level* of financial development, measured as the country's enterprise credit-to-GDP ratio, on average during the sample period, that is more specific to the degree of *firms'* access to credit than the private credit-to-GDP ratio[34] (Beck et al.; 2012); $Small_k$ the log of industry k's technological composition of small firms as discussed earlier; and $CBG_{c,t}$ the growth rate of the efficiency of financial intermediaries' information production in country c at time t, measured as annual growth in the credit bureau index and explained later. And $\epsilon_{i,k,c,t}$ is the error term. To isolate the effect of the financial intermediaries' efficiency growth $CBG_{c,t}$ on the small industry's firm growth, we control for a number of industry- and country-specific characteristics, mainly those used in Beck, Demirguc-kunt, Laeven and Levine (2008), as follows: $GDP_{c,t}$ refers to per-capita real GDP in country c at time t (controlling for economic development); $ValueAddedShare_{k,c,t}$ the industry k's value added share across industries in country c at time t (controlling for the country-and-time specific industrial composition); $\mathbf{X}_k$ the vector of industry-specific characteristics (measured for the corresponding U.S. industry).

$\mathbf{X}_k$ is a vector of industry characteristics (of which definitions are listed in appendix, section A) and includes industry-specific components of (i) global growth opportunities *Growth Opportunity*$_k$ (Fisman and Love; 2007), (ii) the degree of opaqueness in terms of assessing firm performance in the stock market *Opaqueness*$_k$ Durnev et al. (2004), (iii) dependence on intangible assets *Intangibility*$_k$ (Claessens and Laeven; 2003), (iv) the four-firm concentration ratio *Concentration*$_k$ (Beck, Demirguc-kunt, Laeven and Levine; 2008) , and (v) dependence on external finance *Ext Dep*$_k$ (Rajan and Zingales; 1998). The three characteristics (iii)–(v) are those that have been already used in the earlier analysis of the cost of financial intermediation, while the first two characteristics (i)–(ii) (*Growth Opportunity*$_k$

[34]By contrast, the private credit-to-GDP ratio includes credit given both to firms and to households.

and $Opaqueness_k$) are new ones and additionally controlled for as these two factors could be potentially relevant to the industry-specific sensitivity to the financial sector's improved efficiency. The first one $Growth\ Opportunity_k$ is intended to capture the industry-specific growth opportunities (e.g., global shift in demand that would increase firms' growth in the given industry), and the second one $Opaqueness_k$ captures the industry-specific sensitivity to improvement in the financial market's capability to assess the firm performance. As such, these two characteristics $Growth\ Opportunity_k$ and $Opaqueness_k$ could be related to the industry-specific growth sensitivity to the financial intermediary's efficiency growth, and hence they are additionally controlled for our regression of industry-specific firm growth.

One of the key variables of interest is growth in the financial intermediaries' efficiency. Ideally, it should to be measured in terms of facilitating the provision of information on borrowers' profitability/creditworthiness, which is difficult. As for its proxy, we use the annual growth rate of the country's credit bureau index (*aka* credit bureau growth $CBG_{c,t}$) during the period 2004-2012, taken from the *Doing Business* publications of the *World Bank*. For a given country and year, the credit bureau index measures the percentage of individuals and companies of which past repayment history is provided, labeled *coverage rate*.[35] Borrowers' past repayment history is likely to provide valuable information on the likelihood of the *comparable* borrowers' future repayment, and hence to be used as for the proxy of production of information on borrowers' creditworthiness about the future repayment (Djankov et al.; 2007; Arellano et al.; 2012). Under this plausible assumption, the credit bureau index is taken as our measure of the financial intermediaries' efficiency (i.e., inverse of the cost) of information production, and hence its average growth rate measures the per-year improvement in the financial intermediaries' efficiency of information production. The measure indicates

[35] Both private and public credit bureaus could exist; in such a case, we take the average of the two credit-bureau coverage rates as the measure of credit bureau index for a given country-year observation.

$g(a_t)$ in the equation (20) and (26). We drop observations if the average growth rate of the country's credit bureau is extremely high, i.e., higher than 200 percent per year.

One caveat is that the credit bureau index measures the total number of individuals and companies but not separately for each of these two different types of borrowers. Thus, evidence presented in this paper is limited to the presumed case in which credit bureau growth, even if the level of the credit bureau index is skewed for the individual borrowers rather than corporate borrowers, would be positively correlated with growth in the financial intermediary's efficiency of production of information on corporate borrowers. This is likely the case given that there could exist the economy of scope in the financial intermediary's production of information on different types of borrowers (e.g., a feedback effect from the assessment of creditworthiness of individuals to that of companies, and vice versa).

Results Table 4 presents summary statistics of key variables of the *U. N. Industrial Statistics* data together with country-level variables related to financial development. Descriptive statistics (across industry-country observations) of industry-level variables such as real value added per worker and real investment per worker are summarized in Panel A in Table 4. And Panel B in Table 4 provides statistics of the country-level variables related with financial development and growth in the financial intermediaries' efficiency of information production. (See section C in the online appendix for more detailed statistics for a given country and industry, respectively.) As shown by Table 4, our sample exhibits substantial variations both in investment growth and in value added growth. (See, in Panel A in Table 4, their substantial standard deviations compared to their mean values.)

[Insert Table 4.]

It is of our interest to measure the disproportionate effect of credit bureau growth $CBG_{c,t}$

on the technically small industry's growth, captured by the coefficient on the interaction term $Small_k \times CBG_{c,t}$. In particular, we are interested in testing whether or not such disproportionate firm growth in the small industry is greater, at least in the sense of the linear relationship, in a country with a higher level of financial development: $REIFIE(y_t)/a_t > 0$, which is effectively captured by the coefficient on the triple interaction term $Small_k \times CBG_{c,t} \times FD_c$. Here, the interaction term $Small_k \times CBG_{c,t}$ is supposed to capture the disproportionate firm growth in the small industry in response to the financial intermediary's efficiency growth (proxied by $CBG_{c,t}$); as such, the triple interaction term $Small_k \times CBG_{c,t} \times FD_c$ is intended to measure the linear variation of $Small_k \times CBG_{c,t}$ over a country's financial development FD_c that is a proxy for the model's measure of the financial intermediary's efficiency a_t. Taken together, the regression results are supposed to suggest evidence on whether or not the disproportionate effect of credit bureau growth on the small industry's growth $Small_k \times CBG_{c,t}$ is systematically related to the country's level of financial development FD.

[Insert Table 5.]

Table 5 present the results for the dynamic panel regression of industry-level firm growth, estimated by the system GMM estimator. As shown by Table 5, that the coefficient, β_2, on the triple interaction term $Small_k \times CBG_{c,t} \times FD_c$ is positive and significantly different from zero at the level of one percent and five percent in the regression of value added growth and investment growth, respectively. These findings indicate that in a country with a higher enterprise credit-to-GDP ratio, the technologically small industry's value added and investment growth is associated with growth in the provision of information on borrowers' creditworthiness to the extent significantly greater than in a country with a lower enterprise credit-to-GDP ratio. As such, these findings provide some evidence supporting the main results of the model.

Moreover, given that as shown by Table 1, the coefficient β_1 on the interaction term $Small_k \times CBG_{c,t}$ is negative, our findings suggest that in financially underdeveloped countries where FD_c is low, the improved efficiency of financial intermediaries does not necessarily increase capital growth in the small industry relative to that in the large industry. For instance, if a country's level of financial development is sufficiently low (e.g., Argentina), then the estimated coefficient $[\beta_1 + \beta_2 FD_c]$ would be even negative; in this case, an increase in credit bureau growth increases disproportionately the large industry's firm growth, opposite to the case of financially advanced countries where $[\beta_1 + \beta_2 FD_c]$ is positive.

5 Conclusion

This paper highlights the importance of understanding the mechanism of financial intermediaries' information production and its implications for the cross-section of capital allocation and disproportionate firm growth in the small industry. In particular, we emphasize the trade-off between the cost and benefit of financial intermediaries' production of information on borrowing firms' profitabilities, especially the evolution of such a trade-off over a country's level of financial development. More specifically, we explore implications of the hypothesis that the financial intermediary's marginal cost curve of information production is much steeper for the small firm than for the large firm, especially to magnitude greater in the financially less developed country.

We build a growth model in which financial intermediaries' production of information on borrowers' creditworthiness and loan contracts are endogenously determined. In particular, we consider the case in which as in the data, the smaller firm's productivity is more costly to assess, i.e., the financier's marginal cost curve of information production is much steeper for the smaller firm. Analytic results show that under some sufficient conditions, firm growth in the technologically small industry relative to that in the technologically large industry is more sensitive to growth in the financial intermediary's efficiency of information production, especially to the grater extent in the more financially developed country. These results imply that in financially underdeveloped countries, the effect of the improved efficiency of financial intermediaries on firm growth in the small industry could be of magnitude quite small.

Using data on syndicated loans and industry-level firm growth, we provide evidence supporting the key mechanism. More specifically, using the data on various fees charged to the loans made to firms, we provide some evidence supporting the key assumption that the cost of financial intermediation for the small industry is higher than that for the large industry, especially to magnitude greater in the financially underdeveloped countries. Moreover, by using the data on the industry-level firm growth (measured both in value added growth and in investment growth), we find evidence supporting the model's main result: within-country per-year growth in the credit bureau coverage is associated with significantly higher firm growth in the technologically small industry than in the technologically large industry, especially to the magnitude significantly greater in the more financially developed country than in the less financially developed country.

In this paper, we develop and integrate the theory of financial intermediaries' information production more tightly with extant empirical findings about financial development and firm growth as well as with new facts documented in this paper. It would be interesting to examine how differently the firm-level degree of financial constraint is relaxed in response to various improvements in the external financing opportunities, e.g., improved efficiency in raising capital via equity financing and other financial innovations. Such empirical findings could help researchers to reduce the gap between the theory of financial intermediary's information production and the rich empirical findings, which we leave for future work.

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A Definitions of Industry-Specific Characteristics

- **Small firm share**: the industry's share in employment of small firms (as of 1997) that have hired less than 20 employees in 1997, constructed by Beck, Demirguc-kunt, Laeven and Levine (2008).
- **Industry share in value added**: the industry's share in total value added of the country's manufacturing sector in year t.
- **External finance dependence**: *technological* dependence on external finance, measured as the corresponding U.S. industry's counterpart (Rajan and Zingales; 1998).
- **Intangibility**: the industry's dependence on intangible assets, from Claessens and Laeven (2003); it is calculated as the ratio of intangible assets to fixed assets (using the *Compustat* data) of U.S. firms in 2002.
- **Growth opportunity**: industry-specific component of global growth opportunities (Fisman and Love; 2007)—measured as real annual growth in net sales in the corresponding U.S. industry on average over the period 2002-2007.
- **Opaqueness**: the industry-level degree of opaqueness in assessing firm performance in the stock market—measured as one minus firm-specific variability of stock returns as in Durnev et al. (2004), based on *Compustat* and *CRISP* database. A high score indicates more stock return synchronicity and thus less informative pricing.
- **Concentration**: industry-level four-firm concentration ratio—measured as the corresponding U.S. industry's counterpart in 2002 as in Beck, Demirguc-kunt, Laeven and Levine (2008), based on the 2002 U.S. Census.

B Theoretical Appendix

The proof of Lemma 1 immediately follows from the results in Chapter 2 of Salanie (2005). We present proofs of other results: Lemma 2, Lemma 3, Corollary 1, and Proposition 1.

- First, the proof of Lemma 2 is as follows:

Proof. $dMPK^N(z)/dz = 0$ is obvious from the results in (14). Results in (15) show that $MPK^O(z)$ is strictly increasing in $\phi(z)/z$, which is strictly decreasing in z because $\phi(z)$ is weakly decreasing in z (assumption **A1**), and $1/z$ is strictly decreasing in z. □

- Second, the proof of Lemma 3 is as follows.

Proof. The industry j-specific equilibrium marginal cost and revenue of information production $\mu_t(j)$ are written as:
$E[HMC(z)|F_j] = \int_{\underline{z}}^{\overline{z}} c[z^{-\gamma}]dF_j(z)$ and $E[MR(z)|F_j] = [(1-\alpha)/(1+r_f)[\alpha/(1+r_f)]^{(\frac{\alpha}{1-\alpha})} \int_{\underline{z}}^{\overline{z}} \lambda(z)dF_j(z)$ where $\lambda(z) \equiv z \cdot \left[1 - \left\{1 - (1-\alpha)\frac{\phi(z)}{z}\right\}^{\frac{\alpha}{1-\alpha}}\right]$. To prove the first part of the results $E[MR(z)|F_S] \geq E[MR(z)|F_L]$, we essentially need to show that $\int_{\underline{z}}^{\overline{z}} \lambda(z)dF_S(z)$ is greater than or equal to $\int_{\underline{z}}^{\overline{z}} \lambda(z)dF_L(z)$. Given that F_L "first-order stochastically dominates (FOSD)" F_S, it immediately follows that $\int_{\underline{z}}^{\overline{z}} \varphi(z)dF_S(z) \geq \int_{\underline{z}}^{\overline{z}} \varphi(z)dF_L(z)$ for every function $\varphi(z)$ that is non-increasing in z. Thus, we proceed to showing that $\lambda(z)$ is non-increasing in z. The first-order derivative of $\lambda(z)$ is written as:

$$\frac{d\lambda(z)}{dz} = 1 - \left[1-(1-\alpha)\frac{\phi(z)}{z}\right]^{\frac{\alpha}{1-\alpha}} - \underbrace{\alpha\left(\frac{\phi(z)}{z} - \phi'(z)\right)\left[1-(1-\alpha)\frac{\phi(z)}{z}\right]^{\frac{\alpha}{1-\alpha}-1}}_{\equiv\xi}. \quad (31)$$

Note that $1-(1-\alpha)\phi(z)/z$ is larger than zero under the assumption (A1) as discussed earlier and smaller than one because $\phi(z)/z > 0$ and $\alpha < 1$. Thus, a sufficient, but not necessary, condition for $d\lambda(z)/dz < 0$ is that the terms indicated by the underbrace denoted by 'ξ' is larger than or equal to one, which is true under the two conditions: (i) $\alpha[\phi(z)/z - \phi'(z)] > 1$ and (ii) $\alpha/[1-\alpha] - 1 < 0$. In fact, the condition (i) above is obviously satisfied by the first part of the assumption (A4), and moreover, the condition (ii) above is also satisfied by the second part of the assumption (A4) as follows: The second part of the assumption (A4) states that $\alpha < 0.5$, from which it follows that $1/[1-\alpha] < 2$ and hence that the condition (ii) $\alpha/[1-\alpha] < 1$ is satisfied. Thus, in this case, $\left[1-(1-\alpha)\frac{\phi(z)}{z}\right]^{\frac{\alpha}{1-\alpha}-1} > 1$, and hence $\alpha\left(\frac{\phi(z)}{z} - \phi'(z)\right)\left[1-(1-\alpha)\frac{\phi(z)}{z}\right]^{\frac{\alpha}{1-\alpha}-1} > 1$.

The second result follows from the property that $d\{c[z]^{-\gamma}\}/dz = -\gamma c[z]^{-\gamma-1} < 0$. That is, the function $c[z]^{-\gamma}$ is non-increasing in z, and hence $\int_{\underline{z}}^{\overline{z}} c[z]^{-\gamma}dF_S(z) \geq \int_{\underline{z}}^{\overline{z}} c[z]^{-\gamma}dF_L(z)$ because F_L "first-order stochastically dominates (FOSD)" F_S. □

- Third, the proof of Corollary 1 is as follows:

Proof. It is obvious that $E[y^N(z)|F_L] \geq E[y^N(z)|F_S]$ because $y^N(z) = \left(\frac{\alpha}{1+r_f}\right)^{\frac{\alpha}{1-\alpha}} \cdot z$ is proportional to z with a positive slope, i.e., $y^N(z)$ is strictly increasing in z, and F_L "first-order stochastically dominates (FOSD)" F_S. We proceed to proving that $E[y^O(z)|F_L] \geq E[y^O(z)|F_S]$, for which it suffices to show that $y^O(z)$ is non-decreasing in z. The first-order derivative of $y^O(z)$ is written as:

$$\frac{dy^O(z)}{dz} = \left(\frac{\alpha}{1+r_f}\right)^{\frac{\alpha}{1-\alpha}} \left(\left[1-(1-\alpha)\frac{\phi(z)}{z}\right]^{\frac{\alpha}{1-\alpha}} + \left[1-(1-\alpha)\frac{\phi(z)}{z}\right]^{\frac{\alpha}{1-\alpha}-1} \cdot \alpha \left[\frac{\phi(z)}{z} - \phi'(z)\right] \right) \tag{32}$$

which is positive because $1-(1-\alpha)\phi(z)/z > 0$ as shown earlier and $\phi'(z) \leq 0$ by the assumption (A1). Last, we prove the remaining results that $E[y^N(z)-y^O(z)|F_S] \geq E[y^N(z)-y^O(z)|F_L]$. Because of $E[y^h(z)] = \frac{1}{1-\alpha} \cdot E[\pi^h(z)]$ for $h \in \{N, O\}$, it follows that for $j \in \{S, L\}$, $E[y^N(z)-y^O(z)|F_j] = E[y^N(z)|F_j] - E[y^O(z)|F_j] = [1/(1-\alpha)] \cdot \Big[E[\pi^N(z)|F_j] - E[\pi^O(z)|F_j]\Big]$, which is strictly increasing in and proportional to $E[MR(z)|F_j] = E[\pi^N(z)|F_j] - E[\pi^O(z)|F_j]$ because $(1-\alpha) > 0$. Note that $E[MR(z)|F_S] \geq E[MR(z)|F_L]$ by Lemma 3 and assumption (A4), which proves that $E[y^N(z)|F_S] - E[y^O(z)|F_S] \geq E[y^N(z)|F_L] - E[y^O(z)|F_L]$. □

- Fourth, the proof of Proposition 1 is as follows.

Proof. Assume that five assumptions (1)-(5) hold. We want to show that $\Psi_t(S) > \Psi_t(L)$ where $\Psi_t(j)$ is defined as in equation (25). That is, $\Psi_t(j) = 1\Big/[\widetilde{\psi}_t(j) + \psi_t(j)]$ where

$$\widetilde{\psi}_t(j) \equiv a_t - \frac{E[HMC(z)|F_j]}{E[MR(z)|F_j]}, \text{ and } \quad \psi_t(j) \equiv \left[\frac{1}{E[MR(z)|F_j]}\right] \times \left[\frac{E[y^O|F_j]}{E[y^N|F_j] - E[y^O|F_j]}\right]. \tag{33}$$

Given that $\Psi_t(j)$ is strictly decreasing both in $\widetilde{\psi}_t(j)$ and in $\psi_t(j)$, it suffices to show that $\widetilde{\psi}_t(S) < \widetilde{\psi}_t(L)$ and $\psi_t(S) < \psi_t(L)$, where it was shown earlier that $\widetilde{\psi}_t(S) > 0$ and $\psi_t(S) > 0$. First, $\widetilde{\psi}_t(S) < \widetilde{\psi}_t(L)$ directly follows from the assumption (A5) that $E[HMC(z)|F_S]\Big/E[HMC(z)|F_L] > E[MR(z)|F_S]\Big/E[MR(z)|F_L]$. Second, $\psi_t(S) < \psi_t(L)$ is proven as follows: Note that $1/E[MR(z)|F_S] < 1/E[MR(z)|F_L]$ by Lemma 3. Moreover, $E[y^O|F_S] < E[y^O|F_L]$ and $\Big(1\Big/\Big[E[y^N|F_S] - E[y^O|F_S]\Big]\Big) < \Big(1\Big/\Big[E[y^N|F_L] - E[y^O|F_L]\Big]\Big)$ by Corollary 1. □

Table 1: Summary Statistics: ***LPC's DealScan*** Data

Note: this table presents descriptive statistics of information on loan characteristics.

	Obs.	Mean	SD	Min	p25	Median	p75	Max
	Panel A: Costs of Financial Intermediation							
Commitment fee (bps)	628	31.2	15.2	5	20	25	37.5	130
Letter of credit (LC) fee (bps)	788	158.4	94.7	11	82.5	137.5	225	550
Annual fee (bps)	420	20.1	11.2	4	12.5	17.5	25	75
Utilization fee (bps)	100	21.8	39.4	0	10	12.5	25	250
	Panel B: Loan Characteristics							
Loan spread (bps)	8,366	247.7	170.2	18	125	225	325	1,500
Loan amount (mil. USD)	8,366	244.2	754.6	0.05	20.3	60.5	180.4	18,821.6
Maturity (years)	8,366	51.7	34.7	1	24	59	63	300

Table 2: Determinants of Costs of Financial Intermediation

Note: this table presents results for the cross-sectional regression of the firm-level cost of financial intermediation $Ln(1 + c_{i,k,c,t})$—in terms of commitment fee, LC fee, annual fee, utilization fee and loan spread –at period t, in industry k and in country c over the sample period 1987-2015. 'FD' refers to the private credit-to-GDP ratio (proxy for the level of financial development of a given country), 'Growth Opportunity' refers to the industry-specific component of global growth opportunities, 'Ext Dep' the industry's technological dependence on external finance, 'Intangibility' the industry's dependence on intangible assets, and 'Concentration' the industry's four-firm concentration ratio. Standard errors are inside the parenthesis and robust to cross-sectional clustering for a borrowing country. '*', '**', and '***' indicates significance at the 10%, 5%, and 1% level, respectively.

Dependent Variable	Commitment Fee	Letter of Credit (LC) Fee	Annual Fee	Utilization Fee	Loan Spread
Regression	(1)	(2)	(3)	(4)	(5)
Small	0.0015***	0.0139***	-0.0002	-0.0059**	0.031**
	(0.0003)	(0.0032)	(0.0007)	(0.0012)	(0.013)
Small × FD	-0.0013*	-0.0138***	-0.0014*	0.0002	-0.055***
	(0.0006)	(0.0031)	(0.0008)	(0.0002)	(0.0006)
Intangibility × FD	-0.0006	-0.0138***	-0.0021	0.0016**	0.0002
	(0.0009)	(0.0047)	(0.013)	(0.0004)	(0.0013)
Concentration × FD	0.0000	-0.0001	-0.0000	-0.0003***	-8.52e-06
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Ext Dep × FD	-0.0028*	-0.0269***	-0.0018	0.0023***	-0.0080***
	(0.0014)	(0.0065)	(0.0025)	(0.011)	(0.0028)
Ln(Loan amount)	-0.0003***	-0.0032***	-0.0001***	-0.0003***	-0.0037***
	(0.0000)	(0.0002)	(0.0000)	(0.0000)	(0.0001)
Ln(Maturity)	0.0003***	0.0023**	0.0003***	0.0006***	0.0012***
	(0.0000)	(0.0009)	(0.0000)	(0.00000)	(0.0004)
Active	0.0004****	-0.0018	-0.0002	-	0.0003
	(0.0000)	(0.0015)	(0.0003)	-	(0.0007)
Refinancing	0.0000	-0.0002	0.0002	-0.0033***	-0.0020***
	(0.0000)	(0.0007)	(0.0001)	(0.0003)	(0.0002)
Currency risk	0.0002***	-5.69e-06	-0.0002*	0.0001**	-0.0017***
	(0.0000)	(0.0006)	(0.0001)	(0.0000)	(0.0002)
Constant	-0.0001	0.0302***	0.0110	0.0240**	0.0596***
	(0.0022)	(0.0098)	(0.0103)	(0.0046)	(0.0046)
Industry-fixed effects	Yes	Yes	Yes	Yes	Yes
Country-fixed effects	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	628	788	420	100	8,366
Number of countries	11	4	5	5	47
R^2	0.25	0.42	0.28	0.29	0.26

Table 3: Determinants of Costs of Financial Intermediation: Robustness Check

Note: this table presents results for the cross-sectional regression of the firm-level cost of financial intermediation $Ln(1 + c_{i,k,c,t})$—in terms of commitment fee, LC fee, annual fee, utilization fee and loan spread –at period t, in industry k and in country c over the sample period 1987-2015. Standard errors are inside the parenthesis and robust to cross-sectional clustering for a borrowing country. '*', '**', and '***' indicates significance at the 10%, 5%, and 1% level, respectively.

Dependent Variable	Commitment Fee	Letter of Credit (LC) Fee	Annual Fee	Utilization Fee	Loan Spread
Regression	(1)	(2)	(3)	(4)	(5)
Small	0.0008***	0.0028*	0.0002	0.0018***	0.0024***
	(0.0000)	(0.0014)	(0.0002)	(0.0001)	(0.0008)
Ln(Loan amount)	-0.0003***	-0.0032***	-0.0001***	-0.0003**	-0.0036***
	(0.0000)	(0.0002)	(0.0000)	(0.0000)	(0.0001)
Ln(Maturity)	0.0003***	0.0023**	0.0003***	0.0007	0.0012***
	(0.0000)	(0.0009)	(0.0000)	(0.0000)	(0.0004)
Active	0.0005***	-0.0017	-0.0003	-	0.0003
	(0.0000)	(0.0015)	(0.0003)	-	(0.0007)
Refinancing	0.0000	-0.0001	0.0000	-0.0035***	-0.0020***
	(0.0000)	(0.0007)	(0.0001)	(0.0004)	(0.0002)
Currency risk	0.0002***	0.0000	-0.0002*	0.0002	-0.0018***
	(0.0000)	(0.0006)	(0.0001)	(0.0002)	(0.0002)
Constant	0.0074***	0.0642***	0.0032**	0.0023	0.1035***
	(0.0005)	(0.0075)	(0.0014)	(0.0012)	(0.0038)
Industry-fixed effects	Yes	Yes	Yes	Yes	Yes
Country-fixed effects	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	628	788	420	100	8,366
Number of countries	11	4	5	5	47
R^2	0.25	0.42	0.26	0.24	0.26

Table 4: Summary Statistics: ***UN Industrial Statistics*** Data

Note: this table presents descriptive statistics of key variables of the *United Nations (U. N.) Industrial Statistics* data. Panel A presents statistics of variables unconditionally across industry-country-year observations. And 'Panel B' presents cross-country statistics of country-level variables related to financial and economic development and 'Panel C' their correlation coefficients. 'Enterprise Credit-to-GDP' refers to the average ratio of enterprise credit to GDP, which measures a country's level of financial development in terms of facilitating firms' access to credit, and 'Credit Bureau Growth' the annual growth rate of the credit bureau coverage over period 2004-2012, which measures the within-country per-year improvement in the financial intermediaries' efficiency of production of information on borrowers' creditworthiness. 'SD' refers to the standard deviation, 'p25' the 25 percentile, and 'p75' the 75 percentile. '*' indicates significance at the 1% level.

	Panel A: Unconditional Statistics Across Industry-Country Observations							
	Obs.	Mean	SD	Min	p25	Median	p75	Max
Investment per Worker: Growth	2,209	0.011	0.374	-2.310	-0.127	0.007	0.125	3.225
Investment per Worker: Level(USD)	2,209	61,784	114,206	758	22,224	37,634	64,612	2,529,991
Value Added per Worker: Growth	2,209	0.014	0.344	-2.725	-0.235	0.024	0.104	4.057
Value Added per Worker: Level(USD)	2,209	411,448	639,166	11,534	172,462	328,323	461,922	11,841,150

	Panel B: Statistics of Country-Level Financial Development							
	Country-Year Obs.	Mean	SD	Min	p25	Median	p75	Max
Per-Capita GDP (in USD)	530	32,300	12,247	3,698	23,415	36,393	40,954	53,179
Enterprise Credit/GDP	28	0.41	0.27	0.08	0.19	0.31	0.60	1.14
Private Credit/GDP	530	0.96	0.49	0.20	0.47	0.99	1.24	1.96
Credit Bureau: Growth	530	0.12	0.29	-0.75	0	0.02	0.14	1.48

	Panel C: Correlation Coefficients of Country-Level Financial Development and Firm Growth							
	Per-Capita GDP	Enterprise Credit/ GDP	Private Credit/ GDP	Credit Bureau: Growth	Invest-ment: Growth	Value Added: Growth	Invest-ment: Level	Value Added: Level
Per-capita GDP	1.0							
Enterprise Credit/GDP	0.18*	1.0						
Private Credit/GDP	0.66*	0.42*	1.0					
Credit Bureau: Growth	-0.29*	-0.17*	-0.34*	1.0				
Investment per Worker: Growth	0.01	-0.01	-0.02	0.05*	1.0			
Value Added per Worker: Growth	0.02	-0.01	-0.05	-0.02	0.65*	1.0		
Investment per Worker: Level	0.15*	0.06	0.09*	-0.07*	-0.01	-0.02	1.0	
Value Added per Worker: Level	0.36*	0.09*	0.25*	-0.13*	-0.01	-0.01	0.66*	1.0

Table 5: Determinants of Industrial Growth

Note: this table presents results for the dynamic panel regression of industry-level growth $g_{k,c,t}$, defined as $\log(y_{k,c,t+1}) - \log(y_{k,c,t})$—in terms of real investment per worker and real value added per worker—at period t, in industry k and in country c over the sample period 2004-2012. 'CBG' refers to growth in credit bureau (proxy for growth in the financial intermediary's capability of information production), 'FD' the enterprise credit-to-GDP ratio (proxy for the level of financial development), 'GDP per capita' the yearly per-capita real GDP, 'Growth Opportunity' the industry-specific component of global growth opportunities, 'Ext Dep' the industry's dependence on external finance, 'Intangibility' the industry's dependence on intangible assets, 'Opaqueness' the industry's degree of opaqueness in terms of assessing firm performance in the stock market, and 'Concentration' the industry's four-firm concentration ratio. Standard errors are inside parenthesis. '*', '**', and '***' indicates significance at the 10%, 5%, and 1% level, respectively.

Dependent Variable ($g_{k,c,t}$)	Investment Growth		Value-Added Growth	
Regression	(1)	(2)	(3)	(4)
Small	0.331	0.333	4.001***	4.028***
	(1.433)	(1.435)	(1.398)	(1.387)
Small × CBG	-0.061**	-0.103**	-0.106***	-0.068
	(0.029)	(0.049)	(0.027)	(0.046)
Small × CBG × FD	0.123**	0.123**	0.191***	0.201***
	(0.053)	(0.053)	(0.050)	(0.050)
Small × GDP per capita	-0.083	-0.086	-0.525***	-0.518***
	(0.158)	(0.158)	(0.154)	(0.153)
Industry Share in Value Added	-0.115*	-0.118*	-0.240***	-0.232***
	(0.063)	(0.063)	(0.060)	(0.060)
Growth Opportunity × CBG		-0.250		-0.930
		(1.225)		(1.148)
Opaqueness × CBG		0.304		-0.564
		(0.377)		(0.353)
Intangibility × CBG		0.024		0.011
		(0.070)		(0.065)
Concentration × CBG		0.000		0.001
		(0.003)		(0.003)
Ext Dep × CBG		-0.006		-0.020
		(0.032)		(0.030)
Investment per Worker			-0.021	-0.019
			(0.070)	(0.070)
Wage	0.081	0.085	0.190***	0.179***
	(0.068)	(0.068)	(0.066)	(0.066)
y_{t-1}	-0.009***	-0.009***	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	2,209	2,209	2,209	2,209
Number of countries	28	28	28	28
Wald χ^2	559.52	559.35	368.80	375.19