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IMPACT ON GDP AND INEQUALITY

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Distinguishing Constraints on Financial Inclusion and Their Impact on GDP and Inequality  
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**ABSTRACT**

We develop a micro-founded general equilibrium model with heterogeneous agents to identify pertinent constraints to financial inclusion. We evaluate quantitatively the policy impacts of relaxing each of these constraints separately, and in combination, on GDP and inequality. We focus on three dimensions of financial inclusion: access (determined by the size of participation costs), depth (determined by the size of collateral constraints resulting from limited commitment), and intermediation efficiency (determined by the size of interest rate spreads and default possibilities due to costly monitoring). We take the model to firm-level data from the World Bank Enterprise Survey and World Development Indicators for six countries at varying degrees of economic development – three low income countries (Uganda, Kenya, Mozambique), and three emerging market countries (Malaysia, the Philippines, and Egypt). The results suggest that alleviating different financial frictions have a differential impact across countries, with country-specific characteristics playing a central role in determining the linkages and trade-offs among inclusion, GDP, inequality, and the distribution of gains and losses.

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# 1 Introduction

Financial deepening has accelerated in emerging market and low-income countries over the past two decades. The record on financial inclusion, however, has not kept apace. Large amounts of credit do not always correspond to broad use of financial services, as credit is often concentrated among the largest firms. Moreover, firms in developing countries evidently continue to face barriers in accessing financial services. For instance, 95 percent of firms in advanced economies have access to a bank loan or line of credit as compared with 58 percent in developing economies, and 20 percent in low-income countries (Figure I). Collateral requirements for loans, which impose borrowing constraints on firms, are also 2-3 times as high in developing countries as compared to advanced economies. Similarly, interest rate spreads (the difference between lending and deposit rates) tend to be much higher than in advanced economies. Firms also differ in terms of their own identification of access to finance as a major obstacle to their operations and growth: in developing economies, 35 percent of small firms report that access to finance is a major obstacle to their operations, compared with 25 percent of large firms, and 8 percent of large firms in advanced economies (Figure II).<sup>1</sup>

These considerations warrant a tractable framework that allows for a systematic examination of the linkages between financial inclusion, GDP, and inequality. Moreover, there is a need for better understanding of the economic channels through which these relationships are sustained. Given that financial inclusion is multi-dimensional, involving both participation barriers and financial frictions that constrain credit availability, policy implications to foster financial inclusion are likely to vary across countries. In this paper, we develop a micro-founded general equilibrium model to address these issues. This approach offers a consistent framework to elucidate the linkages between financial inclusion, GDP, and inequality, and to quantify the impact of specific policy changes. This can help guide policy makers in prioritizing between different financial sector policies depending upon their goals. In the concluding section of this paper, we summarize typical micro level policy discussions, and our goal is to advance these discussions by tracing out macro general equilibrium impacts.

[Figure 1 about here.]

In the model, agents are heterogeneous—distinguished from each other by wealth and talent. Individuals choose in each period whether to become an entrepreneur or to supply labor for a wage. Workers supply labor to entrepreneurs and are paid the equilibrium wage. Entrepreneurs have access to a technology that uses capital and labor for production. In equilibrium, only talented individuals with a certain level of wealth choose to become entrepreneurs. Untalented individuals, or those who are talented but wealth-constrained, are unable to start a profitable business, choosing

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<sup>1</sup>This problem is more acute for firms in the informal sector. In this paper, we focus primarily on formal sector firms.

instead to become wage earners. Thus, occupational choices determine how individuals can save and also what risks they can bear, with long-run implications for growth and the distribution of income.

[Figure 2 about here.]

The model features an economy with two “financial regimes”, one with credit and one with savings only. Individuals in the savings regime can save (i.e., make a deposit in financial institutions to transfer wealth over time) but cannot borrow. Participation in the savings regime is free, but individuals must pay a participation cost to borrow. The size of this participation cost is one of the determinants of financial inclusion, capturing the fixed transactions costs and high annual fees, documentation requirements, and other access barriers facing firms in developing countries. This is in short a variable which captures the various nuanced dimensions of credit access elaborated in the concluding section.

Once in the credit regime, individuals can obtain credit, but its size is constrained by two additional types of financial frictions—limited commitment and asymmetric information. These distort the allocation of capital and entrepreneurial talent in the economy, lowering aggregate total factor productivity (TFP). The first financial friction is modeled as collateral constraints, which arise from the imperfect enforceability of contracts. Entrepreneurs have to post collateral in order to borrow. The amount/value of collateral is thus another determinant of financial inclusion, affecting the amount of the credit available. The second financial friction arises from asymmetric information between banks and borrowers. In this environment, interest rates charged on borrowing must cover the cost of monitoring of highly-leveraged firms. Because more productive and poorer agents are more likely to be highly leveraged, the ensuing higher intermediation cost is another source of inefficiency and financial exclusion. As only highly leveraged firm are monitored, firms face differential costs of capital and may choose not to borrow even when credit is available.

In our model, greater financial inclusion impacts GDP and inequality primarily through two channels. First, it allows for a more efficient allocation of funds among entrepreneurs, thereby increasing aggregate output. This occurs as funds are channeled to talented entrepreneurs, increasing their output disproportionately more than that of less-talented ones. Second, more efficient financial contracts limit waste from financial frictions (e.g., the credit participation and monitoring costs) leading to higher GDP. If higher output is achieved through the reallocation of funds to more talented entrepreneurs, who are already receiving a higher income than other agents, income inequality can rise. However, financial inclusion through lower credit participation costs can also crowd-in relatively untalented agents, resulting in a decrease in income inequality. This underlines the trade-off between GDP and inequality.

We calibrate the model using data from the World Bank Enterprise Surveys and World Development Indicators. The Enterprise Survey is a firm-level survey of a representative sample of firms

in an economy. The surveys cover a broad range of business environment topics including access to finance, corruption, infrastructure, crime, competition, and performance measures. We jointly choose the model's key parameters to match the simulated moments, such as the percent of firms with credit and the firm employment distribution, as well as the economy-wide non-performing loans ratio, and interest rate spread. We calibrate the model separately for six developing countries at varying degrees of economic development: three low-income countries (Uganda in 2005, Kenya in 2006, and Mozambique in 2006), and three emerging market economies (Malaysia in 2006, Philippines in 2007, and Egypt in 2007). Although financial systems in emerging market economies are more developed than in low-income countries, this does not hold for every dimension of financial inclusion. For example, the collateral requirement in the Philippines is 238.4% of the loan amount, which is higher than the requirement in Uganda, Kenya and Mozambique. Moreover, different dimensions of financial inclusion vary significantly even within countries at a similar stage of economic development. For example, Kenya outperforms Uganda and Mozambique in terms of the percentage of firms with access to credit, but the collateral requirement is more stringent.

The quantitative model developed in this paper enables us to examine the impact of various financial inclusion policies on GDP, income inequality (as measured by the Gini coefficient) and overall welfare. The model simulations suggest that the impact of financial inclusion policies depends upon country-specific characteristics. For example, Uganda's GDP is most responsive to a relaxation of borrowing/collateral constraints. This is because firms in Uganda are severely constrained by high collateral requirements, so that reducing intermediation costs only benefits a small number of highly-leveraged firms. By contrast, high fixed participation costs are a major obstacle to financial inclusion in Malaysia. These results suggest that understanding the specific factors constraining financial inclusion in an economy is critical for tailoring policy advice. The focus of public policy should thus be on ameliorating the most pressing financial frictions.

The model simulations also indicate that different dimensions of financial inclusion unambiguously increase the economy's TFP as talented entrepreneurs, who desire to operate firms at a larger scale, benefit disproportionately. However, they have a differential impact on GDP and inequality and there are trade-offs. For example, a decline in participation costs reduces income inequality as entrepreneurs living in the savings regime obtain credit and workers receive higher wages. Relaxing borrowing constraints, on the other hand, can have an ambiguous impact on inequality, with inequality initially increasing and then declining. In other words, a Kuznets-type response can be generated. In fact, different dimensions of financial inclusion can result in different distributional consequences. In a partial equilibrium analysis, everyone can benefit from a more inclusive financial system, albeit to varying degrees. However, in general equilibrium, the resulting changes in interest rates and wages can lead to losses for some agents. For example, the policy that is most effective in increasing access (reducing participation costs) benefits the poor and talented agents primarily, while wealthy agents lose due to higher interest rates and wages. By contrast, policies that target

financial depth (relaxing borrowing constraints) benefit wealthy and talented agents but can impose losses on wealthy but less-talented agents.

We also show that there exist rich interactions between different dimensions of financial inclusion. Conducting two policies that target different financial frictions simultaneously can lead to a larger increase in GDP for some range of parameter values. However, to the extent that these policies are substitutes, implementing one policy can reduce the effectiveness of other policies in boosting GDP.

The remainder of the paper is organized as follows. The next section provides a brief overview of the related literature. Section 3 sets out the structure of the model. Section 4 presents the data and the model calibration. Section 5 discusses the quantitative results. Section 6 presents several robustness checks. Finally, section 7 provides policy conclusions and concluding remarks.

## 2 Literature Review

A growing theoretical literature has emphasized the aggregate and distributional impacts of financial intermediation in models of occupational choice and financial frictions. This theoretical framework is first introduced by Banerjee and Newman (1993) to capture the process of economic development. Lloyd-Ellis and Bernhardt (2000) extend the model to explain income inequality and the existence of a Kuznets curve. Cagetti and Nardi (2006) build on the framework to show that the introduction of a bequest motive generates lifetime savings profiles more consistent with data. In these studies, improved financial intermediation leads to greater entry into entrepreneurship, higher productivity and investment, and a general equilibrium effect that increases wages. Moreover, the models suggest that the distribution of wealth or the joint distribution of wealth and productivity is critical.

A related literature has found sizable impacts of improved financial intermediation on aggregate productivity and income (Gine and Townsend, 2004; Jeong and Townsend, 2007, 2008; Amaral and Quintin, 2010; Buera, Kaboski and Shin, 2011; Greenwood, Sanchez and Wang, 2013). Buera, Kaboski and Shin (2011) incorporate forward-looking agents in an occupational choice framework, showing that financial frictions account for a substantial part of the observed cross-country differences in output per worker and aggregate TFP. Moreover, Buera, Kaboski and Shin (2012) focus on the general equilibrium effects of micro finance. They find that the impact of scaling-up microfinance on per-capita income is small, because of the ensuing redistribution of income from high-savers to low-savers, but the vast majority of the population benefits from higher wages. Moll (2014) shows that the impact of financial frictions on GDP and TFP depends on the persistence of idiosyncratic shocks, and that the short-run effects of financial frictions tend to be larger than their long-run impacts.

Our model builds on this occupational choice framework, but with novel features. We focus on several dimensions of financial inclusion within an economy. Although these dimensions have typically been considered separately in the previous literature, our paper provides a unified framework for

examining them individually as well as jointly. Our model features three types of financial frictions: fixed costs of credit entry, limited commitment, and asymmetric information. Unlike previous studies, our model allows us to also uncover how different frictions interact with each other. In this sense, our paper is related to studies in which multiple financial frictions co-exist and are compared. Clementi and Hopenhayn (2006) and Albuquerque and Hopenhayn (2004) argue that moral hazard and limited commitment have different implications for firm dynamics. Abraham and Pavoni (2005) and Doepke and Townsend (2006) discuss how consumption allocations differ under moral hazard with and without hidden savings versus full information. Martin and Taddei (2013) study the implications of adverse selection on macroeconomic aggregates and contrast them with those under limited commitment. Karaivanov and Townsend (2014) estimate the financial/information regime in place for households (including those running businesses) in Thailand and find that a moral hazard constrained financial regime fits the data best in urban areas, while a more limited savings regime is more applicable for rural areas. Similarly, Paulson, Townsend and Karaivanov (2006) argue that moral hazard best fits the data in the more urban Central region of Thailand but not in the more rural Northeast. Kinnan (2014) uses a different metric based on the first-order conditions characterizing optimal insurance under moral hazard, limited commitment and hidden income to distinguish between these regimes in Thai data. Finally, Moll, Townsend and Zhorin (2014) use a general equilibrium framework that encompasses different types of frictions, and examines the equilibrium interactions among various frictions. Our paper is related to these studies, but constitutes a normative policy analysis. By developing a quantitative macroeconomic framework and disciplining it with micro data, we shed light on a number of policy issues. For instance, what financial frictions are most relevant for the economy's GDP and income inequality? And what is the impact of alleviating these financial frictions individually or jointly?

Our paper is also related to a large empirical literature on the real effects of credit. The view that financial inclusion spurs economic growth is supported by empirical evidence (King and Levine, 1993; Levine, 2005). Regression-based analyses at the aggregate level reveal a strong correlation between broad measures of financial depth (such as M2 or credit to GDP) and economic growth. For firms, access to finance is positively associated with innovation, job creation, and growth (Beck, Demirg-Kunt and Maksimovic, 2005; Ayyagari, Demirg-Kunt and Maksimovic, 2008). There is also evidence that aggregate financial depth is positively associated with poverty reduction and income inequality (Beck, Demirg-Kunt and Levine, 2007; Clarke, Xu and fu Zou, 2006). Cross-sectional regression analysis, however, can be problematic as causality cannot easily be established, causal mechanisms are difficult to pin down, and policy evaluation is more challenging. Moreover, the implicit assumptions of stationarity and linearity in regression analysis could be incorrect, even after taking logs and including lags, if these variables lie on complex transitional growth paths (Townsend and Ueda, 2006). The advantage of using a structural framework such as ours lies in capturing salient features of the economy and the pertinent financial sector frictions.

Our paper is also broadly related to the literature on misallocation (Hsieh and Klenow, 2009; Caselli and Gennaioli, 2013; Midrigan and Xu, 2014; Moll, 2014) and inequality (Davies, 1982; Huggett, 1996; Aghion and Bolton, 1997; Castaneda, Diaz-Gimenez and Rios-Rull, 2003; Nardi, 2004). Our contribution is to show that policy options that target different financial sector frictions have different impacts on resource allocation and inequality. More importantly, even for the same policy, the impacts on inequality can differ as these impacts are contingent on country-specific characteristics.

### 3 The Model

The economy is populated by a continuum of agents of measure one. Agents are heterogeneous in terms of initial wealth  $b$  and talent  $z$ .

Each agent lives for two periods. In the first period, the agent makes credit participation, occupational choice, and investment decisions, taking the optimal consumption/bequest decision made in the second period as given. In the second period, the agent realizes income as wage or business profit, depending on the occupation, and makes consumption and bequest decisions to maximize utility. Each agent has an offspring, whose wealth is equal to the bequest, and talent is drawn from a stochastic process.<sup>2</sup> The time sub-script  $t$  is omitted unless necessary.

#### 3.1 Individuals

The agent generates utility only in the second period through consumption and a bequest to her offspring. The utility function is Cobb-Douglas, given by

$$u(c, b') = c^{1-\omega} b'^{\omega}, \tag{3.1}$$

where  $c$  is consumption, and  $b'$  is bequest. The bequest motive transfers wealth across periods, which endogenously determines the economy's wealth distribution. The assumption that utility is generated by bequest rather than the offspring's utility simplifies the analysis and captures the idea of a tradition for bequest-giving following Andreoni (1989). It is equivalent to a myopic savings rate for the same agent. In section 6 and appendix B, we consider robustness checks and fully explore the implication of myopic savings rate by contrasting the baseline model's simulation results with the results obtained from a model with forward looking agents.

In the second period, the agent maximizes (3.1) by choosing  $c$  and  $b'$  subject to the budget constraint  $c + b' = W$ , where  $W$  denotes the second period wealth, and it depends on initial wealth and realized first-period income.

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<sup>2</sup>The successor of an agent can be interpreted as the reincarnation of the original agent with potentially new talent.



The Cobb-Douglas form implies that the optimal bequest rate is  $\omega$ .<sup>3</sup> Hence, the utility function  $u(c, b')$  is a linear function of end-of-period wealth ( $W$ ), i.e., the agent is risk neutral. This implies that maximizing expected utility is equivalent to maximizing expected second-period wealth. Therefore, in the first period, the agent chooses financial participation, occupation, and investment to maximize expected income.

In the first period, agents need to make an occupational choice between being a worker or an entrepreneur.<sup>4</sup> Each worker supplies one unit of labor, and the income realized in the first period is equal to the equilibrium wage,  $w$ . The entrepreneur invests capital and labor, and obtains income through business profit.

Talent is drawn from a Pareto distribution  $\mu(z)$  with a tail parameter  $\theta$ . The offspring inherits the talent of her parents (or former self) with probability  $\gamma$ , otherwise, a new talent is drawn from  $\mu(z)$ .<sup>5</sup>

The entrepreneur has access to a production technology, the productivity of which depends on the agent's talent. The production function is given by

$$f(k, l) = z(k^\alpha l^{1-\alpha})^{1-\nu} \quad (3.2)$$

where  $1 - \nu$  is the Lucas span-of-control parameter, representing the share of output accruing to the variable factors. Out of this, a fraction  $\alpha$  goes to capital, and  $1 - \alpha$  goes to labor. Production exhibits diminishing returns to scale, with  $\nu > 0$ . Firms make profits, and capital depreciates by  $\delta$  after use.

Production fails with probability  $p$ , in which case output is zero and the agent is able to recover only a fraction  $\eta < 1$  of installed capital, net of depreciation in the second period. To simplify the calculation, we assume workers get paid only when production is successful. Therefore, each worker earns a wage with probability  $1 - p$ .

All agents can make a deposit in a financial institution so as to transfer income and initial wealth across periods for consumption and bequest. However, following Greenwood and Jovanovic (1990) and Townsend and Ueda (2006), agents need to pay a fixed credit participation cost,  $\psi$ , to obtain a borrowing contract from financial institutions. We assume that an agent lives in a “credit” regime, if the agent pays the cost  $\psi$  and can borrow; that an agent lives in a “savings” regime, if the agent does not pay  $\psi$  and can thereby only save. This cost can be considered as a contractual fee or a bargaining cost with financial institutions. Intuitively, since workers do not invest, they never demand external credit. Entrepreneurs may want to borrow in order to expand their firm

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<sup>3</sup>The value of  $\omega$  affects the amount of wealth transferred from the current period to the next period. Therefore, ceteris paribus a higher  $\omega$  implies that the economy would have a higher level of wealth.

<sup>4</sup>In our framework, farmers can be considered as entrepreneurs, who operate their own farming businesses.

<sup>5</sup>The shock to talent is interpreted as changes in market conditions that affect the profitability of individual skills as in Buera, Kaboski and Shin (2011).

scale and profits. In equilibrium, the fixed entry cost  $\psi$  is more likely to exclude poor entrepreneurs from financial markets, because this amounts to a larger fraction of their initial wealth. The next section illustrates the structure of the borrowing contract in detail.

Note that both the wage and deposit interest rate are potentially time-varying and determined endogenously by the labor and capital market clearing conditions. Given the equilibrium wage rate  $w$ , and deposit interest rate  $r^d$ , an agent of type  $(b, z)$  makes credit participation and occupational choice decisions to maximize expected income.

We solve the problem in two steps: first, the agent chooses her occupation conditional on the regime she is living in; second, the agent chooses the underlying regime by comparing the expected income that can be obtained in each regime. The next section presents the occupational choice problem in the savings and credit regimes, respectively.

### 3.1.1 Savings Regime

Individuals living in the savings regimes cannot borrow from financial institutions—they have to finance the project exclusively using their own resources.

In the first period, the goal of the agent is to maximize expected income. Given a certain initial wealth, maximizing expected income is equivalent to maximizing expected end-of-period wealth,  $W$ . Let  $\pi(b, z)$  be the expected end-of-period wealth function for an entrepreneur of type  $(b, z)$ . Denoting variables with superscript  $S$  for the savings regime, one can write

$$W^S = \begin{cases} (1 + r^d)b + (1 - p)w & \text{for workers} \\ \pi^S(b, z) & \text{for entrepreneurs} \end{cases} \quad (3.3)$$

where workers are paid only if production is successful, with a probability  $(1 - p)$ .<sup>6</sup> Since agents are risk-neutral, they choose to be workers if  $(1 + r^d)b + (1 - p)w > \pi^S(b, z)$ , and entrepreneurs otherwise. Therefore, end-of-period wealth for an agent can be simply written as  $W^S = \max\{(1 + r^d)b + (1 - p)w, \pi^S(b, z)\}$ .

The wealth function  $\pi^S(b, z)$  for entrepreneurs is obtained from the following maximization problem

$$\pi^S(b, z) = \max_{k, l} \{(1 - p)[z(k^\alpha l^{1-\alpha})^{1-\nu} - wl + (1 - \delta)k] + p\eta(1 - \delta)k + (1 + r^d)(b - k)\} \quad (3.4)$$

subject to

$$k \leq b \quad (3.5)$$

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<sup>6</sup>To simplify the computation, we do not explicitly track which firms hire which workers in our numerical simulation. All agents receive the full wage income  $w$  with probability  $p$ , and receive nothing with probability  $1 - p$ . Since agents are risk-neutral in our model, they only care about the expected wage income, which is  $(1 - p)w$ , when making occupational choice decisions.

With probability  $1 - p$ , production succeeds, and the entrepreneur gets revenue  $z(k^\alpha l^{1-\alpha})^{1-\nu} - wl$  plus  $(1 - \delta)k$  undepreciated working capital. With probability  $p$ , production fails, and the entrepreneur can only get a fraction  $\eta$  of end-of-period undepreciated working capital. The last term in the maximization problem accounts for wealth that is not used in production, which earns the equilibrium interest rate  $r^d$ . The constraint reflects the fact that the entrepreneur needs to finance capital through her own initial wealth. The optimal choice of capital and labor is characterized in Proposition 1.

**Proposition 1.** *In the savings regime, the optimal amount of capital invested by entrepreneur of type  $(b, z)$  is given by*

$$\begin{aligned} k^*(b, z) &= \min(b, \tilde{k}^S(z)) \\ l^*(b, z) &= \left[ \frac{z(1-\alpha)(1-\nu)}{w} \right]^{\frac{1}{\alpha(1-\nu)+\nu}} k^*(b, z)^{\frac{\alpha(1-\nu)}{\alpha(1-\nu)+\nu}} \end{aligned}$$

where,  $\tilde{k}^S(z) = \left[ \frac{\alpha w(1-p)}{(1-\alpha)(r^d + (1-p)\delta - p\eta(1-\delta) + p)} \right]^{\frac{\alpha(1-\nu)+\nu}{\nu}} \left( \frac{(1-\nu)(1-\alpha)z}{w} \right)^{\frac{1}{\nu}}$  is the unconstrained level of capital (scale of business) in the savings regime.

Note that  $\tilde{k}^S(z)$  is the desired amount of capital that entrepreneurs living in the savings regime would like to invest when facing no wealth constraints. The value of  $\tilde{k}^S(z)$  is finite because production has diminishing returns to scale. For entrepreneurs whose wealth is lower than  $\tilde{k}^S(z)$ , capital investment is constrained by wealth,  $k^*(b, z) = b$ .

### 3.1.2 Credit Regime

Individuals living in the credit regime have access to external credit by paying an up-front credit participation cost  $\psi$ . As workers receive no benefit from obtaining external credit, they never pay  $\psi$ . Therefore, we only consider the entrepreneur's problem in the credit regime.

Since our focus is on the macroeconomic impact of financial inclusion, we assume that the financial sector is perfectly competitive, driving profits from intermediation to zero. This assumption can be easily relaxed by adding a profit margin for intermediation to capture noncompetitive banking sectors in most developing countries. This serves to increase the lending interest rates facing entrepreneurs, but the model's qualitative predictions remain the same.

In order to borrow, agents need to sign a contract with a financial institution. A financial contract is characterized by three variables,  $(\Phi, \Delta, \Omega)$ , where  $\Phi$  is the amount of borrowing,  $\Delta$  is the value of collateral, and  $\Omega$  is the face value of the contract. The face value,  $\Omega$ , is the amount of money that needs to be repaid by the borrower if there is no default, which is determined by the bank's zero profit condition. For simplicity, we assume that collateral is interest bearing, that is, agents earn the deposit interest rate  $r^d$  on the value of collateral.

Although the financial contract does not specify the lending interest rate, we can define the implied interest rate in the following way

$$r^l = \frac{\Omega}{\Phi} - 1 \quad (3.6)$$

Note that  $r^l$  would be potentially different for different entrepreneurs, depending on the terms of the contract.

Similarly, the leverage ratio (the amount of borrowing relative to the size of collateral) is defined as

$$\tilde{\lambda} = \frac{\Phi}{\Delta} \quad (3.7)$$

If production fails, the entrepreneur may not be able to repay the loan's face value  $\Omega$ . If this happens, the entrepreneur defaults and the financial institution seizes the interest-bearing collateral,  $(1 + r^d)\Delta$  and the recovered value of undepreciated working capital,  $\eta(1 - \delta)k$ . In equilibrium, since highly-leveraged entrepreneurs default in case of a production failure, they are charged with a higher lending interest rate in the event of success (to compensate for losses in event of failure).

We consider two types of financial frictions in the credit regime: (i) limited commitment, and (ii) asymmetric information. The former imposes a form of “credit rationing” on entrepreneurs since they have to post collateral in order to borrow. For some entrepreneurs, this constraint is binding. The latter friction increases the lending interest rate for entrepreneurs with default possibilities. Specifically, the constraints imply the following:

**Limited commitment** In order to borrow, an entrepreneur needs to post collateral in the financial institution. Suppose an entrepreneur can borrow  $\Phi$  if an amount of collateral  $\Delta$  is posted. Suppose further that contract enforcement is imperfect, therefore, she can abscond with a fraction of  $1/\lambda$  of the rented capital. The only punishment is that she will lose her collateral  $\Delta$ . In equilibrium, entrepreneurs do not abscond only if  $\Phi/\lambda < \Delta$ .<sup>7</sup> Therefore, the bank is only willing to lend  $\lambda\Delta$  to the entrepreneur if  $\Delta$  units of collateral are posted. This single parameter  $\lambda \geq 1$  parsimoniously captures the degree of financial friction resulting from limited commitment. A special case of  $\lambda = 1$  implies that entrepreneurs cannot borrow.

**Asymmetric information** There is asymmetric information between entrepreneurs and banks (i.e. whether the production of a particular entrepreneur fails or not is only known to the entrepreneur herself). Due to limited liability, entrepreneurs have a default option when production fails. This implies that they could pay less if a production failure is reported and the lie is not discovered by

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<sup>7</sup>The interest earnings on collateral are not in the equation because entrepreneurs can abscond immediately after getting the money from the bank. See Banerjee and Newman (2003), Buera and Shin (2013), and Moll (2014) for a similar motivation of this type of constraint.

banks. Banks have a monitoring technology through which they get information on the success of production at a cost proportional to the scale of the production (denoted by  $\chi$ ). If entrepreneurs are caught cheating, then banks can legally enforce the full repayment of the loan's face value. As banks make zero profits in equilibrium, the monitoring cost is borne by entrepreneurs when the financial contract is designed. In sum, all agents are truth-telling. However, this comes at a cost.

The bank's optimal verification strategy follows Townsend (1979), which occurs if and only if entrepreneurs cannot repay the face value of the loan. This happens when the entrepreneur is highly leveraged and also experiences a production failure.<sup>8</sup> To be more specific, when production succeeds, entrepreneurs can repay the face value of the loan.<sup>9</sup> Therefore, there is no incentive for the bank to monitor. However, if a production failure is reported, banks monitor only if the loan contract is highly leveraged. This is because a low-leveraged loan contract implies that entrepreneurs are not borrowing much from the bank. Therefore, the required repayment is small, and can be covered by the value of interest-bearing collateral  $((1 + r^d)\Delta)$  plus the value of recovered working capital  $(\eta(1 - \delta)k)$ , even if production fails. In this case, entrepreneurs have no incentive to lie because regardless of the production outcome, as they can and have to repay the face value of the loan. For the same reason, banks have no incentive to monitor.

On the other hand, if the loan contract is highly-leveraged<sup>10</sup>, and if production fails, the amount that entrepreneurs can repay is not sufficient to cover the face value of the loan. As a result, default happens. Finally, note that in this case entrepreneurs do have an incentive to lie when production is successful because they know with high leverage they would repay less if a production failure is reported. Therefore, to motivate truth-telling, banks verify all the results of the highly-leveraged loan contract if a production failure is reported. We formalize the optimal verification strategy in Proposition 2.

**Proposition 2.** *Bank's optimal verification strategy is pinned down ex-ante and determined by the contract,  $(\Phi, \Delta, \Omega)$ , parameter  $\eta$  and  $\delta$ , and the deposit interest rate  $r^d$ ,*

- i. For a low-leveraged loan,  $\eta(1 - \delta)\Phi + (1 + r^d)\Delta \geq \Omega$ , no verification occurs.*
- ii. For a highly-leveraged loan,  $\eta(1 - \delta)\Phi + (1 + r^d)\Delta < \Omega$ , verification occurs iff production fails.*

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<sup>8</sup>Implicitly assumed here is that entrepreneurs would not decline the repayment of the loan if they have sufficient funds because the bank monitors and seizes the face value of the loan when default happens.

<sup>9</sup>This argument is trivial, since entrepreneurs would borrow to produce only if they can make profits. Therefore, when production succeeds the gross output should be at least higher than the capital input. On the other hand, if the entrepreneur defaults, the bank will monitor output and seize the face value of the loan anyway. Thus, the entrepreneur has no incentive to default.

<sup>10</sup>The threshold between low and high leverage ratio is derived by considering whether the value of interest-bearing collateral plus the recovered working capital is sufficient to repay the face value of the loan. In particular, as we discuss later, the loan contract is highly leveraged if  $\eta(1 - \delta)\Phi + (1 + r^d)\Delta < \Omega$ .

In the credit regime, the end-of-period wealth is denoted by

$$W^C = \pi^C(b, z)$$

where the superscript  $C$  refers to the credit regime. The agent chooses to pay the credit participation cost when  $W^C > W^S$ .

We assume that banks cannot observe entrepreneurs' type  $(b, z)$ , and therefore have to provide a menu of contracts for entrepreneurs of different types  $(b, z)$ . The entrepreneur of type  $(b, z)$  chooses the optimal contract from the menu. Notice that the schedule of contracts is designed to be incentive-compatible, namely, entrepreneurs of type  $(b, z)$  would have no incentive to imitate type  $(b', z')$  and chooses the optimal contract of other entrepreneurs. Moreover, all loan contracts make zero profits given that financial intermediation is perfectly competitive. Below, we first elaborate the optimal contract for the entrepreneur of type  $(b, z)$ . We then discuss why the contract is incentive compatible.

To solve the optimal loan contract  $(\Phi, \Delta, \Omega)$  for the entrepreneur of type  $(b, z)$ , we use the following procedures:

First, notice that collateral is interest-bearing; therefore, entrepreneurs are willing to post all of their wealth net of credit participation cost,  $b - \psi$  as collateral instead of depositing a fraction of it in a savings account. Hence, the collateral term,  $\Delta = b - \psi$  belong to the set of optimal loan contracts.<sup>11</sup>

Second, notice that entrepreneurs borrow to increase production scale and make higher profits. Therefore, there is no reason to borrow more funds from the bank and not use them in production, since this would only increase the leverage ratio, which, in turn, potentially increase the cost of capital. Hence, the amount of loan,  $\Phi$ , is equal to the amount of capital,  $k(b, z)$ , if the loan contract is optimal.

The above arguments suggest that the optimal loan contract chosen by the entrepreneur of type  $(b, z)$  should be of the form  $(k(b, z), b - \psi, \Omega)$ , so  $\Omega$  remains the only element to be determined.

The face value of the loan,  $\Omega$ , in the optimal contract is set by the bank such that the bank makes zero profit knowing that only entrepreneurs of type  $(b, z)$  will choose it. From the bank's perspective, the expected payoff of this loan contract is  $(1 - p)\Omega + p \min(\Omega, \eta(1 - \delta)k + (1 + r^d)(b - \psi))$ . The first term refers to the payoff when production succeeds, which happens with probability  $(1 - p)$ . In this case, the bank receives the full face value of the loan,  $\Omega$ . The second term refers to the payoff when production fails. When production fails, before repaying the debt, the entrepreneur's "net value" is equal to the recovered undepreciated working capital,  $\eta(1 - \delta)k$ , plus the after-interest value of

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<sup>11</sup>Note that there might exist multiple optimal contracts for wealthy entrepreneurs since they do not demand much credit. But all these contracts would result in an identical net outcome for both entrepreneurs and banks. The optimal contract we focus here is the one with the lowest leverage ratio, i.e., with all wealth  $b$  being posted as collateral.

collateral,  $(1 + r^d)(b - \psi)$ . The bank receives the full face value of the loan,  $\Omega$ , if the entrepreneur's "net value" is sufficient to repay it. Otherwise, the bank only receives the "net value" due to limited liability, and the entrepreneur would end up with nothing. In sum, when production fails, the bank receives either  $\Omega$  or  $\eta(1 - \delta)k + (1 + r^d)(b - \psi)$ , whichever is smaller.

On the other hand, the cost of creating the loan contract, is equal to the after-interest value of loan,  $(1 + r^d)k$ , plus the expected cost of monitoring. Note that monitoring occurs only if entrepreneurs cannot repay the loan, namely, when production fails and the net value,  $\eta(1 - \delta)k + (1 + r^d)(b - \psi)$ , is smaller the loan's face value,  $\Omega$ . In this case, a monitoring cost,  $\chi k$ , is incurred. Therefore, the expected cost of monitoring is equal to the monitoring cost,  $\chi k$ , multiplied by the monitoring rate. The monitoring rate is equal to the production failure rate,  $p$ , when entrepreneurs are highly leveraged, i.e.  $\eta(1 - \delta)k + (1 + r^d)(b - \psi) < \Omega$ , and zero otherwise. Thus the expected cost of monitoring can be expressed as  $p\chi k \cdot \mathbb{1}_{\{\eta(1-\delta)k+(1+r^d)(b-\psi)<\Omega\}}$ , where  $\mathbb{1}_{\{\eta(1-\delta)k+(1+r^d)(b-\psi)<\Omega\}}$  is an indicator function, which equals to 1 if  $\eta(1 - \delta)k + (1 + r^d)(b - \psi) < \Omega$  and 0 otherwise. Hence, the cost of creating the loan contract is  $(1 + r^d)k + p\chi k \cdot \mathbb{1}_{\{\eta(1-\delta)k+(1+r^d)(b-\psi)<\Omega\}}$ .

The zero profit function is obtained when the expected payoff of the loan is equal to its cost

$$(1 - p)\Omega + p \min(\Omega, \eta(1 - \delta)k + (1 + r^d)(b - \psi)) = (1 + r^d)k + p\chi k \cdot \mathbb{1}_{\{\eta(1-\delta)k+(1+r^d)(b-\psi)<\Omega\}} \quad (3.8)$$

Equation (3.8) pins down  $\Omega$ , which implies that in the optimal contract we consider,  $\Omega$  is a function of  $k$  and  $b$ . The optimal contract chosen by an entrepreneur of type  $(b, z)$  can be written as  $(k^*(b, z), b - \psi, \Omega(k^*(b, z), b))$ , where  $k^*(b, z)$  is the optimal amount of capital invested in production, and  $\Omega(k^*(b, z), b)$  is determined by equation (3.8). This implies that to exactly characterize the optimal contract as a function of initial variables  $b$  and  $z$ , we only need to know  $k^*(b, z)$ , which is solved in the following problem.

The entrepreneur of type  $(b, z)$  chooses capital  $k$  and labor  $l$  optimally to maximize expected production profit

$$\begin{aligned} \pi^C(b, z) = & \max_{k,l} \{ (1 - p)[z(k^\alpha l^{1-\alpha})^{1-\nu} - wl + (1 - \delta)k - \Omega + (1 + r^d)(b - \psi)] \\ & + p \max(0, \eta(1 - \delta)k + (1 + r^d)(b - \psi) - \Omega) \end{aligned} \quad (3.9)$$

subject to

$$k \leq \lambda(b - \psi)$$

where, the term  $\Omega$  in problem (3.9) is the solution to bank's zero profit condition (3.8). The solution to (3.8) and (3.9) determines the optimal capital investment  $k$  as a function of  $b$  and  $z$ , and pins

down the optimal contract.

In (3.9), the first term refers to the end-of-period wealth for the entrepreneur when production succeeds. The second term refers to the case of production failure. The entrepreneur has something left only if  $\eta(1-\delta)k + (1+r^d)(b-\psi) > \Omega$ , that is when the recovered undepreciated working capital plus the after-interest value of collateral is sufficient to repay the loan. Otherwise, the entrepreneur will end up with zero wealth at the end of the period.

To characterize the closed form solution to problem 3.9 (subject to 3.8), we restrict ourselves to analyze a more interesting case where default occurs, with the endogenously determined interest rate satisfying,  $r^d > \frac{\eta(1-\delta)\lambda}{\lambda-1} - 1$ .<sup>12</sup> Note that this condition is satisfied for all the six countries in our quantitative analysis.

Below we first illustrate the default boundary (Lemma 1) and the associated cost of capital for different cases (Lemma 2), and then we characterize the optimal amount of capital in Proposition 3.

**Lemma 1.** *In the credit regime, default occurs for highly-leveraged entrepreneurs. In particular, there is a default boundary,  $\bar{\lambda} = \frac{1+r^d}{1+r^d-\eta(1-\delta)}$ , depending on parameters  $\eta$  and  $\delta$  and the endogenous deposit interest rate  $r^d$ . For an entrepreneur who operates a business with leverage ratio  $\tilde{\lambda}$ ,*

- i. If  $\tilde{\lambda} \leq \bar{\lambda}$  (low-leverage case), default never occurs, and the implied lending rate is  $r^l = r^d$ .*
- ii. If  $\tilde{\lambda} > \bar{\lambda}$  (high-leverage case), default occurs when production fails, and the implied lending rate is increasing in  $\tilde{\lambda}$ ,  $r^l = \frac{1+r^d+p\chi-p\eta(1-\delta)-p(1+r^d)/\tilde{\lambda}}{1-p} - 1$*

Lemma 1 states that default happens only for highly leveraged entrepreneurs whose production fails. Moreover, for entrepreneurs with no default risk ( $\tilde{\lambda} \leq \bar{\lambda}$ ), banks can always get repaid the face value of the loan, and the implied lending rate  $r^l$  is equal to the deposit rate  $r_d$ ; while for entrepreneurs facing a risk of default ( $\tilde{\lambda} > \bar{\lambda}$ ), the implied lending rate is increasing in the leverage ratio, to compensate the losses from default. Figure III illustrates the components of the lending interest rate. If an entrepreneur's leverage ratio is low, the lending rate is equal to the deposit rate. For highly leveraged entrepreneurs, the lending rate also includes a risk premium, which depends on the leverage ratio, and a fixed intermediation cost, due to bank monitoring.

[Figure 3 about here.]

Note that the implied lending rate is not equal to the cost of capital facing entrepreneurs. The lending rate should be considered as the interest rate entrepreneurs need to pay when production is

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<sup>12</sup>If  $r^d \leq \frac{\eta(1-\delta)\lambda}{\lambda-1} - 1$ , there is no default in the economy. This is because in our model, whether a firm defaults or not depends on its leverage ratio. As shown in Lemma 1, only firms whose leverage ratio are larger than  $\bar{\lambda}$  default when production fails. Notice that  $\bar{\lambda}$  is decreasing in  $r_d$ . Therefore,  $\bar{\lambda}$  could be higher than  $\lambda$  (the highest possible leverage ratio imposed by limited commitment) for small  $r_d$ . In this case, even firms with fully leveraged loan do not default.



successful. But if production fails, entrepreneurs have the option to default and pay less. The cost of capital includes this default option. Therefore it should be a weighted average of the lending rate and the repayment rate during default. This is characterized in Lemma 2.

**Lemma 2.** *In the credit regime, for an entrepreneur who operates a business with leverage ratio  $\tilde{\lambda}$ ,*

- i. If  $\tilde{\lambda} \leq \bar{\lambda}$ , the cost of capital is  $r^d$ .*
- ii. If  $\tilde{\lambda} > \bar{\lambda}$ , the cost of capital is  $r^d + p\chi$ .*

In Figure IV, we show how the lending interest rate, the probability of being monitored, and the cost of capital change when entrepreneurs' leverage ratio varies. As noted in Proposition 2, only highly leveraged entrepreneurs are monitored. In particular, there is a default boundary ( $\bar{\lambda} = 1.69$ ), below which the probability of being monitored is zero, and thus both the lending interest rate and the cost of capital are equal to the deposit interest rate. If entrepreneurs increase leverage beyond this boundary, they cannot repay the face value of the loan when production fails. Therefore, the probability of being monitored is exactly equal to the production failure rate,  $p$ . Since banks are making zero profits, the monitoring cost is completely borne by the entrepreneurs, generating a higher cost of capital. Note that the cost of capital in this case is  $r^d + p\chi$ , which is constant regardless of the leverage ratio (see Lemma 2). This is due to our assumption that the monitoring cost is proportional to the scale of production but not the value of loan. Moreover, the implied lending interest rate characterized in Lemma 1 is strictly increasing in the leverage ratio when the leverage ratio is higher than the default boundary. This is because banks have to be repaid more (as reflected by a higher face value  $\Omega$ ) when production succeeds to compensate for larger losses when the project fails due to higher leverage.

Next we characterize the optimal amount of capital invested by an entrepreneur of type  $(b, z)$ .

**Proposition 3.** *In the credit regime, for an entrepreneur of type  $(b, z)$ , denote the optimal leverage ratio by  $\lambda^*(b, z)$  and optimal capital by  $k^*(b, z)$ . There is a threshold level of wealth  $b(z)$ , such that*

- i. If wealth  $b$  is between the participation cost and the threshold level,  $\psi \leq b < b(z)$ , the optimal leverage ratio lies between the default boundary and the inverse of the absconding rate,*

$$\begin{aligned} \bar{\lambda} &< \lambda^*(b, z) \leq \lambda \\ k^*(b, z) &= \min(\lambda(b - \psi), \tilde{k}^h(z)) \end{aligned}$$

where  $\tilde{k}^h(z)$  is defined in (iii) below.

- ii. If wealth  $b$  is above the threshold level,  $b \geq b(z)$ , the optimal leverage ratio is below the*

default boundary,

$$\begin{aligned}\lambda^*(b, z) &\leq \bar{\lambda} \\ k^*(b, z) &= \min(\bar{\lambda}(b - \psi), \tilde{k}^l(z))\end{aligned}$$

where  $\tilde{k}^l(z)$  is defined in (iii) below.

iii.  $\tilde{k}^h(z)$  is the unconstrained level of capital in the high-leverage case,

$$\tilde{k}^h(z) = \left[ \frac{(1-p)\alpha w}{(r^d + p\chi + (1-p)\delta - p\eta(1-\delta) + p)(1-\alpha)} \right]^{\frac{\alpha(1-\nu)+\nu}{\nu}} \left( \frac{(1-\nu)(1-\alpha)z}{w} \right)^{\frac{1}{\nu}}$$

$\tilde{k}^l(z)$  is the unconstrained level of capital in the low-leverage case,

$$\tilde{k}^l(z) = \left[ \frac{(1-p)\alpha w}{(r^d + (1-p)\delta - p\eta(1-\delta) + p)(1-\alpha)} \right]^{\frac{\alpha(1-\nu)+\nu}{\nu}} \left( \frac{(1-\nu)(1-\alpha)z}{w} \right)^{\frac{1}{\nu}}$$

Note that  $k^h(z) < k^l(z)$  for all  $z$ . This is because in the “high-leverage case”, the bank monitors when production fails, which increases the cost of capital. When entrepreneurs are constrained by wealth, increasing the leverage ratio can generate higher revenue, but this may also bring the entrepreneur to the “default” region, increasing their cost of capital. Entrepreneurs want to maximize profits, but always face this trade-off when making capital investment decisions. For entrepreneurs with low wealth, the marginal return on capital is high. The extra revenue generated by increasing leverage beyond  $\bar{\lambda}$  outweighs the increase in the cost of capital, hence entrepreneurs want to choose higher leverage ( $\tilde{\lambda} > \bar{\lambda}$ ). By contrast, for relatively wealthy entrepreneurs, the marginal return on capital is low. As a result, they choose to borrow less and stay in the “low-leverage” region to avoid paying the monitoring cost.

[Figure 4 about here.]

Notice that our model features both limited commitment and asymmetric information. In a model with only limited commitment, the supply of credit is rationed exogenously by the parameter  $\lambda$ . When asymmetric information is introduced, because monitoring is costly, in equilibrium there exist some entrepreneurs who restrain themselves from borrowing more. For these entrepreneurs, the borrowing constraint imposed by limited commitment is not binding. These entrepreneurs restrict themselves from using up the credit line precisely because obtaining more credit brings them into the “high-leverage case” and increases their cost of capital. In this sense, credit rationing is endogenously imposed by entrepreneurs themselves.

Intuitively, the return on production is higher for talented entrepreneurs, which induces them to leverage more. This leads to Proposition 4.

**Proposition 4.** *The threshold level of wealth  $b(z)$  is increasing in  $z$ .*

Finally, all contracts offered by the bank are incentive-compatible, although talent may not be observable. This implies that entrepreneurs of low talent have no incentive to pretend to be highly-talented and ask for a different contract, or vice versa. To see this, divide both sides of equation (3.8) by  $k$ ,

$$(1-p)\frac{\Omega}{k} + p \min\left(\frac{\Omega}{k}, \eta(1-\delta) + (1+r^d)\frac{b-\psi}{k}\right) = (1+r^d) + p\chi \cdot 1_{\{\eta(1-\delta) + (1+r^d)\frac{b-\psi}{k} < \frac{\Omega}{k}\}} \quad (3.11)$$

Equation (3.11) suggests that the implied gross lending interest rate,  $\frac{\Omega}{k}$ , depends only on the inverse of the leverage ratio  $\frac{b-\psi}{k}$ <sup>13</sup>, but not directly on entrepreneur's talent. That is, capital  $k$  and talent  $z$  enter equation (3.11) only through the leverage ratio, which is observable. Therefore, for all entrepreneurs, given the amount of capital they want to invest (or demand for credit) and the amount of wealth they own (or collateral value), it is impossible to receive a lower interest rate from the bank by cheating on talent. This result is obtained because it is assumed that the recovered value of undepreciated working capital does not depend on entrepreneurs' talent.

### 3.1.3 Occupational Choice

The occupation map is plotted according to the choice of occupation for agents with different talent  $z$  and wealth  $b$ , and whether this choice is constrained by wealth. We identify four categories of agents in the savings regime, separated by the solid lines in the left panel of Figure V: unconstrained workers, constrained workers, constrained entrepreneurs, and unconstrained entrepreneurs.

As shown in the figure, there is a certain threshold level of talent (1.3), below which agents always find that working for a wage is better than operating a firm. These people are identified as unconstrained workers, suggesting that their talent is so low that they never find it is optimal to become an entrepreneur. Above this talent level, the figure is further segmented into three regions. In the left region, agents are talented, but do not have sufficient wealth, so they cannot operate a firm at a profitable scale. Hence, they choose to be workers. These are constrained workers. The middle region represents agents with sufficient wealth to operate a profitable firm but scale is still constrained by wealth ( $k^*(b, z) < k^s(z)$ ). These agents are constrained entrepreneurs. Agents in the right region of the figure choose to be entrepreneurs, operating a firm at the unconstrained scale ( $k^*(b, z) = k^s(z)$ ), with the marginal return on capital equal to the deposit interest rate. Thus, they are identified as unconstrained entrepreneurs.

[Figure 5 about here.]

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<sup>13</sup>According to (3.7), the inverse of leverage ratio is defined as  $\frac{\Delta}{\Phi}$ . In the optimal contract illustrated above,  $\Delta = b - \psi$ , and  $\Phi = k$ .

When an agent obtains external credit, the occupation map changes to the one represented in the right panel of Figure V. The occupation map for the credit regime is plotted with the same value of parameters, and under the assumption that there is no credit participation cost,  $\psi = 0$ , or monitoring cost,  $\chi = 0$ .<sup>14</sup> This is to highlight the effect of external credit. Clearly, the area of constrained workers shrinks and that of unconstrained entrepreneurs increases. This implies that the agent is more likely to become an entrepreneur and operate her business at a larger scale once credit is obtained from the financial institution. Note that the region of constrained entrepreneurs is further partitioned by the dotted line into two sub-categories: entrepreneurs with a low leverage ratio and those with a high leverage ratio. Agents in the low-leverage region are not borrowing much in the sense that the face value of loan can be repaid even if production fails. Thus, banks do not monitor them, and the lending interest rate is equal to the deposit interest rate, as shown in Figure IV. By contrast, agents in the high-leverage region default when production fails, in which case banks monitor and seize the recovered undepreciated working capital and after-interest collateral. In accordance with Proposition 3, the high-leverage region is to the left of the low-leverage region, implying that entrepreneurs would prefer to leverage more when wealth is low to benefit from the high marginal return on capital.

The policy options we consider in section 5, move the lines in the occupation map (Figure V), and also alter the relative income received by different agents. This kind of micro-level adjustment for each agent impacts the aggregate economy and generates a movement in GDP and income inequality.

## 3.2 Competitive Equilibrium

Given an initial joint probability density distribution of wealth and talent  $h_0(b, z)$ , a competitive equilibrium consists of allocations  $\{c_t(b, z), k_t(b, z), l_t(b, z)\}_{t=0}^{\infty}$ , sequences of joint distributions of wealth and talent  $\{h_t(b, z)\}_{t=1}^{\infty}$  and prices  $\{r^d(t), w(t)\}_t$ , such that

- (1). Agent of type  $(b, z)$  optimally chooses the underlying regime, occupation, consumption  $c_t(b, z)$ , capital  $k_t(b, z)$ , and labor  $l_t(b, z)$  to maximize utility at  $t \geq 0$
- (2). Capital market clears at all  $t \geq 0$

$$\iint_{(b,z) \in E(t)} k_t(b, z) h_t(b, z) db dz = \iint_{(b,z)} b h_t(b, z) db dz - \psi \iint_{(b,z) \in Fin(t)} h_t(b, z) db dz$$

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<sup>14</sup>Note that we also use the same wage and interest rate while plotting the occupation choice map for the credit regime. This is to highlight the partial equilibrium result of moving an agent from the savings regime to the credit regime. When financial inclusion allows more agents to get credit, the wage and interest rate would also change in general equilibrium.

where  $E(t)$  is the set for all type  $(b, z)$ , who choose to be entrepreneurs at time  $t$ ;  $Fin(t)$  is the set for all type  $(b, z)$ , who are in the credit regime.

(3). Labor market clears at all  $t \geq 0$

$$\iint_{(b,z) \in E(t)} l_t(b, z) h_t(b, z) db dz = \iint_{(b,z) \notin E(t)} h_t(b, z) db dz$$

(4).  $\{h_t(b, z)\}_{t=1}^{\infty}$  evolves according to the equilibrium mapping.

$$h_{t+1}(\bar{b}, \bar{z}) db = \gamma \mu(\bar{z}) \int_z \mathbb{1}_{\{b'=\bar{b}\}} h_t(b, z) db dz + (1 - \gamma) \int_b \mathbb{1}_{\{b'=\bar{b}\}} h_t(b, \bar{z}) db$$

where  $b'$  is the bequest for agent of type  $(b, z)$ , and  $\mathbb{1}_{\{b'=\bar{b}\}}$  is an indicator function which equals 1 if  $b' = \bar{b}$ , and equals 0 otherwise.

The steady-state of the economy is defined as the invariant joint distribution of wealth and talent  $h(b, z)$ ,

$$h(b, z) = \lim_{t \rightarrow \infty} h_t(b, z)$$

## 4 Data and Calibration

We calibrate the model for 6 countries at various stages of economic development: 3 low-income countries (Uganda in 2005, Kenya in 2006, and Mozambique in 2006), and 3 emerging market economies (Malaysia in 2007, the Philippines in 2008 and Egypt in 2007). We use two data sets from World Bank: the Enterprise Surveys which provide firm-level cross-section data and World Development Indicators (WDI) from which we obtain data on economy-wide gross savings, non-performing loans, and the interest rate spread.<sup>15</sup>

In general, financial inclusion in low-income countries in our sample is more constrained compared with emerging market economies across different dimensions, as indicated by high collateral requirements, low share of firms with credit, and high borrowing costs (see Table I). In particular, interest rate spreads in low-income countries are almost twice as high as those in emerging market countries. However, there is significant heterogeneity within country groups across these different dimensions. For example, access to the financial system, as measured by the share of firms with credit, is lower in Mozambique than in Uganda and Kenya, despite relatively lower

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<sup>15</sup>The selection of the countries is mainly driven by data availability. First and foremost, we need sufficient cross-section units to run our framework. The numbers of cross section of firms in our sample are 563 for Uganda, 781 for Kenya, 599 for Mozambique, 1115 for Malaysia, 1326 for Philippines, and 996 for Egypt. Second, we consider relatively recent cases but exclude countries with financial turbulence around the year of the survey.

collateral requirements and interest rate spreads. In the Philippines, collateral requirements are very high, while interest rate spreads are comparable to other emerging market economies in the sample.

[TABLE 1 about here.]

To calibrate the model, we use standard values from the literature for some of the parameters. The one-year depreciation rate,  $\delta$ , is set at 0.06. Following Buera and Shin (2013), we choose the share of output going to the variable factors in the production function,  $v$ , to be 0.21, of which the share of capital,  $\alpha$ , is 0.33. The probability that the offspring inherits the talent of his parents,  $\gamma$ , is assumed to be 0.894. The other parameters are estimated by matching the simulated moments to real data, with the exception of parameter  $\eta$  (see below).

[TABLE 2 about here.]

Each generation is interpreted as one year as in Gine and Townsend (2004) and Jeong and Townsend (2008). We match the gross savings rate, which measures the overall funds available for financial intermediation in a closed economy, in the data and the model to calibrate the optimal bequest rate,  $\omega$ . We use the average value of collateral as a percentage of the loan to calibrate the parameter  $\lambda$ , which captures the degree of financial friction caused by limited commitment.

The credit participation cost,  $\psi$ , intermediation cost,  $\chi$ , the probability of failure,  $p$ , and the parameter governing the talent distribution,  $\theta$  are jointly calibrated to match the moments of the percent of firms with a line of credit, non-performing loans (NPLs) as a percentage of total loans, interest rate spreads, and the employment share distribution (using four brackets of employment shares—top 5% / 10% / 20% / 40%). Even though parameters  $\psi$ ,  $\chi$ ,  $p$  and  $\theta$  affect the value of all these moments, and are jointly calibrated, each moment is primarily affected by some particular parameters. Specifically, the moment of percent of firms with credit is mostly determined by the credit participation cost  $\psi$ . Increasing the value of  $\psi$  increases the percent of firms with credit. The non-performing loans ratio (NPLs) and interest rate spreads are determined by parameters  $\chi$ , and  $p$ . However, the relationships are non-monotonic for some parameter values. For example, when the probability of project failure  $p$  increases, if the entrepreneurs' leverage ratio is unchanged, the NPLs and interest rate spreads should increase. However, the higher  $p$  may reduce the leverage ratio due to higher monitoring costs, which results in fewer defaults, and, thereby lower NPLs and interest rate spreads. Notice that the interest rate spread can be considered as an ex-ante margin that banks charge as compensation for risks, which may not be the best moment to capture the efficiency of intermediation. In section 6, we provide a robustness check where the bank overhead costs to total assets ratio is used to calibrate the parameter  $\chi$ . The employment share distribution is matched primarily by adjusting the value of parameter  $\theta$ , which governs the shape of the entrepreneurial

talent distribution. Note that the parameter  $\eta$  may not be well identified for some countries, because to some extent it has a similar impact on all the moments as the parameter  $p$ . The way we calibrate parameter  $\eta$  is to set its value close to but below  $\frac{(\lambda-1)(1+r^d)}{\lambda(1-\delta)}$ , so that the moments of interest rate spreads and the non-performing loans ratio are most sensitive to parameters  $p$  and  $\chi$ . In this sense, the parameter  $\eta$  could be regarded as a scale parameter, which is important for us to calibrate the other parameters and match the moments. To best match the empirical moments, we set  $\eta$  at 0.37 for Uganda, Kenya and Malaysia, 0.54 for Mozambique, 0.29 for Philippines, and 0.44 for Egypt. We provide a robustness check by using smaller  $\eta$ 's for all countries; the result is only changed slightly (see section 6).

From Table II, it is clear that the model performs well in terms of matching the macroeconomic moments. The percent of firms with credit generated by the model is almost exactly matched with that in the data for all six countries. Both NPLs and interest rate spreads are matched well, although some countries have high NPL ratios but a relatively low interest rate spread (e.g. Malaysia and Egypt) while other countries have low NPL ratios and a high interest rate spread (e.g. Uganda and Mozambique). The employment share distribution is also captured, but in general the model tends to generate more larger firms compared to the data (a larger value for the top 5% employment share and a lower value for the 40% employment share).

The linkages between different characteristics of an economy and financial inclusion are complex. For example, it might seem surprising that the calibrated financial participation cost,  $\psi$ , in general, is lower in low-income countries despite their lower credit access ratio. This is because  $\psi$  is not the only determining factor in credit access. In fact, both  $\lambda$  and  $\chi$  affect the credit access ratio in the model—a higher  $\lambda$  and lower  $\chi$  increases the participation cost in emerging market countries. Moreover, these countries have higher savings rates (higher  $\omega$ ), which implies that agents transfer more wealth to the next generation. In this case, the credit participation cost is a relatively smaller proportion of the agents' wealth in emerging market countries, and, therefore, is less binding, as reflected in the high financial inclusion ratio. In the next section, we analyze macroeconomic implications of financial inclusion and identify the role that country characteristics play in the process.

## 5 Evaluation of Policy Options

As mentioned above, financial inclusion is reflected by three parameters in our model. The credit participation cost,  $\psi$ , directly measures the difficulty of obtaining credit. A decrease in its value therefore reflects greater financial access. The parameter  $\lambda$  in the borrowing constraint coincides directly with the maximum leverage ratio, an increase in which reflects lower collateral requirements. Finally, a decrease in the cost of state verification,  $\chi$ , indicates an increase in the “efficiency” of financial intermediation. It should be noted that the percent of firms with credit in our model is

endogenous and is affected by all the three parameters.

Because financial inclusion is multidimensional, it is difficult to identify precisely the meaning of these three parameters from an empirical standpoint. However, one can find evidence of policies that address one dimension or the other. For example, Assuncao, Mityakov and Townsend (2012) and Alem and Townsend (2013) find that the distance to a bank branch matters for credit access, which suggests that policies that promote branch openings in rural, unbanked locations could help reduce the credit participation cost,  $\psi$ .<sup>16</sup> Moreover, during the recent financial crisis, many countries widened the range of securities that could be accepted as collateral with the aim of boosting lending to companies and households. This reflects an increase in  $\lambda$  in our model. Finally, financial liberalization and the resultant competition between financial institutions could accelerate investment in computerization, thereby improving intermediation efficiency (as reflected by a decrease in  $\chi$  in our model). For example, from 1985 to 1994, the Thai banking sector had become a more capital-intensive industry, substituting physical capital for labor. The average cost of raising funds decreased from 14.40% in 1985 to 5.61% in 1994 for large-sized banks (Okuda and Mieno, 1999). We return to this discussion in the concluding section.

This section analyzes the policy implications of promoting financial inclusion across these three dimensions for the countries in our sample. Specifically, we focus on changes in the steady states of the economy when these parameters change.<sup>17</sup> Figures VI – XI below present the simulation results when each of the three financial parameters changes separately (on the horizontal axis). For all the following experiments, we measure inequality with the Gini coefficient. GDP is measured as the sum of all individual incomes. We follow Buera and Shin (2013), and measure the model implied TFP as  $Y/(K^\alpha L^{1-\alpha})$ , where  $Y$  is aggregate output,  $K$  is aggregate capital, and  $L$  is the size of labor force. We use circles in the figure to pin point the position of countries in the survey dates.

## 5.1 Reducing the participation cost

Figures VI – VII present the impact of a decline in the credit participation cost  $\psi$  from 0.15 to 0 (moving from left to right). A decrease in the participation cost pushes up GDP through its positive impact on investment for two reasons. First, a lower credit participation cost enables more firms to

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<sup>16</sup>Many developing countries have conducted such kind of policies. For example, after a bank nationalization in 1969, the Indian government launched an ambitious social banking program which sought to improve the access of the rural poor to formal credit and savings opportunities (Burgess and Pande, 2005).

<sup>17</sup>Note that it takes time for the economy to transition from one steady state to another when these parameters change. The transitional dynamics are also computable from the model. However, we only report the outcome of simulations in steady states because focusing on the transitional dynamics could be misleading for at least two reasons: (1) the transition is rapid at the beginning but becomes slower when the economy is approaching the steady state. This is inconsistent with reality, where the impact of financial reforms happen gradually, or at least the immediate impact is not significant; (2) the numerical error is large relative to that in the steady state, possibly leading to overshooting of some variables if parameters are adjusted a lot. These two problems associated with transitional dynamics exist for all quantitative macroeconomic models, although the first problem could be mitigated to some extent if agents were modeled as forward-looking (e.g. Buera and Shin, 2013, and our robustness check).



have access to credit, leading to more capital invested in production. Second, less funds are wasted in unproductive contract negotiation and, hence, firms can invest more capital in production. TFP increases as capital is more efficiently allocated among entrepreneurs.

The interest rate spread is stable when  $\psi$  is high, but eventually decreases in some countries (Uganda, Mozambique, and Philippines) and increases slightly in others (Kenya and Malaysia). This is because a decrease in  $\psi$  has two countervailing effects on interest rate spreads in our model. First, it has a wealth effect—entrepreneurs become richer (as they need to pay less to get credit), and tend to deleverage, which results in a lower average interest rate spread. Second, a smaller  $\psi$  enables some of the constrained workers to become entrepreneurs. These entrepreneurs are severely wealth constrained, and therefore, choose a very high leverage ratio, driving the average interest rate spread up. Nevertheless, these two effects are significant only when  $\psi$  is small enough. The first effect dominates the second effect when the borrowing constraint is tighter (smaller  $\lambda$ ), thus discouraging constrained workers from obtaining credit and becoming entrepreneurs.

[Figure 6 about here.]

[Figure 7 about here.]

As financial inclusion increases, income inequality (Gini coefficient in our simulation) first increases and then decreases in low-income countries, consistent with the Kuznets’ hypothesis. This is because when  $\psi$  decreases from a particularly high value, it only enables a very small number of constrained workers to become entrepreneurs. As shown in Figure VI, the percent of firms with credit is almost unchanged for high values of  $\psi$ . However, the effect on the incumbent entrepreneurs is large since it reduces their contracting cost, thus allowing them to invest more capital in production. These entrepreneurs make more profits, leading to higher income inequality. If  $\psi$  decreases further (all the way to zero), it becomes disproportionately more beneficial for constrained workers and entrepreneurs without access to credit. This enables relatively poorer agents to earn a higher income, driving down the Gini coefficient.

By contrast, in emerging market economies, this Kuznets’ pattern is not observed. The reason is that at  $\psi = 0.15$ , financial systems in these economies are already highly developed compared to low-income countries. In other words, emerging market economies are already in the “second stage” of development.<sup>18</sup> A decrease in  $\psi$  unambiguously leads to a lower Gini coefficient in emerging market economies, such as Malaysia. Since  $\psi$  is a fixed cost, a decrease in  $\psi$  benefits poor entrepreneurs disproportionately as this constitutes a larger proportion of their wealth. In the Philippines and in Egypt, the decline in inequality is less noticeable, reflecting other binding constraints to financial inclusion.

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<sup>18</sup>As reflected in Figures VI – VII, at  $\psi = 0.15$ , the percent of firms with credit is about 50% in Malaysia while it is close to zero in Uganda. Identified by the circle on the blue solid line in Figure VI, Uganda in 2006 was about to move from the initial stage of development (in the Kuznets’ sense).

## 5.2 Relaxing collateral constraints

In Figures VIII – IX, we vary the borrowing constraint parameter  $\lambda$  from 1 to 3. Following the relaxation of the borrowing constraint, aggregate GDP increases in all countries. However, the responsiveness of output is highly dependent on the economy’s savings rate. In low-income countries, GDP is typically more responsive as agents’ production relies heavily on external financing due to small transfers across periods (low savings rates). This suggests that credit constraints are one of the major obstacles to economic development for low-income countries in our sample. In the Philippines, GDP also responds well to the relaxation of the borrowing constraint; however, the reason for this is different than in low-income countries. Financial access is moderate in the Philippines, but interest spreads are low and savings rates are high. Therefore, the relaxation of borrowing constraints unlocks financial resources, leading to a significant increase in GDP.

As  $\lambda$  increases, TFP increases, implying a more efficient resource allocation across firms. A relaxation of the borrowing constraint benefits talented entrepreneurs disproportionately as they often desire to operate firms at a larger scale than untalented entrepreneurs ( $\tilde{k}^l(z)$  and  $\tilde{k}^h(z)$  increase in  $z$ ). Relaxing the borrowing constraint allows all entrepreneurs to borrow more, but, on average, untalented ones do not borrow as much because their smaller (maximum) business scale may have already been achieved. As a result, more talented entrepreneurs expand their scale of operations, driving up TFP in the credit regime.

The interest rate spread increases in this scenario. The spread is zero when  $\lambda$  is low, because firms’ leverage is low—no default happens even when production fails. As  $\lambda$  increases above a threshold, agents leverage more, the share of non-performing loans increases, and the interest rate spread starts increasing. Note that, in general, low-income countries have higher interest rate spreads relative to emerging market countries due to higher intermediation costs.

In terms of inequality, the Kuznets pattern is again observed for low-income countries. As  $\lambda$  increases, talented entrepreneurs can leverage more and increase their profits, which drives up the Gini coefficient. In low-income countries, the savings rate is low. As a result, external credit is limited and the interest rate increases by more, the easier borrowing constraints are. As  $\lambda$  becomes larger, the sharp increase in the interest rate shrinks entrepreneurs’ profits, leading to a lower Gini coefficient.

Relaxing the borrowing constraint provides more external credit to entrepreneurs once they pay the participation cost. This induces more entrepreneurs to join the financial regime. However, NPLs also increase. This occurs as a relaxation of collateral constraints opens up the doors for small new entrants who tend to be more leveraged.

[Figure 8 about here.]

[Figure 9 about here.]

### 5.3 Increasing intermediation efficiency

In Figure X – XI, we vary the financial monitoring cost  $\chi$  from 1.2 to 0 to reflect financial inclusion from an intermediation efficiency angle.<sup>19</sup> When  $\chi$  decreases, the response of GDP varies across countries. In some countries (Uganda, Mozambique and Philippines), GDP is not responsive as lower intermediation costs only benefit highly-leveraged firms, which are few (due to the low credit access ratio and tight borrowing constraints).

TFP increases (but only slightly) as the lower intermediation cost facilitates the allocation of capital to efficient entrepreneurs. The interest rate spread monotonically declines in Kenya and Malaysia, but displays an inverted *V*-shape in other countries. Two opposing forces are in effect here. First, the decline in the net lending rate induces entrepreneurs to leverage more because it reduces the cost of capital for risky firms, pushing up the share of NPLs. This tends to increase the endogenous interest rate spread. Second, a lower intermediation cost decreases the interest spread through its pass-through effect. Whether the interest rate spread increases or decreases depends on which effect dominates.

The Gini coefficient increases as efficient intermediation disproportionately benefits highly leveraged firms (who already have higher income than workers).<sup>20</sup> Moreover, lower intermediation costs induce more agents to borrow, hence increasing the percent of firms with credit.

[Figure 10 about here.]

[Figure 11 about here.]

### 5.4 Interactions among three financial parameters

In sections 5.1 – 5.3, we have shown that policies that target different financial parameters have differential effects on macroeconomic aggregates. Moreover, the effects vary across countries depending on how country-specific economic characteristics interact with financial sector characteristics. In this section, we shed light on how the three financial sector parameters interact with each other and examine the implications for the macroeconomy and financial policies.

We take a specific country—the Philippines—and study the change in GDP per capita following a relaxation of the borrowing constraint (i.e. an increase in parameter  $\lambda$ ).<sup>21</sup> In particular, we relax the borrowing constraint by 20%, and compare the increase in GDP relative to the previous state (i.e. before relaxing the borrowing constraint) for different levels of the credit participation cost,  $\psi$ , and intermediation cost,  $\chi$ . Figure XII shows that the relative change in GDP following an

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<sup>19</sup>The actual intermediation cost is  $p\chi$  as stated in Equation 3.8.

<sup>20</sup>There is only a slight increase (almost invisible from the figure) in the Gini coefficient of Uganda, Mozambique, and Philippines, because intermediation cost is not a binding constraint in these countries.

<sup>21</sup>Using other countries' calibrated parameters does not change the qualitative results we emphasize.

increase in  $\lambda$  depends on the two costs,  $\psi$  and  $\chi$ . When  $\chi$  increases, the increase in GDP becomes smaller for all  $\psi$ . This is because relaxing the borrowing constraint increases GDP by providing more credit to entrepreneurs. However, this channel is partially blocked if the intermediation cost is very high. A higher intermediation cost restricts entrepreneurs from borrowing more as they want to keep a low leverage ratio to avoid being monitored. This dampens the GDP-boosting effect that arises from a relaxation of the borrowing constraint. If the intermediation cost is too high, relaxing borrowing constraints would be futile as all entrepreneurs prefer to stay with a low leverage ratio to avoid paying the monitoring cost.

[Figure 12 about here.]

However, the change in GDP is non-monotonic when  $\psi$  increases. The change in GDP stays almost constant for low values of  $\psi$  ( $\psi < 0.03$ ); it is increasing in  $\psi$  when  $\psi$  lies between 0.03 and 0.04, and is decreasing for large values of  $\psi$  ( $\psi > 0.04$ ). This non-monotonic pattern results from the two channels through which relaxing the borrowing constraint impacts GDP. On the one hand, it enables agents in the credit regime to borrow more (intensive margin). On the other hand, it induces more agents to join the credit regime, as a lower borrowing constraint increases the benefit of obtaining a credit contract (extensive margin). Gains on both the intensive and extensive margins depend on the fraction of agents in the credit regime. A decrease in  $\psi$  promotes financial inclusion, increasing the gains on the intensive margin. However, it decreases the gains on the extensive margin as relaxing the borrowing constraint has less of an impact on increasing the credit access ratio when this ratio is already high. Therefore, as  $\psi$  decreases, change in GDP first increases and then decreases. The change in GDP, however, stays almost constant for low values of  $\psi$ . This is because the financial access ratio is about 100% when  $\psi < 0.03$  (see Figure VII), so that further reducing  $\psi$  has no impact on the gains accruing on both margins.

This exercise suggests that the effectiveness of financial inclusion policies depends crucially on the underlying financial sector characteristics within an economy. Relaxing the borrowing constraint is less effective if financial intermediation cost is high, which is partially reflected in a high interest rate spread. The impact of relaxing borrowing constraints also depends on the credit access ratio, although the relationship is not as clear-cut because of the coexistence of the two margins. The exercise also suggests that financial inclusion policies can be used in a complementary way in order to be more effective. For example, reducing intermediation costs not only directly boosts GDP, but it also amplifies the effect of relaxing borrowing constraints. However, simultaneously reducing participation costs and relaxing borrowing constraints may be partially substitutable, as both policies increase GDP by promoting credit access. The optimal mix of policies thus depends on the underlying financial sector parameters and country-specific characteristics.

## 5.5 Impact on GDP and Inequality: A Numerical Comparison

Figures VI – XI suggest that the economic implications of financial inclusion policies depend on the source of the friction. In this section, we zoom-in on a numerical comparison of the marginal responses of income and inequality. The numbers in Table III are calculated as differences between the current state of the country (shown with the circle in Figures VI – XI) and the eventual steady-state value when the economy’s credit to investment ratio is increased by one percentage point.

As before, although financial inclusion brings an increase in GDP and TFP in all cases, its impact on inequality varies. The impact on the Gini coefficient can be positive or negative for a reduction in the credit participation cost, depending on country-specific characteristics.

Moreover, in line with the discussion above, the numbers highlight that the form of financial inclusion and country characteristics matter in how the economies respond. For example, Uganda’s GDP responds more if the increase in credit to investment ratio comes from reduced participation costs. However, Egypt’s GDP responds more to relaxing the borrowing constraint; while the other countries are more responsive to lower financial intermediation costs.<sup>22</sup>

[TABLE 3 about here.]

How far are these countries from the world best financial sector technology in terms of these three financial parameters? Which country is most underdeveloped along which dimension? To shed light on these questions, we show a numerical comparison for the changes of GDP, TFP and Gini coefficient when the six countries adopt the best-possible intermediation technology. Obviously, the best possible value for the credit participation cost and financial monitoring cost are zero ( $\psi = \chi = 0$ ). Among the 127 countries in the enterprise survey, we consider countries that require the lowest amount of collateral (Germany, Spain, and Portugal). The average amount of collateral required as a percent of loan in these countries is about 50% ( $\lambda = 3$ ), which is regarded as the best possible borrowing constraint.

Table IV shows the simulation results when one of the financial parameters is equal to the world frontier value, one at a time. The increase in GDP is largest when the borrowing constraint is relaxed in Uganda, Kenya, the Philippines and Egypt, implying that the financial sector in these countries is facing disproportionately higher collateral requirements. By contrast, the GDP of Mozambique and Malaysia is more responsive to a decrease in the credit participation cost, indicating that limited credit availability or low financial access is the major obstacle. Moreover, reducing the credit participation cost leads to a uniform increase in TFP and decrease in the Gini

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<sup>22</sup>Using the credit to investment ratio might bias the results on the effectiveness of different sources of financial inclusion since the credit to investment ratio itself is more responsive to some factors (e.g.  $\lambda$ ), and significantly less responsive to some other factors (e.g.  $\chi$ ). Therefore, the impact of  $\lambda$  is likely to be underestimated, while the impact of  $\chi$  is likely to be overestimated.

coefficient in all countries for reasons mentioned above, while relaxing the borrowing constraint increases TFP, but has an ambiguous impact on income inequality. Not surprisingly, adopting the most efficient intermediation technology ( $\chi = 0$ ) does not boost GDP significantly. However, this does not imply that intermediation costs are not crucial in terms of financial inclusion. As shown in Figure XII, there exist rich interactions among these parameters: inefficient intermediation will dampen the responsiveness of GDP to lower credit participation costs and relaxed borrowing constraints, or even block these channels.

[TABLE 4 about here.]

## 5.6 Welfare Analysis

[Figure 13 about here.]

Financial inclusion engenders growth in aggregate GDP; however not all agents are necessarily better off. In this section, we investigate the heterogeneous welfare redistribution effects following different financial inclusion policies. In particular, we quantify the amount of income change for different types of agents (endowed with different wealth and talent) when one of the financial sector parameters ( $\psi, \lambda, \chi$ ) changes. In Figure XIII, we present the partial equilibrium (top three panels) and general equilibrium (bottom three panels) results separately to highlight their differences. A comparison between the partial equilibrium and general equilibrium results suggests that changes in equilibrium interest rates and wages are sources of losses for some agents. That is, if the interest rate and wages were fixed, all agents would gain following financial inclusion.

The left-most panels show the change in income when the credit participation cost  $\psi$  decreases. Agents in the white areas experience a reduction in income after financial inclusion. This is because a reduction in  $\psi$  enables more entrepreneurs to borrow, driving up equilibrium wages and interest rates. Wealthier agents lose as they benefit less from lower credit participation cost and suffer more from the ensuing increase in wage and the interest rate. Interestingly, the boundary line is not monotonic. As talent increases, the threshold level of wealth beyond which agents lose first increases then decreases. To understand this pattern we compare agents around the boundary line. We find that the lower part of the boundary line (talent  $< 1.5$ ) separates agents who use external funds from those who do not. Agents on the right side of the boundary line are sufficiently wealthy to self-finance production. These agents do not demand external credit, so a reduction in the participation cost does not benefit them. However, because of the increase in wages and the interest rate, these agents make lower profits when the participation cost declines. The threshold wealth level is increasing in talent when talent is below 1.5 because talented agents have a higher demand for capital, and therefore need to have higher wealth in order to self-finance production. By contrast, when talent is above 1.5, and increases further, the threshold level of wealth decreases.

This is because in our model, talented entrepreneurs disproportionately demand more labor than capital (see the optimal labor decision in Proposition 1), therefore they suffer more from the increase in wages. Since labor demand is also increasing in wealth, as talent increases, the marginal gainer should have lower wealth to mitigate the wage effect. Notice that the biggest winner after a reduction in the credit participation cost lies in the upper left corner. These agents are poor but very talented. The reduction in participation cost enables them to have access to external credit, allowing them to expand significantly and increase their profits.

The middle two panels present the income change following a relaxation of the borrowing constraint. In this case, untalented entrepreneurs, whose demand for credit is low lose. They incur income losses because they do not benefit as much from the relaxation of the borrowing constraint due to their low credit demand. Instead, they suffer from the increase in wage and the interest rate. The biggest winners are the talented and wealthy agents, as credit is proportional to wealth. Hence, relaxing the borrowing constraint enables wealthier agents to receive more funds, increasing their profits. Note that if the talented and wealthy agents are not financially constrained, these agents will actually lose due to the general equilibrium effect. However, in our calibration, a severe credit constraint is observed for almost all agents due to low savings rates and the finite horizon framework.<sup>23</sup>

The right-most panels show the income change following a decrease in intermediation cost,  $\chi$ . The biggest winners are the most talented agents with moderate amounts of wealth. Intuitively, talented agents employ more capital, hence a reduction in intermediation cost reduces their cost of production by more. Note that the biggest winner are not the wealthiest agents, because they already have sufficient internal funds, and have a low demand for credit. Agents in the two white areas both experience a decrease in their income, but for different reasons. Agents in the upper-left area are talented but poor, and operate their firms at the maximum leverage ratio. Hence, they benefit from the decrease in intermediation cost. However, because their demand for capital is low, the benefit from the lower cost of capital is smaller than the increased cost of labor wages.<sup>24</sup> Agents in the lower-right area lose because they operate firms with a low leverage ratio (not being monitored), hence they do not receive benefits from the lower intermediation cost but suffer from the increase in labor costs.

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<sup>23</sup>We expect this result to change if agents are infinitely lived and forward looking in the model, as talented agents would have time to accumulate wealth and eventually mitigate their credit constraint.

<sup>24</sup>According to the labor demand function in Proposition 1, the capital/labor ratio is increasing in wealth. Therefore, poor agents benefit less from a reduction in cost of intermediation.

## 6 Robustness Checks

**Forward Looking Agents** Our model is based on an overlapping generation framework with a constant savings rate (or bequest rate). Therefore, the model is unable to capture one important way of coping with financial frictions: self-financing. Buera, Kaboski and Shin (2011) and Moll (2014) all emphasize that the effects of financial frictions are amplified if a self-financing channel is precluded. As a result, it is expected that in the presence of forward looking agents and an endogenous savings rate, the impact of financial inclusion on GDP could be smaller.

In appendix B, we extend the model with forward looking agents to address this concern. Solving the forward-looking-agents model, however, requires substantially more computing power, which restricts us from matching the employment distribution for each country. For this reason, we set the productivity distribution tail parameter,  $\theta$ , to 4.15 for all six countries, as in Buera and Shin (2013) calibrated using the U.S. employment distribution. The other parameters are calibrated to match the same set of moments as in the baseline model (see Table A.1). To obtain consistent comparisons with the baseline model, we re-calibrate the other parameters in the baseline model for each country under the parameter restriction,  $\theta = 4.15$  (see Table A.2).<sup>25</sup>

The results shown in Table A.3 indicate that, in general, the impact of relaxing the borrowing constraint on GDP and TFP is smaller (except for Mozambique), which is consistent with the results of Buera, Kaboski and Shin (2011). But the difference is not as large partly because in our model production fails with probability  $p$ , in which case entrepreneurs' wealth is wiped out. This constrains the self-financing channel. However, there are other differences. Notably, a reduction in intermediation costs has a much larger GDP and TFP boosting effect as compared to the baseline model.<sup>26</sup> One reason for this could be that entrepreneurs response to lower intermediation costs by saving more, which is not captured if the savings rate is constant.<sup>27</sup> The same most-binding-constraint that constrains GDP are identified for all six countries by the two models. In Uganda, Kenya, Mozambique, and the Philippines, GDP increases more if borrowing constraints are relaxed, while in Malaysia and Egypt, GDP is most responsive to reduced participation costs. The prediction on the change in income inequality is broadly consistent with the baseline model for reducing the participation cost and relaxing the borrowing constraint. However, the change in Gini coefficient has a flipped sign when the intermediation cost is lowered.

We prefer to retain our baseline overlapping generations framework as our primary specification.

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<sup>25</sup>By comparing the baseline model's simulation results with  $\theta$  being calibrated to match country-specific results and  $\theta$  being fixed at 4.15, we can analyze the impact of parameter  $\theta$ . However, according to the simulation results presented in Table A.3, the impact of parameter  $\theta$  on the model-predicted change in GDP, TFP, and the Gini coefficient is not as clear cut, depending on country-specific characteristics.

<sup>26</sup>This seems to be consistent with the results in Greenwood, Sanchez and Wang (2013), which is able to capture a wide range of GDP per worker by purely varying the intermediation costs.

<sup>27</sup>This is confirmed in the response of the credit access ratio. In the model with forward looking agents, agents save to pay the credit participation cost as the monitoring cost decreases, which increases the credit access ratio significantly. However, this is not happening in the baseline model's simulation.



First, the lemmas and propositions are clear in the baseline model and would not have closed-form expressions in a more general forward-looking-agents model, due to the concavity of the value function. Second, computational complexity increases tremendously in a model with forward looking agents.<sup>28</sup> This precludes the possibility of matching the employment distribution in every country.<sup>29</sup>

**Recovery Rate** The recovery rate  $\eta$  is a commonly used modeling ingredient in the corporate finance literature (see Altman, 2008). In our model, introducing a non-zero recovery rate  $\eta$  is necessary to match the relative moments for a wide range of countries. Since the calibration does not allow us to exactly identify the value of  $\eta$ , we provide here a robustness check, to show that the model’s quantitative performance is not determined by its value. We calibrate the baseline model to match the same set of moments for all six countries, with the value of  $\eta$  being set at a lower value than the baseline calibration. Table A.4 presents the calibration results. All else being equal, a lower  $\eta$  leads to a higher proportion of non-performing loans, which dictates a lower production failure rate (parameter  $p$ ) and a higher intermediation cost (parameter  $\chi$ ) if the moments of non-performing loans ratio and interest rate spread are matched. However, the quantitative results (Table A.5) are mostly in line with the baseline model.

**Monitoring Cost** We calibrate the intermediation cost (parameter  $\chi$ ) by matching the interest rate spread, which is an ex-ante margin that banks charge as compensation for risks. To address the concern that the interest rate spread may not be capturing the costs of operating banks, we provide an alternative calibration. We use an ex-post margin, the bank overhead costs to total assets ratio obtained from World Bank Global Financial Development Database (GFDD) and calibrate the intermediation cost to match its average value over the period 2000 – 2011.<sup>30</sup> The calibration and simulation results are shown in Tables A.6 – A.7. In general, the calibrated parameter  $\chi$  using the ex-post margin has a larger value compared with the baseline calibration. As a result, the impact of reducing the intermediation cost on GDP is larger. However, the impact of reducing the participation cost and relaxing the borrowing constraint are relatively unchanged. Thus, the most binding financial constraint in each country identified in the baseline model’s prediction remains

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<sup>28</sup>For a computer with i7-4700MQ CPU (2.40GHz), it takes 20 minutes to compute the steady-state of the baseline model using matlab (2014a). However, for the model with forward looking agents, it takes more than 24 hours if reasonable accuracy level is required. To promote the computation speed, we code the value function iteration and wealth distribution iteration parts of the program in C++ (VS studio 2014) and use matlab to call these scripts. At the same time, we use a 20-core server to parallel the computation of heterogeneity. This reduces the computation time of the steady-state to 40 minutes. So more complicated dynamics are within reach, but require more hardware and coding, which limits their wide applicability and are still two times slower.

<sup>29</sup>As noted before, the calibration for the forward looking model is done by selecting parameter  $\theta$  from the literature, which is calibrated using the U.S. employment distribution, not the distribution of each country. Similar approaches are also seen from several other quantitative papers with forward looking heterogeneous agents (e.g. Buera, Kaboski and Shin, 2011; Buera and Shin, 2013; Greenwood, Sanchez and Wang, 2013).

<sup>30</sup>Greenwood, Sanchez and Wang (2013, Figure 6) show that this variable reflects the monitoring efficiency in a cross-country analysis.

valid.

## 7 Conclusion

We develop a tractable micro-founded general equilibrium model with heterogeneous agents to analyze the implications of financial inclusion policies on GDP and inequality in developing countries. In particular, we focus on three specific dimensions of greater financial inclusion: access (as measured by the size of credit participation costs), depth (as measured by the size of collateral constraints resulting from limited commitment), and intermediation efficiency (as measured by the size of interest rate spreads, reflecting default risk and asymmetric information).

Using analytical and numerical methods, we calibrate the model for six low-income and emerging market countries—Uganda, Kenya, Mozambique, Malaysia, the Philippines, and Egypt. While our simulation results are intended to be illustrative, they indicate that relaxing various financial sector frictions may affect GDP and inequality in different ways. Moreover, our findings suggest that country-specific characteristics play a central role in determining the impacts, interactions, and trade-offs among policies.

In the following, we first summarize typical policy discussions, though they are at a micro-economic level. We then return to macro, general equilibrium consequences.

Policies to enhance inclusion encompass developing appropriate legal, regulatory, and institutional frameworks and supporting the information environment. The government has a central role to play in enhancing financial inclusion by introducing laws that protect property and creditor rights and by ensuring that these laws are adequately enforced. This is captured by the parameter  $\lambda$ . Indeed, country experiences suggest that poorly designed and enforced creditor rights discourage lending and encourage individuals to default. Improvements in the collateral framework can thus play an important role in alleviating borrowing constraints and reducing intermediation costs. Indeed, recent evidence suggests that the introduction or reform of registries for movable collateral (as opposed to fixed assets such as land and buildings), such as machines and other equipment, can greatly spur firm availability of finance (World Bank, 2014).

Alleviating information asymmetries can reduce credit rationing and have a disciplining effect on borrowers. This is captured by the parameter  $\chi$ . The government can enhance financial inclusion by facilitating access to borrower information or by introducing or reforming credit bureaus and registries. In countries with no private credit bureaus, the establishment of public credit registries can jump-start credit reporting, as long as the registries provide timely and sufficient data on borrowers and their credit worthiness (e.g., borrowing and repayment behavior to assess default risk). In some countries, buyer-supplier relationships (e.g., trade credit) can also be another valuable source of credit information. Insolvency regimes are also a key aspect of financial infrastructure, helping regulate efficient exit from markets and providing opportunities for recovery by bankrupt

entities and their creditors.

Other direct interventions aimed specifically at enhancing banking penetration (e.g., low-fee accounts, simplified documentation requirements, providing non-financial services to improve record keeping, improving competition in banking system) can reduce credit participation costs by increasing access to financial services. These are captured by the parameter  $\psi$ . Direct interventions in the credit market, such as directed lending programs and risk-sharing arrangements, can have positive effects on firm access, particularly that of small and medium enterprises, but country experiences indicate that the design and management of such schemes can be challenging. These concerns are magnified in environments with weak institutions.

Our goal in this paper is to go beyond these policy discussions to the likely macroeconomic, general equilibrium impact, in which occupation choice, financial regime, and wages and interest rates are all endogenous and can move when policy changes. The model simulations suggest that the impact of financial inclusion policies do depend greatly upon country-specific characteristics. Thus understanding the specific constraints generating the lack of financial inclusion in an economy is critical for tailoring policy recommendations. Moreover, the model simulations indicate that different dimensions of financial inclusion have a differential impact on GDP and inequality and that there are trade-offs. There also exist rich interactions among the three dimensions of financial inclusion. Policies that address different dimensions could be complementary, but it is also likely that implementing one policy reduces the effectiveness of other policies.

A defining feature of our model is having three different types of financial frictions, limited participation, limited commitment, and asymmetric information (or costly state verification) all embedded in a unified framework. Most of the recent literature has only one. We emphasize that the micro-foundations for each of the three financial frictions included in this paper are very different. As just noted, alleviating each financial friction is directly linked to some particular financial inclusion policy. And even within a given economy, there exists evidence that individuals face different types of financial frictions depending on location (Paulson, Townsend and Karaivanov, 2006; Ahlin and Townsend, 2007; Karaivanov and Townsend, 2014). Thus a quantitative framework that incorporates multiple types of financial frictions is needed to capture the multifaceted nature of financial systems. Even at the aggregate level, alleviating different sources of financial frictions can have differential impacts, either qualitatively or quantitatively, on some macro variables. Incorporating these frictions altogether in a unified framework enables us to identify the most binding constraints that hinder financial development within an economy. Moreover, multiple frictions are necessary ingredients to match the data for a wide set of countries. If the only financial friction is limited commitment, relaxing it increases the credit access ratio, interest rate spread, and non-performing loans in tandem. However, in the data, the three moments are not perfectly positively correlated across countries. For example, Uganda has a high interest rate spread but low non-performing loans, while Egypt is associated with a high non-performing loans ratio and

low interest rate spread. It is not possible to match the two moments in both countries without allowing for both limited commitment and costly state verification. Our bottom-line contribution is to allow and quantify the impact of different types of constraints on GDP and inequality in an economy where all these frictions are potentially present.

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# Appendix

## A Proofs

### A.1 Proof of Proposition 1

For any level of capital, the optimal labor employed by the entrepreneur is given by the first order condition of 3.4,

$$l = \left[ \frac{z(1-\alpha)(1-\nu)}{w} \right]^{\frac{1}{\alpha(1-\nu)+\nu}} k^{\frac{\alpha(1-\nu)}{\alpha(1-\nu)+\nu}} \quad (\text{A.1})$$

Plugging  $l$  into the profit function 3.4, the entrepreneur solves

$$\begin{aligned} \pi^S(b, z) = \max_k \{ & (1-p) \left[ \left( \frac{(1-\nu)(1-\alpha)}{w} z \right)^{\frac{1}{\alpha(1-\nu)+\nu}} w \frac{\nu + \alpha(1-\nu)}{(1-\nu)(1-\alpha)} k^{\frac{\alpha(1-\nu)}{\nu + \alpha(1-\nu)}} - \delta k \right] + k \} \\ & + p\eta(1-\delta)k + (1+r^d)(b-k) \} \end{aligned}$$

subject to

$$k \leq b$$

Solving this problem without imposing the wealth constraint, the unconstrained capital demand is

$$\tilde{k}^S(z) = \left[ \frac{1-p}{r^d + (1-p)\delta - p\eta(1-\delta) + p} \frac{\alpha w}{1-\alpha} \right]^{\frac{\alpha(1-\nu)+\nu}{\nu}} \left( \frac{(1-\nu)(1-\alpha)}{w} z \right)^{\frac{1}{\nu}} \quad (\text{A.2})$$

Since profit,  $\pi^S(b, z)$ , is increasing in  $k$  for  $k \leq \tilde{k}^S(z)$ , the optimal investment for the constrained problem is,

$$k^*(b, z) = \min\{b, \tilde{k}^S(z)\}$$

### A.2 Proof of Lemma 1

First we compute the default boundary  $\tilde{\lambda}$ . For firms with no default risk, the recovered capital when production fails plus the amount of collateral (including interest earning) should be higher than the face value of the loan. Therefore,

$$\eta(1-\delta)k + (1+r^d)(b-\psi) \geq \Omega \quad (\text{A.3})$$

When condition A.3 is satisfied, the zero profit condition 3.8 implies that  $\Omega = (1+r^d)k$ . Substituting this into A.3, we obtain



$$\eta(1 - \delta)k + (1 + r^d)(b - \psi) \geq (1 + r^d)k \quad (\text{A.4})$$

Following the definition of leverage ratio (3.7), A.4 can be written as

$$\tilde{\lambda} = \frac{k}{b - \psi} \leq \frac{1 + r^d}{1 + r^d - \eta(1 - \delta)} \quad (\text{A.5})$$

Hence, the default boundary is  $\bar{\lambda} = \frac{1+r^d}{1+r^d-\eta(1-\delta)}$ . Note that limited commitment imposes the constraint,  $\tilde{\lambda} \leq \lambda$ . To obtain a positive default rate for the model economy, we require  $\frac{1+r^d}{1+r^d-\eta(1-\delta)} < \lambda$ . This determines the range of endogenous interest rate  $r_d > \frac{\eta(1-\delta)\lambda}{\lambda-(b-\psi)} - 1$ .

Next, we compute the lending interest rate for an entrepreneur with leverage ratio  $\tilde{\lambda}$ .

If  $\tilde{\lambda} \leq \bar{\lambda}$ , the entrepreneur does not default. As stated above, the lending interest rate is equal to the deposit interest rate,  $r^l = r^d$ .

If  $\tilde{\lambda} > \bar{\lambda}$ , the entrepreneur defaults when production fails and condition A.3 is violated. The zero profit condition 3.8 implies that the face value of principal is,

$$\Omega = \frac{(1 + r^d)k + p\chi k - p\eta(1 - \delta)k - p(1 + r^d)(b - \psi)}{1 - p} \quad (\text{A.6})$$

The lending rate defined by IV is

$$r^l = \frac{1 + r^d + p\chi - p\eta(1 - \delta) - p(1 + r^d)/\tilde{\lambda}}{1 - p} - 1 \quad (\text{A.7})$$

Note that the lending rate is discontinuous at  $\bar{\lambda}$ ,  $\lim_{\tilde{\lambda} \rightarrow \bar{\lambda}^+} r^l = r^d + \frac{p\chi}{1-p} \neq \lim_{\tilde{\lambda} \rightarrow \bar{\lambda}^-} r^l = r^d$ . This is due to the discontinuity of the optimal verification strategy as described in Proposition 2.

### A.3 Proof of Lemma 2

For an entrepreneur in the low-leverage case ( $\tilde{\lambda} \leq \bar{\lambda}$ ), default never happens, and the entrepreneur pays the interest rate  $r^l = r^d$  regardless of whether production fails or not. Thus, the cost of capital is,  $R = r^d$ .

For an entrepreneur in the high-leverage case ( $\tilde{\lambda} > \bar{\lambda}$ ), when production succeeds, the entrepreneur pays the face value of the loan,  $\Omega$ ; when production fails, the entrepreneur defaults and pays  $\eta(1 - \delta)k + (1 + r^d)(b - \psi)$ . The cost of capital is equal to the expected amount of payment divided by the total amount of borrowing,

$$R = \frac{(1-p)\Omega + p[\eta(1-\delta)k + (1+r^d)(b-\psi)]}{k} - 1 \quad (\text{A.8})$$

Substituting the zero profit condition 3.8 into A.8, we obtain  $R = r^d + p\chi$ .

## A.4 Proof of Proposition 3

In the credit regime, the entrepreneur solves problem 3.9 subject to the zero profit condition 3.8. This problem is non-convex because in the high-leverage case, banks monitor the entrepreneur when production fails, increasing the cost of capital.

We solve the problem facing an entrepreneur of type  $(b, z)$  by converting problem 3.9 into two convex sub-problems: in one problem, the entrepreneur does not default, and the leverage ratio is restricted by  $\tilde{\lambda} \leq \bar{\lambda}$ . In the other problem, the entrepreneur defaults when production fails, and the leverage ratio is restricted by  $\tilde{\lambda} \leq \lambda$ .

The wealth function for each sub-problem is convex. The highest end-of-period wealth that can be obtained by the entrepreneur is the upper envelope of the two wealth functions, which is non-convex.

In the following, we first characterize the solution to each sub-problem and then provide the solution to the original problem.

Consider the first sub-problem, in which the entrepreneur does not default. As shown in the proof of Lemma 1,  $\Omega = (1+r^d)k$ . Problem 3.9 can be written as

$$\pi^l(b, z) = \max_{k, l} \{ (1-p)(z(k^\alpha l^{1-\alpha})^{1-\nu} - wl - \delta k - r^d k) + p\eta(1-\delta)k + (1+r^d)(b-\psi) - p(1+r^d)k \}$$

subject to

$$k \leq \bar{\lambda}(b-\psi)$$

By applying a similar analysis used in the proof of Proposition 1, we obtain the unconstrained level of capital,

$$\tilde{k}^l(z) = \left[ \frac{1-p}{r^d + (1-p)\delta - p\eta(1-\delta) + p} \frac{\alpha w}{1-\alpha} \right]^{\frac{\alpha(1-\nu)+\nu}{\nu}} \left( \frac{(1-\nu)(1-\alpha)}{w} z \right)^{\frac{1}{\nu}}$$

The optimal amount of capital is

$$k^*(b, z) = \min(\bar{\lambda}(b-\psi), \tilde{k}^l(z))$$

the optimal amount of labor is

$$l^*(b, z) = \left[ \frac{z(1-\alpha)(1-\nu)}{w} \right]^{\frac{1}{\alpha(1-\nu)+\nu}} k^*(b, z)^{\frac{\alpha(1-\nu)}{\alpha(1-\nu)+\nu}}$$

The wealth function is

$$\pi^l(b, z) = (1-p)(z(k^{\alpha} l^{1-\alpha})^{1-\nu} - wl^* - \delta k^* - r^d k^*) + p\eta(1-\delta)k^* + (1+r^d)(b-\psi) - p(1+r^d)k^*$$

Now, consider the second sub-problem, the entrepreneur defaults when production fails, As shown in the proof of Lemma 1,

$$\Omega = \frac{(1+r^d)k + p\chi k - p\eta(1-\delta)k - p(1+r^d)(b-\psi)}{1-p}$$

Substituting this into (3.9), the entrepreneur solves

$$\begin{aligned} \pi^h(b, z) = \max_{k, l} \{ & (1-p)[z(k^{\alpha} l^{1-\alpha})^{1-\nu} - wl + (1-\delta)k + (1+r^d)(b-\psi)] \\ & - [(1+r^d)k + p\chi k - p\eta(1-\delta)k - p(1+r^d)(b-\psi)] \} \end{aligned}$$

subject to

$$k \leq \lambda(b-\psi)^{31}$$

Similarly, we obtain the unconstrained level of capital,

$$\tilde{k}^h(z) = \left[ \frac{1-p}{r^d + p\chi + (1-p)\delta - p\eta(1-\delta) + p} \frac{\alpha w}{1-\alpha} \right]^{\frac{\alpha(1-\nu)+\nu}{\nu}} \left( \frac{(1-\nu)(1-\alpha)}{w} z \right)^{\frac{1}{\nu}}$$

The optimal amount of capital is

$$k^*(b, z) = \min(\lambda(b-\psi), \tilde{k}^h(z))$$

The optimal amount of labor is

$$l^*(b, z) = \left[ \frac{z(1-\alpha)(1-\nu)}{w} \right]^{\frac{1}{\alpha(1-\nu)+\nu}} k^*(b, z)^{\frac{\alpha(1-\nu)}{\alpha(1-\nu)+\nu}}$$

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<sup>31</sup>Strictly speaking, the constraint should be  $\bar{\lambda}b < k \leq \lambda b$ . But this does not matter for the solution to the original problem. If the optimal amount of capital satisfies  $k \leq \bar{\lambda}b$ , the first sub-problem yields a higher profit than this one, since costly verification is not needed in the first problem.

The wealth function is

$$\begin{aligned}\pi^h(b, z) &= (1-p)[z(k^*\alpha l^{*1-\alpha})^{1-\nu} - wl^* + (1-\delta)k^* + (1+r^d)(b-\psi)] \\ &\quad - [(1+r^d)k^* + p\chi k^* - p\eta(1-\delta)k^* - p(1+r^d)(b-\psi)]\end{aligned}$$

The solution to the original problem is the upper envelop of the two sub-problems,

$$\pi^C(b, z) = \max\{\pi^l(b, z), \pi^h(b, z)\}$$

To obtain some intuition on the optimal choice of leverage, consider two extreme cases:

1). As  $b \rightarrow 0$ ,  $\pi^h(b, z) \geq \pi^l(b, z)$ <sup>32</sup>, this is because the production function satisfies the inada condition. The marginal return is particularly high when  $b$  is small.

2). As  $b \rightarrow \infty$ ,  $\pi^h(b, z) < \pi^l(b, z)$ . This is because the entrepreneur has sufficient wealth to operate the firm at the unconstrained scale, but the cost of capital is lower in the low-leverage case.

Notice that both  $\pi^l(b, z)$  and  $\pi^h(b, z)$  are concave and increasing in  $b$ . This implies that there exists a unique intersection of the two curves, which defines the threshold level of wealth  $b(z)$ . When  $b$  is below  $b(z)$ ,  $\pi^l(b, z) < \pi^h(b, z)$ , and the entrepreneur chooses high-leverage. Otherwise, the entrepreneur chooses low-leverage.

## A.5 Proof of Proposition 4

Consider an entrepreneur with talent  $z$ , whose leverage ratio is denoted by  $\tilde{\lambda}$ . Note that  $b(z)$  is the wealth level at which, the entrepreneur is indifferent between the low-leverage and the high-leverage case, i.e.  $\pi^l(b(z), z) = \pi^h(b(z), z)$ . Therefore, for  $b \in [b(z), b(z) + \epsilon)$  (with  $\epsilon$  very small), the entrepreneur is always hitting the borrowing constraint defined in the “low-leverage case” (i.e.  $\tilde{\lambda} = \bar{\lambda}$ ).<sup>33</sup> Hence, the optimal amount of capital is  $k_l^* = \bar{\lambda}(b(z) - \psi)$  when  $b = b(z)$ . Let  $l_l^*$  be the corresponding optimal amount of labor. The wealth function is

$$\pi^l(b(z), z) = (1-p)(z((k_l^*)^\alpha (l_l^*)^{1-\alpha})^{1-\nu} - wl_l^* - \delta k_l^* - r^d k_l^*) + p\eta(1-\delta)k_l^* + (1+r^d)(b(z) - \psi) - p(1+r^d)k_l^*$$

In the high-leverage case, for entrepreneur with  $b \in (b(z) - \epsilon, b(z))$ , the entrepreneur may or may not hit the borrowing constraint  $\lambda$ . Therefore, the optimal amount of capital is  $k_h^* =$

<sup>32</sup>Equality holds only when  $b = 0$ .

<sup>33</sup>The logic is as follows: if this borrowing constraint is not binding, this implies that the entrepreneur can achieve the unconstrained level of capital  $\tilde{k}^l(z)$  when  $b \in [b(z), b(z) + \epsilon)$ . Therefore, when  $b \in (b(z) - \epsilon, b(z))$ , the entrepreneur can also achieve the unconstrained level of capital in the high-leverage case,  $\tilde{k}^h(z)$ , by borrowing only up to leverage ratio  $\bar{\lambda}$ , since  $\tilde{k}^h(z) < \tilde{k}^l(z)$ . This is in contradiction to Proposition 3, which requires that  $\tilde{\lambda} > \bar{\lambda}$  when  $b \in (b(z) - \epsilon, b(z))$ .

$\min(\lambda(b - \psi), \tilde{k}^d(z))$ . Let  $l_h^*$  be the corresponding optimal amount of labor. The wealth function is

$$\begin{aligned} \pi^h(b(z), z) = \lim_{b \rightarrow b(z)_-} \pi^h(b, z) &= (1-p)[z((k_h^*)^\alpha (l_h^*)^{1-\alpha})^{1-\nu} - wl_h^* + (1-\delta)k_h^* + (1+r^d)(b(z) - \psi)] \\ &\quad - [(1+r^d)k_h^* + p\chi k_h^* - p\eta(1-\delta)k_h^* - p(1+r^d)(b(z) - \psi)] \end{aligned}$$

Since  $\pi^l(b(z), z) = \pi^h(b(z), z)$ ,  $b(z)$  is characterized implicitly by the following equation,

$$p\chi k_h^* = (1-p)[z((k_h^*)^\alpha (l_h^*)^{1-\alpha})^{1-\nu} - ((k_l^*)^\alpha (l_l^*)^{1-\alpha})^{1-\nu}] - w(l_h^* - l_l^*) + [p\eta(1-\delta) - p - (1-p)\delta - r^d](k_h^* - k_l^*)$$

Substituting  $l_l^*$  and  $l_h^*$ , we get

$$p\chi k_h^* = Ez \frac{1}{\alpha(1-\nu)+\nu} ((k_h^*)^{\frac{\alpha(1-\nu)}{\alpha(1-\nu)+\nu}} - (k_l^*)^{\frac{\alpha(1-\nu)}{\alpha(1-\nu)+\nu}}) + F(k_h^* - k_l^*)$$

where  $E = (1-p)w \frac{\alpha(1-\nu)+\nu}{(1-\alpha)(1-\nu)} [\frac{(1-\alpha)(1-\nu)}{w}]^{\frac{1}{\alpha(1-\nu)+\nu}} > 0$ , and  $F = p\eta(1-\delta) - p - (1-p)\delta - r^d < 0$ .

To show that  $b(z)$  is increasing in  $z$ , we consider two cases.

Case 1: Borrowing constraint is binding for  $b \in (b(z) - \epsilon, b(z))$ ,  $k_h^* = \lambda(b - \psi)$

Substituting  $k_l^*$  and  $k_h^*$  into the above equation,

$$[p\chi\lambda - F(\lambda - \bar{\lambda})](b(z) - \psi) = Ez \frac{1}{\alpha(1-\nu)+\nu} (\lambda^{\frac{\alpha(1-\nu)}{\alpha(1-\nu)+\nu}} - \bar{\lambda}^{\frac{\alpha(1-\nu)}{\alpha(1-\nu)+\nu}})(b(z) - \psi)^{\frac{\alpha(1-\nu)}{\alpha(1-\nu)+\nu}}$$

Take derivative with respect to  $z$ ,

$$b(z)' = \frac{b(z) - \psi}{\nu z} > 0$$

Case 2: Borrowing constraint is not binding for  $b \in (b(z) - \epsilon, b(z))$ .

In this case,  $k_h^* = \tilde{k}^h(z) = [\frac{1-p}{r^d+p\chi+(1-p)\delta-p\eta(1-\delta)+p} \frac{\alpha w}{1-\alpha}]^{\frac{\alpha(1-\nu)+\nu}{\nu}} (\frac{(1-\nu)(1-\alpha)}{w} z)^{\frac{1}{\nu}} = Gz^{\frac{1}{\nu}}$ , where  $G = [\frac{1-p}{r^d+p\chi+(1-p)\delta-p\eta(1-\delta)+p} \frac{\alpha w}{1-\alpha}]^{\frac{\alpha(1-\nu)+\nu}{\nu}} (\frac{(1-\nu)(1-\alpha)}{w})^{\frac{1}{\nu}} > 0$ .

Substituting  $k_l^*$  and  $k_h^*$ ,

$$Ez \frac{1}{\alpha(1-\nu)+\nu} \bar{\lambda}^{\frac{\alpha(1-\nu)}{\alpha(1-\nu)+\nu}} (b(z) - \psi)^{\frac{\alpha(1-\nu)}{\alpha(1-\nu)+\nu}} = [EG \frac{\alpha(1-\nu)}{\alpha(1-\nu)+\nu} + (F - p\chi)G]z^{\frac{1}{\nu}} - F\bar{\lambda}(b(z) - \psi)$$

$$b(z)' = \frac{\frac{[EG \frac{\alpha(1-\nu)}{\alpha(1-\nu)+\nu} + (F - p\chi)G]^{\frac{1}{\nu}} z^{\frac{1}{\nu}}}{[EG \frac{\alpha(1-\nu)}{\alpha(1-\nu)+\nu} + (F - p\chi)G]z^{\frac{1}{\nu}} - F\bar{\lambda}(b(z) - \psi)} \frac{1}{z} - \frac{1}{\alpha(1-\nu)+\nu} \frac{1}{z}}{\frac{\alpha(1-\nu)}{\alpha(1-\nu)+\nu} \frac{1}{b(z) - \psi} + \frac{F\bar{\lambda}}{[EG \frac{\alpha(1-\nu)}{\alpha(1-\nu)+\nu} + (F - p\chi)G]z^{\frac{1}{\nu}} - F\bar{\lambda}(b(z) - \psi)}}$$

Next we show that both the numerator and denominator are smaller than 0, so that  $b(z)' > 0$ .

Numerator:

$$F < 0 \Rightarrow \frac{[EG^{\frac{\alpha(1-\nu)}{\alpha(1-\nu)+\nu}} + (F - p\chi)G]^{\frac{1}{\nu}} z^{\frac{1}{\nu}}}{[EG^{\frac{\alpha(1-\nu)}{\alpha(1-\nu)+\nu}} + (F - p\chi)G] z^{\frac{1}{\nu}} - F\bar{\lambda}(b(z) - \psi)} \frac{1}{z} - \frac{1}{\alpha(1-\nu) + \nu} \frac{1}{z} < \frac{1}{z} - \frac{1}{\alpha(1-\nu) + \nu} \frac{1}{z} < 0.$$

Denominator:

$$\begin{aligned} & [EG^{\frac{\alpha(1-\nu)}{\alpha(1-\nu)+\nu}} + (F - p\chi)G] z^{\frac{1}{\nu}} \\ = & - \left( \frac{1}{r^d + p\chi + (1-p)\delta - p\eta(1-\delta) + p} \right)^{\frac{\alpha(1-\nu)}{\nu}} \left[ \frac{(1-\alpha)(1-\nu)}{w} \right]^{\frac{1}{\nu}} \left[ \frac{(1-p)\alpha w}{1-\alpha} \right]^{\frac{\alpha(1-\nu)}{\nu}} (1-p) \frac{\alpha w}{1-\alpha} \frac{\nu}{(1-\nu)} \\ < & 0 \end{aligned}$$

Therefore,

$$\begin{aligned} & \frac{\alpha(1-\nu)}{\alpha(1-\nu) + \nu} \frac{1}{b(z) - \psi} + \frac{F\bar{\lambda}}{[EG^{\frac{\alpha(1-\nu)}{\alpha(1-\nu)+\nu}} + (F - p\chi)G] z^{\frac{1}{\nu}} - F\bar{\lambda}(b(z) - \psi)} \\ < & \frac{1}{b(z) - \psi} + \frac{F\bar{\lambda}}{-F\bar{\lambda}(b(z) - \psi)} \\ = & 0 \end{aligned}$$

In conclusion,  $b(z)' < 0$ .

## B A Model with Forward Looking Agents

### B.1 Model Setup

We modify the baseline model with endogenous savings rate. The main modeling ingredients are similar to the baseline model, thus we state them briefly and only highlight the difference.

There is a continuum of individuals living indefinitely. Population is constant and there is no aggregate uncertainty. Agents are heterogeneous in terms of wealth  $b$  and talent  $z$ . Wealth evolves endogenously, which is determined by agents' forward-looking decisions. Productivity  $z$  follows an exogenous Markov process. With probability  $\gamma$ , agents retain their productivity in the previous period; with probability  $1 - \gamma$ , individuals draw a new entrepreneurial productivity. The new draw is from a time-invariant Pareto distribution governed by parameter  $\theta$  and is independent of agents' previous productivity level.

Agents have preference at time  $t$ ,

$$E_t \sum_{s=t}^{\infty} \beta^{s-t} \frac{c_s^{1-\sigma} - 1}{1-\sigma} \quad (\text{B.1})$$

where  $\beta$  is the time discount factor.

Agents can choose occupation, either to become workers or entrepreneurs. Each worker supplies one unit of labor inelastically and earns the equilibrium wage. Entrepreneurs use capital and hire labor to produce goods. Capital depreciates at rate  $\delta$  after production. Entrepreneurs have access to the following production technology,

$$f(z, k, l) = z(k^\alpha l^{1-\alpha})^{1-\nu} \quad (\text{B.2})$$

Production fails with probability  $p$ , in which case output is zero and the agent is able to recover only a fraction  $\eta < 1$  of installed capital net of depreciation at the end of the period. Again, we assume workers get paid only when production is successful. Therefore, each worker earns a wage with probability  $1 - p$ .

All agents can make a deposit in a financial institution so as to transfer wealth across periods. However, agents need to pay a fixed credit participation cost,  $\psi$ , to borrow from the bank. Borrowing is subject to limited commitment and asymmetric information problems as stated in the baseline model. Similarly, we use parameter  $\lambda$  and  $\chi$  to capture the tightness of the borrowing constraint and bank monitoring costs. Consistent with the myopic agent model, we assume that agents' credit participation status is only maintained for one period. Therefore, agent who obtained credit in period  $t$ , still has to pay  $\psi$  in period  $t + 1$  if she wants to borrow.

To simplify the problem (and also to be consistent with our myopic-agent model), we assume that agent chooses occupation, credit participation, and capital and labor input to maximize the expected end-of-period wealth (or expected income). Then, the agent chooses consumption and savings to maximize utility. Notice that this allows us to solve the problem in two separate steps. In the first step, we solve a static problem to obtain the optimal occupation choice, credit participation, capital and labor inputs conditional on the beginning-of-period wealth and talent. In the second step, we solve a dynamic problem to obtain optimal consumption and savings. Thus the only difference to the baseline myopic agent model is that we endogenize the consumption and savings decision instead of using a constant savings rate.

Since the first part of the problem is solved exactly in the same way as in the baseline myopic agent model, below we only formulate the endogenous consumption/savings decision, while taking the occupation choice, credit participation, capital and labor input as given.

Let  $V(b, z, t)$  be the agent's value function at the beginning of the period  $t$ . Let  $I_t^s$  be the income if production succeeds, and  $I_t^f$  be the income if production fails in period  $t$ .

Therefore, given the occupation choice, credit participation, capital and labor input solved in

the first part of the problem,  $I_t^s$  and  $I_t^f$  can be expressed as,

$$I_t^s = \begin{cases} w_t & \text{Worker} \\ z_t(k_t^\alpha l_t^{1-\alpha})^{1-\nu} - w_t l_t + (1 - \delta - r_t^d)k_t + r_t^d b_t & \text{Entrepreneur, savings regime} \\ z_t(k_t^\alpha l_t^{1-\alpha})^{1-\nu} - w_t l_t + (1 - \delta)k_t - \Omega + r_t^d b_t - \psi(1 + r_t^d) & \text{Entrepreneur, credit regime} \end{cases}$$

$$I_t^f = \begin{cases} 0 & \text{Worker} \\ -k_t + \eta(1 - \delta)k_t + r_t^d(b_t - k_t) & \text{Entrepreneur, savings regime} \\ \max(0, \eta(1 - \delta)k_t + (1 + r_t^d)(b_t - \psi) - \Omega) - b_t & \text{Entrepreneur, credit regime} \end{cases}$$

Then the agent chooses consumption and savings to maximize life-time utility. Denote  $c_t^s/c_t^f$  be the consumption when production succeeds/fails. Taking  $I_t^s$  and  $I_t^f$  as given, the recursive formulation for the second part of the problem is,

$$V(b_t, z_t, t) = \max_{c_t^s, c_t^f, b_{t+1}^s, b_{t+1}^f} (1-p) \left[ \frac{(c_t^s)^{1-\sigma} - 1}{1-\sigma} + \beta E[V(b_{t+1}^s, z_{t+1}, t+1) | z_t] \right] \\ + p \left[ \frac{(c_t^f)^{1-\sigma} - 1}{1-\sigma} + \beta E[V(b_{t+1}^f, z_{t+1}, t+1) | z_t] \right]$$

subject to

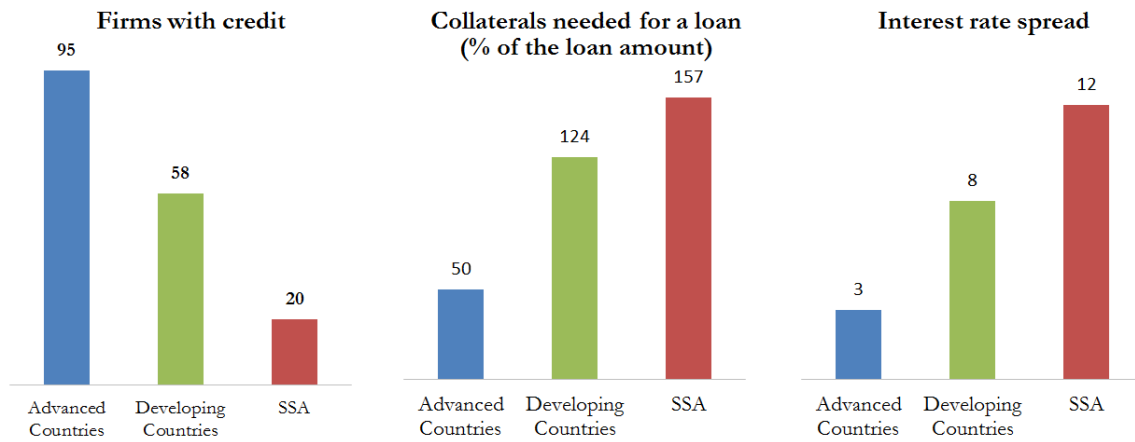
$$\begin{aligned} c_t^s + b_{t+1}^s &= b_t + I_t^s \\ c_t^f + b_{t+1}^f &= b_t + I_t^f \end{aligned}$$

## B.2 Calibration and Simulation results

In the model with forward looking agents, two extra parameter are introduced, the time discount rate  $\beta$  and the risk-aversion parameter  $\sigma$ . Following the standard practice, we set  $\beta = 0.96$  and  $\sigma = 1.5$ . Computation complexity increases tremendously for the model with forward looking agents. For tractability, we do not match the employment distribution, instead we set  $\theta = 4.15$  following Buera and Shin (2013), which is selected to match the U.S. employment distribution. We choose parameters  $\psi$ ,  $p$ , and  $\chi$  to match the percent of firms with credit, the NPLs, and the interest rate spread (see Table A.1). The parameter  $\eta$  is calibrated in the same way as in the baseline model. To provide a consistent comparison with the baseline myopic-agent model, we also re-calibrate the



baseline model for all six countries with  $\theta = 4.15$  (see Table A.2).  
The simulation results are shown in Table A.3.



**FIGURE I**  
**Financial Inclusion in The World**  
 Source: Enterprise Surveys, the World Bank.  
 Note: SSA represents low-income countries in Sub Saharan Africa.

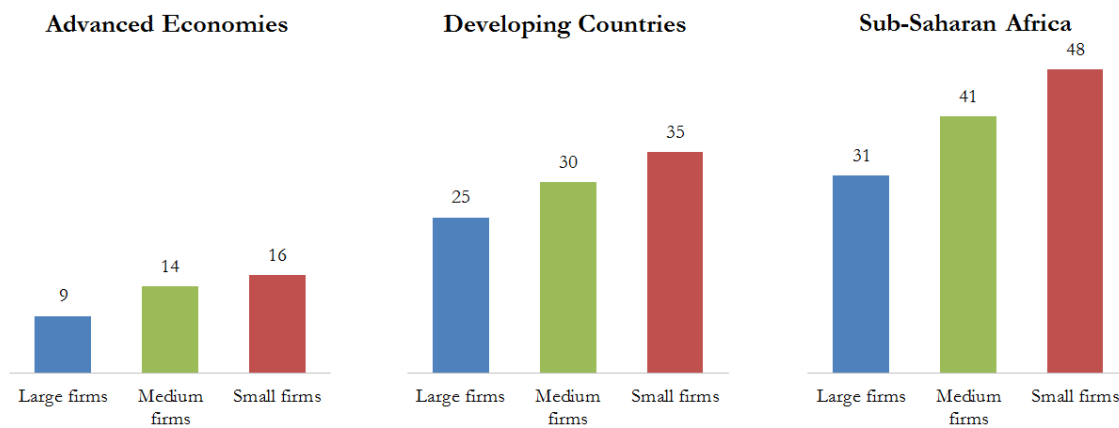


FIGURE II  
 Firms Identifying Access to Finance as a Major Constraint (Percent)  
 Source: Enterprise Surveys, the World Bank.

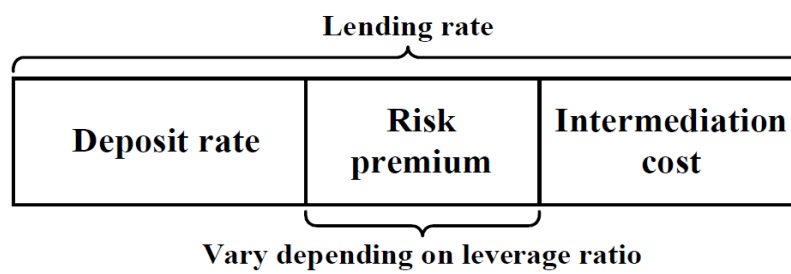


FIGURE III  
Components of the Lending Interest Rate

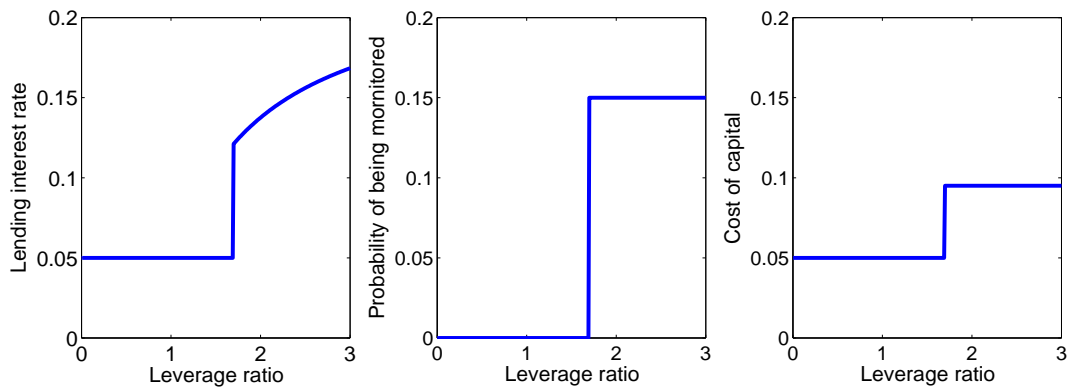


FIGURE IV

Lending Interest Rate, Monitoring Frequency, Cost of Capital, and Leverage Ratio  
 The figure is plotted using  $r_d = 0.05$ ,  $\eta = 0.35$ ,  $\delta = 0.06$ ,  $p = 0.15$ ,  $\chi = 0.3$ .

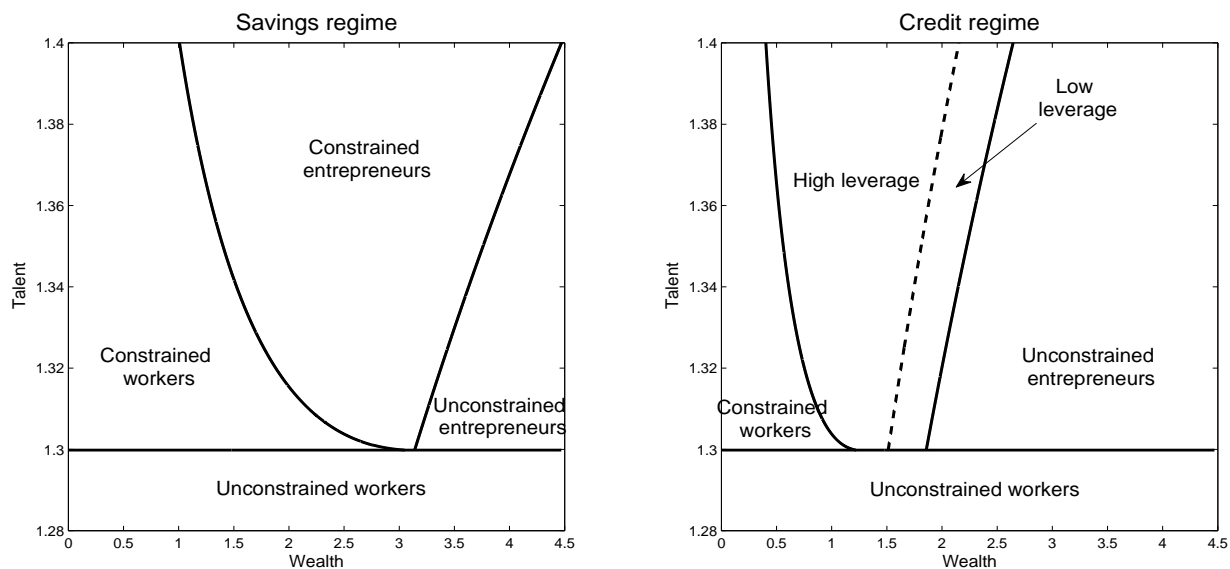


FIGURE V

The Occupation Choice Map in the Two Regimes

Figures are plotted using the following parameter values:  $r_d = 0.05$ ,  $w = 0.6$ ,  $\eta = 0.35$ ,  $\delta = 0.06$ ,  $\nu = 0.21$ ,  $p = 0.15$ ,  $\alpha = 0.33$ ,  $\lambda = 2.5$ ,  $\psi = 0$ ,  $\chi = 0$ .

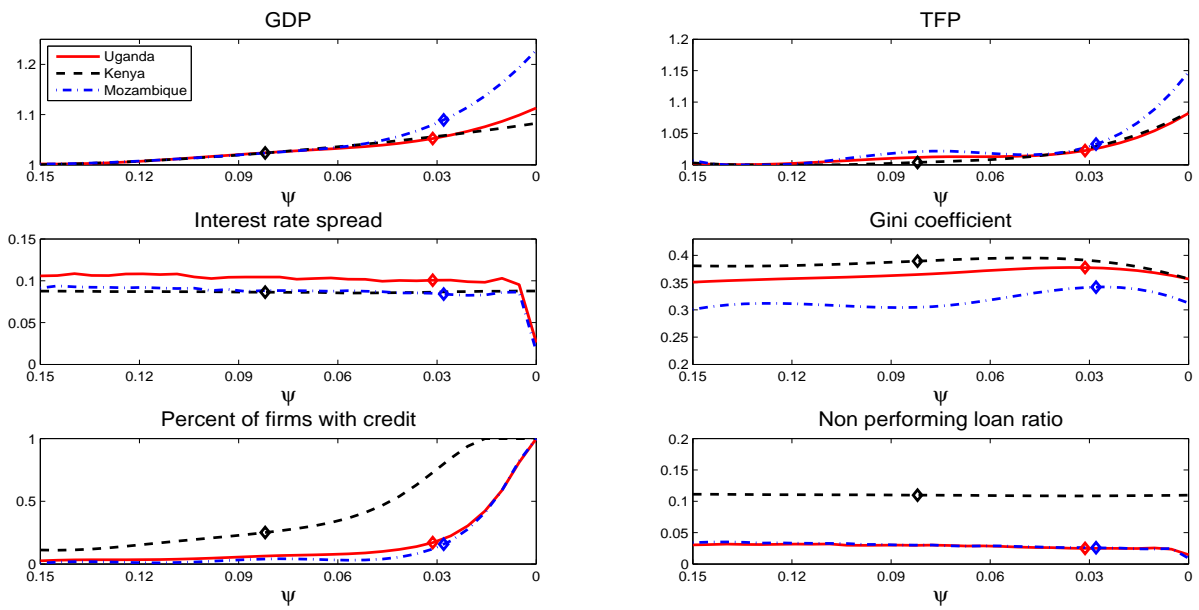


FIGURE VI  
Comparative Statics: Credit Participation Cost—Low-income Countries

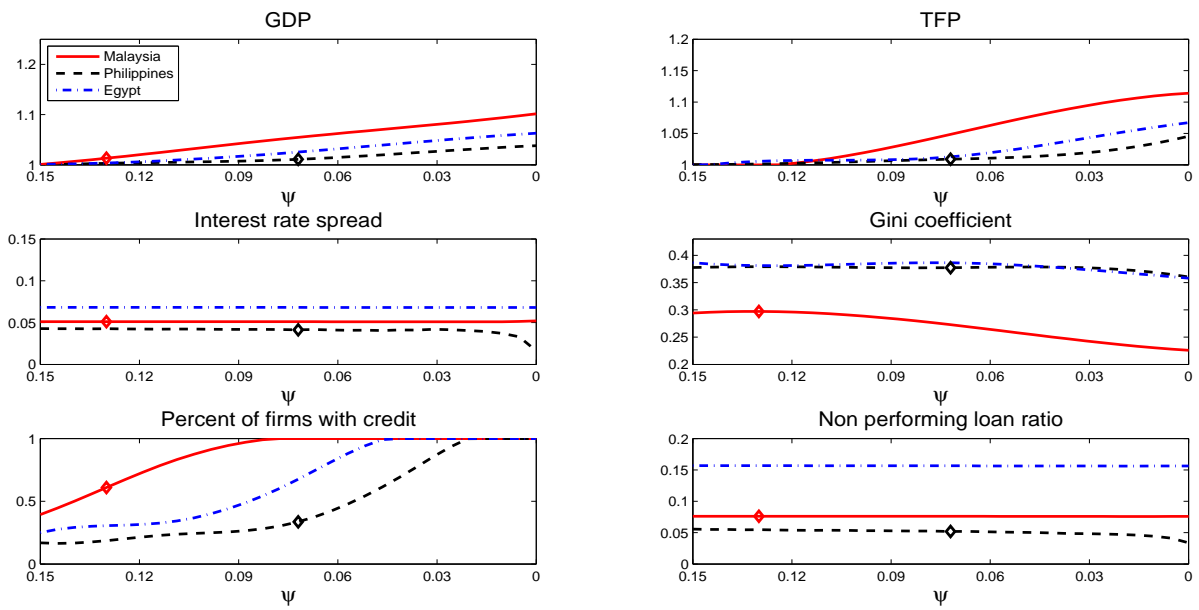


FIGURE VII  
Comparative Statics: Credit Participation Cost—Emerging Market Countries



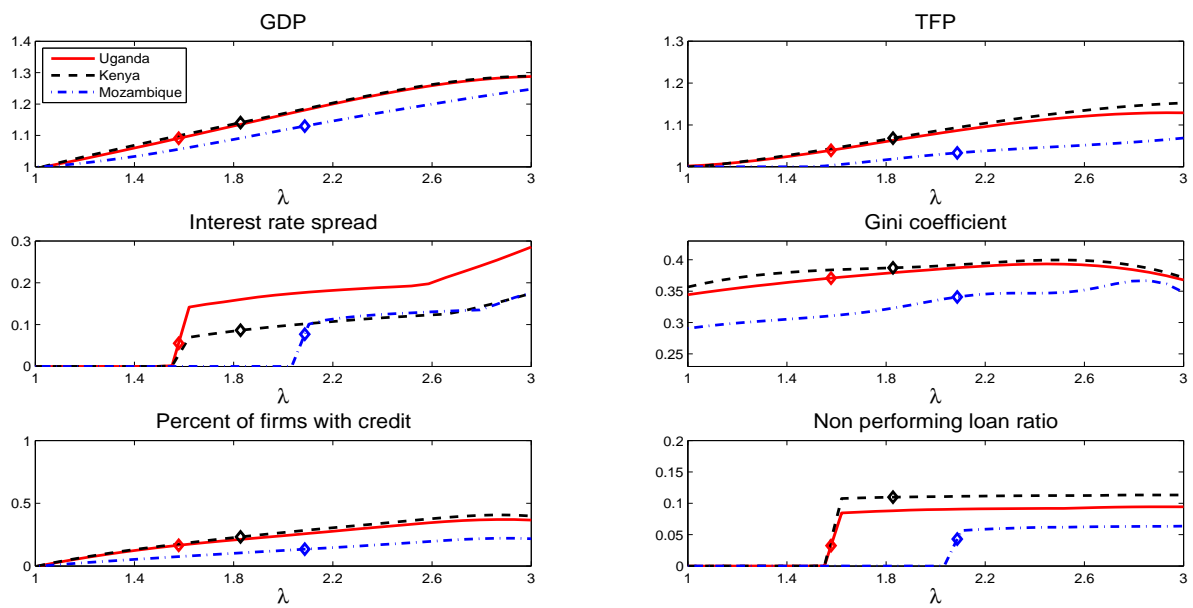


FIGURE VIII  
Comparative Statics: Collateral Constraint—Low-income Countries

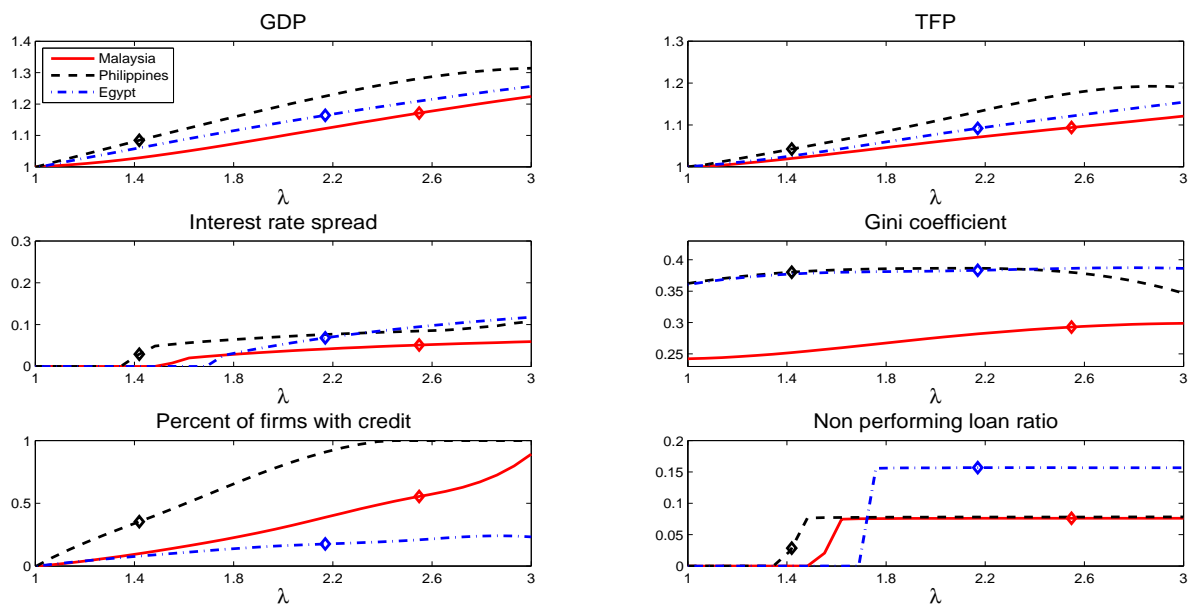


FIGURE IX  
Comparative Statics: Collateral Constraint—Emerging Market Countries

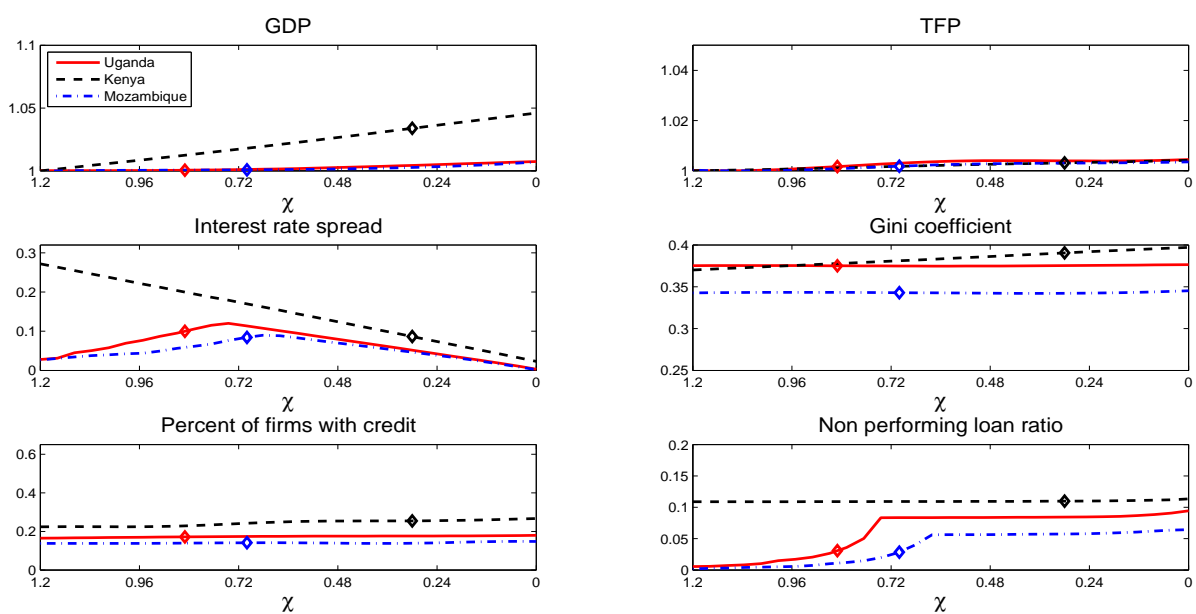


FIGURE X  
Comparative Statics: Intermediation Cost—Low-income Countries

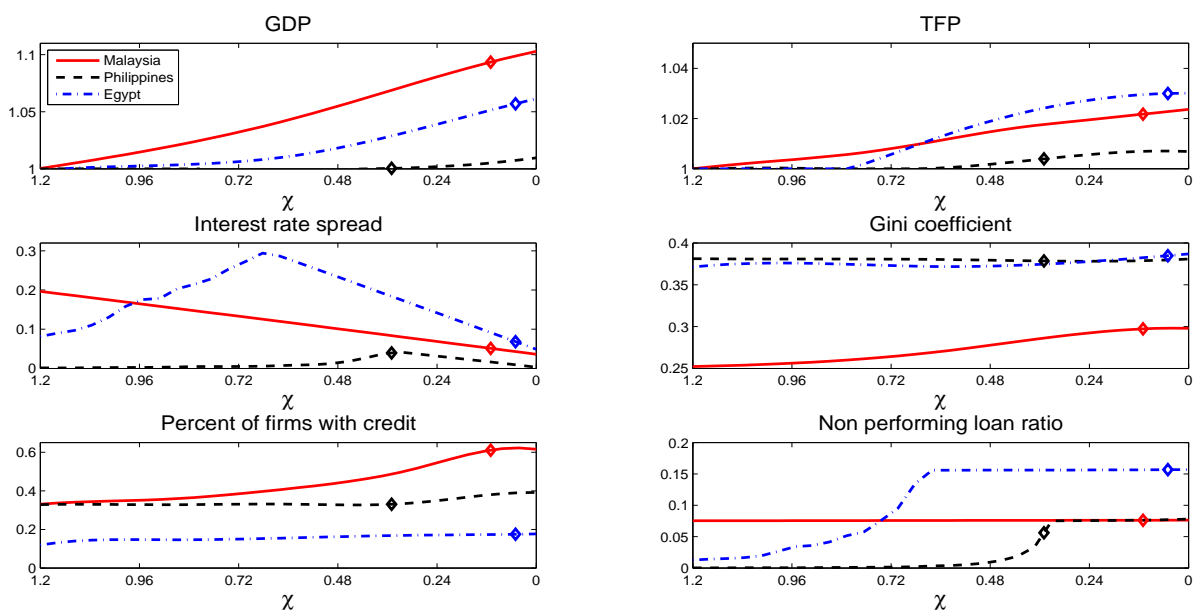


FIGURE XI  
Comparative Statics: Intermediation Cost—Emerging Market Countries

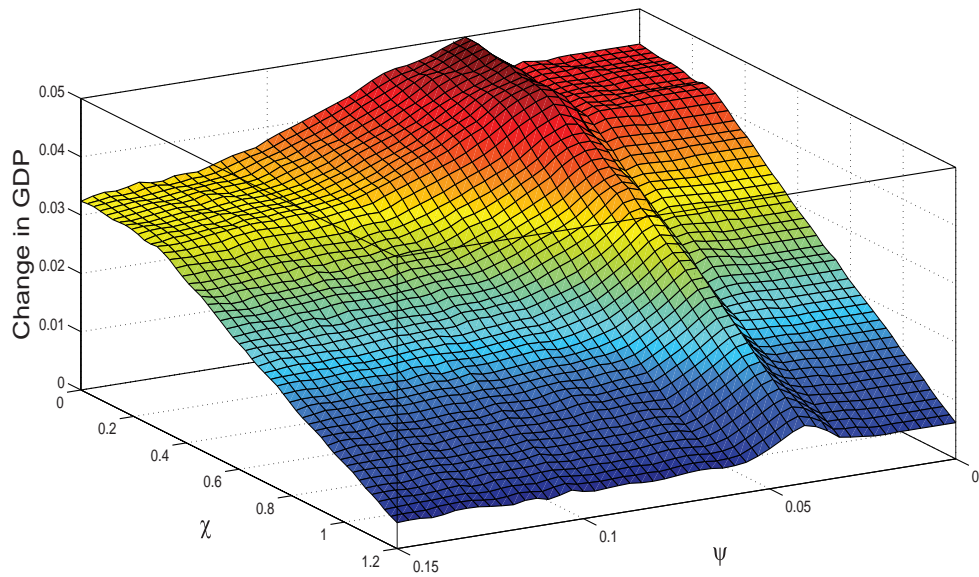


FIGURE XII

Interactions among Three Financial Parameters

We consider the increase in relative GDP per capita, when the borrowing constraint is relaxed by 20% for different financial participation costs and intermediation costs. Horizontal axes refer to cost  $\chi$  and  $\psi$ ; Vertical axis refer to the relative change in GDP. The Philippines' calibrated parameters are used for this study.

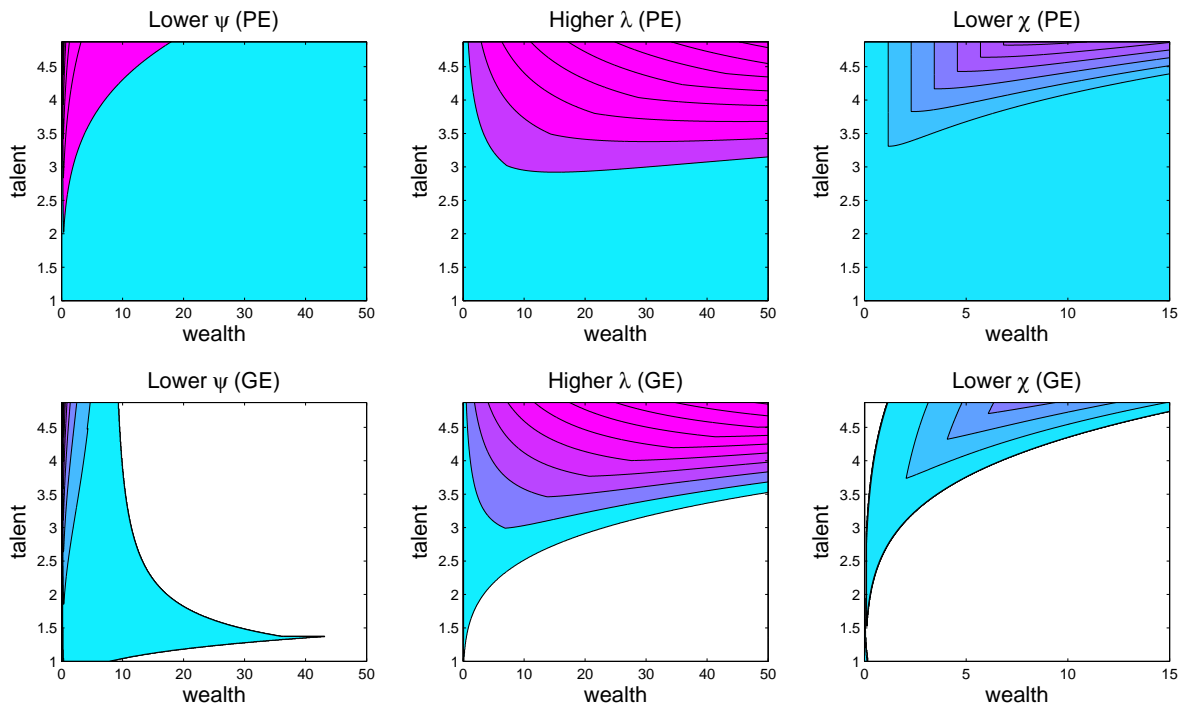


FIGURE XIII

The Impact of Financial Inclusion of Various Forms on Welfare Redistribution  
 The horizontal and vertical axes refer to wealth and talent, respectively. Income gains are reflected by differences in shades of color—gains are low for light areas (white areas incur losses). Panels in the first row are partial equilibrium results when interest rate and wage are fixed; panels in the second row are general equilibrium results. The left, middle, and right columns represent change of  $\psi$ ,  $\lambda$ , and  $\chi$ , respectively.

TABLE I  
OVERVIEW OF THE DATA

	Low-income countries			Emerging market economies		
	Uganda	Kenya	Mozambique	Malaysia	Philippines	Egypt
Savings (% of GDP)	8	15.4	7.1	39	25.7	24.5
Collateral (% of loan)	173	120.8	92	64.6	238.4	85.5
Firms with credit (%)	17.2	25.4	14.2	60.4	33.2	17.4
Non-perfor. loan (%)	2.3	10.6	3.1	8.5	4.5	19.3
Interest rate spread	10.9	8.5	8.2	3.3	4.3	6.1
Top 5% emp. share	53.8	54.1	41.3	29.5	52.7	58.4
Top 10% emp. share	64.2	66.	55.8	46.3	65.7	72.7
Top 20% emp. share	74.6	81	71.9	63.5	79	85.9
Top 40% emp. share	86.4	93.2	87.2	84.1	90.8	95

TABLE II  
DATA, MODEL, AND CALIBRATED PARAMETERS

Target Moments	Uganda			Kenya			Mozambique		
	Data	Model	Parameter	Data	Model	Parameter	Data	Model	Parameter
Savings (% of GDP)	8	8	$\omega = 0.08$	15.4	15.4	$\omega = 0.15$	7.1	7.1	$\omega = 0.07$
Collateral (% of loan)	173	173	$\lambda = 1.58$	120.8	120.8	$\lambda = 1.83$	92	92	$\lambda = 2.09$
Firms with credit (%)	17.2	17.3	$\psi = 0.03$	25.4	25.6	$\psi = 0.08$	14.2	13.8	$\psi = 0.03$
Non-perfor. loan (%)	2.3	2.9	$p = 0.15$	10.6	11	$p = 0.18$	3.1	2.8	$p = 0.14$
Interest rate spread	10.9	10.1	$\chi = 0.85$	8.5	8.7	$\chi = 0.30$	8.2	8.3	$\chi = 0.70$
Top 5% emp. share	53.8	52.9	$\theta = 4.80$	54.1	57.0	$\theta = 4.40$	41.3	47.0	$\theta = 6.00$
Top 10% emp. share	64.2	64.5		66.9	69.5		55.8	59.1	
Top 20% emp. share	74.6	74.7		81	80.3		71.9	69.2	
Top 40% emp. share	86.4	84.8		93.2	88.7		87.2	80.6	
Target Moments	Malaysia			Philippines			Egypt		
	Data	Model	Parameter	Data	Model	Parameter	Data	Model	Parameter
Savings (% of GDP)	39	39	$\omega = 0.39$	25.7	25.7	$\omega = 0.26$	24.5	24.5	$\omega = 0.25$
Collateral (% of loan)	64.6	64.6	$\lambda = 2.56$	238.4	238.4	$\lambda = 1.42$	85.5	85.5	$\lambda = 2.17$
Firms with credit (%)	60.4	60.5	$\psi = 0.13$	33.2	33.2	$\psi = 0.07$	17.4	17.5	$\psi = 0.23$
Non-perfor. loan (%)	8.5	7.6	$p = 0.12$	4.5	5.3	$p = 0.11$	19.3	15.7	$p = 0.28$
Interest rate spread	3.3	5.1	$\chi = 0.11$	4.3	4.1	$\chi = 0.35$	6.1	6.8	$\chi = 0.05$
Top 5% emp. share	29.5	34.7	$\theta = 6.80$	52.7	54.7	$\theta = 4.30$	58.4	62.1	$\theta = 4.25$
Top 10% emp. share	46.3	47.1		65.7	66.3		72.7	74.2	
Top 20% emp. share	63.5	61.7		79	77.3		85.9	83.5	
Top 40% emp. share	84.1	78.6		90.8	87.2		95	90.4	



TABLE III  
THE IMPACT OF FINANCIAL INCLUSION ON GDP, TFP, AND INCOME INEQUALITY

	Participation cost $\psi$			Borrowing constraint $\lambda$			Intermediation cost $\chi$		
	GDP(%)	TFP(%)	Gini	GDP(%)	TFP(%)	Gini	GDP(%)	TFP(%)	Gini
Uganda	0.39	0.34	-0.0006	0.35	0.25	0.0008	0.12	0.23	-0.0004
Kenya	0.63	0.39	0.0030	0.47	0.35	0.0004	1.17*	0.36*	0.0065*
Mozambique	0.39	0.28	0.0002	0.47	0.21	0.0017	0.60	0.24	0.0021
Malaysia	0.43	0.21	-0.0005	0.51	0.33	0.0010	0.86*	0.23*	0.0007*
Philippines	0.29	0.17	0.0006	0.26	0.18	0.0003	0.41	0.33	0.0002
Egypt	0.19	1.45	-0.0110	0.46	0.37	0.0004	0.42*	0.19*	0.0021*

Note: We consider change of parameter that results in 1% increase in credit to investment ratio. In cases marked with \*, we report the change in GDP, TFP, and Gini when parameter  $\chi$  is reduced to zero. This is because in these cases, even if parameter  $\chi$  is reduced to zero, the increase in credit to investment ratio is still less than 1%.

TABLE IV  
THE IMPACT OF FINANCIAL INCLUSION ON GDP, TFP, AND INCOME  
INEQUALITY

	Participation cost $\psi$			Borrowing constraint $\lambda$			Intermediation cost $\chi$		
	GDP(%)	TFP(%)	Gini	GDP(%)	TFP(%)	Gini	GDP(%)	TFP(%)	Gini
Uganda	5.79	5.76	-0.0210	18.05	11.01	-0.0029	0.69	0.33	0.0014
Kenya	5.76	7.99	-0.0324	13.02	9.39	-0.0155	1.17	0.36	0.0065
Mozambique	12.73	11.53	-0.0292	10.40	4.97	0.0206	0.62	0.25	0.0023
Malaysia	8.74	10.69	-0.0713	4.51	2.97	0.0060	0.86	0.23	0.0007
Philippines	2.69	3.52	-0.0170	21.17	16.38	-0.0337	0.92	0.38	0.0023
Egypt	6.81	11.80	-0.0630	7.90	6.66	0.0031	0.42	0.19	0.0021

Note: In all cases, we consider financial inclusion that moves the country to world financial sector frontier in one of the three parameters.

TABLE A.1  
CALIBRATION OF THE MODEL WITH FORWARD LOOKING AGENTS

Target Moments	Uganda			Kenya			Mozambique		
	Data	Model	Parameter	Data	Model	Parameter	Data	Model	Parameter
Collateral (% of loan)	173	173	$\lambda = 1.58$	120.8	120.8	$\lambda = 1.83$	92	92	$\lambda = 2.09$
Firms with credit (%)	17.2	17.9	$\psi = 0.07$	25.4	22.93	$\psi = 0.08$	14.2	14.3	$\psi = 0.21$
Non-perfor. loan (%)	2.3	3.7	$p = 0.15$	10.6	10.9	$p = 0.18$	3.1	3.7	$p = 0.14$
Interest rate spread	10.9	9.5	$\chi = 0.80$	8.5	9.2	$\chi = 0.20$	8.2	7.4	$\chi = 0.7$
Target Moments	Malaysia			Philippines			Egypt		
	Data	Model	Parameter	Data	Model	Parameter	Data	Model	Parameter
Collateral (% of loan)	64.6	64.6	$\lambda = 2.56$	238.4	238.4	$\lambda = 1.42$	85.5	85.5	$\lambda = 2.17$
Firms with credit (%)	60.4	62.2	$\psi = 0.08$	33.2	31.6	$\psi = 0.07$	17.4	14.6	$\psi = 0.08$
Non-perfor. loan (%)	8.5	7.6	$p = 0.15$	4.5	3.4	$p = 0.11$	19.3	16.6	$p = 0.25$
Interest rate spread	3.3	5.0	$\chi = 0.05$	4.3	8.3	$\chi = 0.10$	6.1	8.8	$\chi = 0.01$

TABLE A.2  
CALIBRATION OF THE BASELINE MODEL WITH  $\theta = 4.15$

Target Moments	Uganda			Kenya			Mozambique		
	Data	Model	Parameter	Data	Model	Parameter	Data	Model	Parameter
Savings (% of GDP)	8	8	$\omega = 0.08$	15.4	15.4	$\omega = 0.15$	7.1	7.1	$\omega = 0.07$
Collateral (% of loan)	173	173	$\lambda = 1.58$	120.8	120.8	$\lambda = 1.83$	92	92	$\lambda = 2.09$
Firms with credit (%)	17.2	17.4	$\psi = 0.05$	25.4	23.80	$\psi = 0.09$	14.2	14.1	$\psi = 0.067$
Non-perfor. loan (%)	2.3	4.1	$p = 0.15$	10.6	11.0	$p = 0.18$	3.1	2.4	$p = 0.14$
Interest rate spread	10.9	10.9	$\chi = 0.81$	8.5	8.7	$\chi = 0.30$	8.2	8.0	$\chi = 0.7$
Target Moments	Malaysia			Philippines			Egypt		
	Data	Model	Parameter	Data	Model	Parameter	Data	Model	Parameter
Savings (% of GDP)	39	39	$\omega = 0.39$	25.7	25.7	$\omega = 0.26$	24.5	24.5	$\omega = 0.25$
Collateral (% of loan)	64.6	64.6	$\lambda = 2.56$	238.4	238.4	$\lambda = 1.42$	85.5	85.5	$\lambda = 2.17$
Firms with credit (%)	60.4	60.4	$\psi = 0.26$	33.2	33.3	$\psi = 0.08$	17.4	17.3	$\psi = 0.24$
Non-perfor. loan (%)	8.5	7.6	$p = 0.12$	4.5	4.1	$p = 0.11$	19.3	15.6	$p = 0.28$
Interest rate spread	3.3	5.1	$\chi = 0.11$	4.3	5.3	$\chi = 0.35$	6.1	6.8	$\chi = 0.05$

In this calibration, we set  $\theta = 4.15$  for all six countries to be consistent with the calibration of the model with forward looking agents. We choose parameter  $\psi$ ,  $p$ , and  $\chi$  to match the percent of firms with credit, the non performing loans ratio, and the interest rate spread.

TABLE A.3  
COMPARING THE BASELINE MODEL AND THE MODEL WITH FORWARD LOOKING AGENTS

		Participation cost $\psi$			Borrowing constraint $\lambda$			Intermediation cost $\chi$		
		GDP(%)	TFP(%)	Gini	GDP(%)	TFP(%)	Gini	GDP(%)	TFP(%)	Gini
Uganda	Baseline	5.79	5.76	-0.0210	18.05	11.01	-0.0029	0.69	0.33	0.0014
	Baseline ( $\theta = 4.15$ )	5.93	6.08	-0.0206	18.08	10.36	-0.0078	0.72	0.25	0.0015
	FL model	7.46	1.84	-0.0087	9.65	3.80	-0.0119	6.89	2.11	-0.0165
Kenya	Baseline	5.76	7.99	-0.0324	13.02	9.39	-0.0155	1.17	0.36	0.0065
	Baseline ( $\theta = 4.15$ )	6.08	6.33	-0.0229	15.44	9.15	0.0146	0.94	0.13	0.0032
	FL model	6.98	4.24	-0.0206	10.68	6.16	-0.0263	6.18	2.56	-0.015
Mozambique	Baseline	12.73	11.53	-0.0292	10.40	4.97	0.0206	0.62	0.25	0.0023
	Baseline ( $\theta = 4.15$ )	9.92	8.85	-0.0243	11.46	6.28	0.0159	0.64	0.26	0.0010
	FL model	12.08	6.70	-0.0174	13.32	6.70	-0.0111	10.78	6.36	-0.0241
Malaysia	Baseline	8.74	10.69	-0.0713	4.51	2.97	0.0060	0.86	0.23	0.0007
	Baseline ( $\theta = 4.15$ )	6.46	7.65	-0.0715	3.84	3.57	-0.0033	1.25	0.10	0.0068
	FL model	3.10	2.15	-0.0128	2.88	1.68	-0.0082	1.25	0.11	-0.0045
Philippines	Baseline	2.69	3.52	-0.0170	21.17	16.38	-0.0337	0.92	0.38	0.0023
	Baseline ( $\theta = 4.15$ )	2.33	7.65	-0.0071	20.95	18.63	-0.0303	0.94	0.29	0.0023
	FL model	10.98	5.02	-0.0226	18.58	8.56	-0.0550	7.75	2.17	-0.0092
Egypt	Baseline	6.81	11.80	-0.0630	7.90	6.66	0.0031	0.42	0.19	0.0021
	Baseline ( $\theta = 4.15$ )	7.80	8.44	-0.0431	7.60	5.61	0.0017	0.46	0.03	0.0018
	FL model	5.81	2.00	-0.0502	5.68	2.00	0.0053	1.50	0.16	0.0015

Note: In all cases, we consider financial inclusion that moves the country to world financial sector frontier for one of the three parameters.

TABLE A.4  
CALIBRATION OF THE BASELINE MODEL WITH LOW  $\eta$

Target Moments	Uganda			Kenya			Mozambique		
	Data	Model	Parameter	Data	Model	Parameter	Data	Model	Parameter
Savings (% of GDP)	8	8	$\omega = 0.08$	15.4	15.4	$\omega = 0.15$	7.1	7.1	$\omega = 0.07$
Collateral (% of loan)	173	173	$\lambda = 1.58$	120.8	120.8	$\lambda = 1.83$	92	92	$\lambda = 2.09$
Firms with credit (%)	17.2	17.5	$\psi = 0.036$	25.4	25.5	$\psi = 0.09$	14.2	14.2	$\psi = 0.03$
Non-perfor. loan (%)	2.3	3.1	$p = 0.05$	10.6	10.0	$p = 0.15$	3.1	3.9	$p = 0.08$
Interest rate spread	10.9	10.0	$\chi = 1.95$	8.5	8.7	$\chi = 0.35$	8.2	8.3	$\chi = 0.90$
Top 5% emp. share	53.8	53.2	$\theta = 4.80$	54.1	57.1	$\theta = 4.40$	41.3	47.3	$\theta = 6.00$
Top 10% emp. share	64.2	64.8	$\eta = 0.32$	66.9	69.5	$\eta = 0.32$	55.8	59.3	$\eta = 0.49$
Top 20% emp. share	74.6	74.9		81	80.3		71.9	69.4	
Top 40% emp. share	86.4	84.9		93.2	88.7		87.2	80.7	
Target Moments	Malaysia			Philippines			Egypt		
	Data	Model	Parameter	Data	Model	Parameter	Data	Model	Parameter
Savings (% of GDP)	39	39	$\omega = 0.39$	25.7	25.7	$\omega = 0.26$	24.5	24.5	$\omega = 0.25$
Collateral (% of loan)	64.6	64.6	$\lambda = 2.56$	238.4	238.4	$\lambda = 1.42$	85.5	85.5	$\lambda = 2.17$
Firms with credit (%)	60.4	60.3	$\psi = 0.13$	33.2	32.7	$\psi = 0.08$	17.4	17.5	$\psi = 0.23$
Non-perfor. loan (%)	8.5	8.2	$p = 0.12$	4.5	5.2	$p = 0.07$	19.3	17.1	$p = 0.28$
Interest rate spread	3.3	5.8	$\chi = 0.11$	4.3	3.9	$\chi = 0.45$	6.1	8.7	$\chi = 0.05$
Top 5% emp. share	29.5	34.7	$\theta = 6.80$	52.7	55.1	$\theta = 4.30$	58.4	62.1	$\theta = 4.25$
Top 10% emp. share	46.3	47.1	$\eta = 0.32$	65.7	66.6	$\eta = 0.24$	72.7	74.2	$\eta = 0.39$
Top 20% emp. share	63.5	61.7		79	77.5		85.9	83.5	
Top 40% emp. share	84.1	78.6		90.8	87.3		95	90.3	

In this calibration, we set  $\eta$  to be 0.05 lower than its value in the baseline model for all six countries. We choose parameters  $\psi$ ,  $p$ , and  $\chi$ , and  $\theta$  to match the percent of firms with credit, the non performing loans ratio, the interest rate spread and the employment share distribution.

TABLE A.5  
COMPARING THE BASELINE MODEL AND THE MODEL WITH LOW RECOVERY RATE ( $\eta$ )

		Participation cost $\psi$			Borrowing constraint $\lambda$			Intermediation cost $\chi$		
		GDP(%)	TFP(%)	Gini	GDP(%)	TFP(%)	Gini	GDP(%)	TFP(%)	Gini
Uganda	Baseline	5.79	5.76	-0.0210	18.05	11.01	-0.0029	0.69	0.33	0.0014
	low $\eta$	5.91	7.01	-0.0307	18.79	9.21	-0.0014	0.57	0.07	0.0025
Kenya	Baseline	5.76	7.99	-0.0324	13.02	9.39	-0.0155	1.17	0.36	0.0065
	low $\eta$	5.24	7.78	-0.0380	12.83	7.95	-0.0196	1.16	0.11	0.0065
Mozambique	Baseline	12.73	11.53	-0.0292	10.40	4.97	0.0206	0.62	0.25	0.0023
	low $\eta$	12.92	15.85	-0.0527	11.17	4.91	0.0270	0.50	0.06	0.0018
Malaysia	Baseline	8.74	10.69	-0.0713	4.51	2.97	0.0060	0.86	0.23	0.0007
	low $\eta$	8.85	11.92	-0.0657	4.58	2.93	0.0074	0.99	0.24	0.0032
Philippines	Baseline	2.69	3.52	-0.0170	21.17	16.38	-0.0337	0.92	0.38	0.0023
	low $\eta$	2.33	3.98	-0.0238	22.18	13.58	-0.0321	0.79	0.11	0.0023
Egypt	Baseline	6.81	11.80	-0.0630	7.90	6.66	0.0031	0.42	0.19	0.0021
	low $\eta$	7.88	8.44	-0.0431	7.62	5.72	0.0009	0.47	0.04	0.0019

Note: In all cases, we consider financial inclusion that moves the country to world financial sector frontier for one of the three parameters.

TABLE A.6  
CALIBRATION USING THE BANK OVERHEAD COSTS TO TOTAL ASSETS RATIO

Target Moments	Uganda			Kenya			Mozambique		
	Data	Model	Parameter	Data	Model	Parameter	Data	Model	Parameter
Savings (% of GDP)	8	8	$\omega = 0.08$	15.4	15.4	$\omega = 0.15$	7.1	7.1	$\omega = 0.07$
Collateral (% of loan)	173	173	$\lambda = 1.58$	120.8	120.8	$\lambda = 1.83$	92	92	$\lambda = 2.09$
Firms with credit (%)	17.2	17.1	$\psi = 0.031$	25.4	25.2	$\psi = 0.08$	14.2	14.2	$\psi = 0.03$
Non-perfor. loan (%)	2.3	2.4	$p = 0.05$	10.6	10.9	$p = 0.18$	3.1	3.1	$p = 0.14$
Overhead costs/assets	6.9	6.6	$\chi = 0.90$	6.6	6.5	$\chi = 0.61$	7.4	7.3	$\chi = 0.95$
Top 5% emp. share	53.8	52.9	$\theta = 4.80$	54.1	57.0	$\theta = 4.40$	41.3	46.8	$\theta = 6.00$
Top 10% emp. share	64.2	64.4	$\eta = 0.37$	66.9	69.3	$\eta = 0.37$	55.8	58.9	$\eta = 0.54$
Top 20% emp. share	74.6	74.7		81	80.1		71.9	69.1	
Top 40% emp. share	86.4	84.7		93.2	88.6		87.2	80.5	

Target Moments	Malaysia			Philippines			Egypt		
	Data	Model	Parameter	Data	Model	Parameter	Data	Model	Parameter
Savings (% of GDP)	39	39	$\omega = 0.39$	25.7	25.7	$\omega = 0.26$	24.5	24.5	$\omega = 0.25$
Collateral (% of loan)	64.6	64.6	$\lambda = 2.56$	238.4	238.4	$\lambda = 1.42$	85.5	85.5	$\lambda = 2.17$
Firms with credit (%)	60.4	60.5	$\psi = 0.13$	33.2	33.0	$\psi = 0.07$	17.4	17.5	$\psi = 0.23$
Non-perfor. loan (%)	8.5	7.6	$p = 0.12$	4.5	3.8	$p = 0.11$	19.3	19.6	$p = 0.28$
Overhead costs/assets	1.5	1.5	$\chi = 0.16$	3.2	3.1	$\chi = 0.60$	1.5	1.4	$\chi = 0.08$
Top 5% emp. share	29.5	34.5	$\theta = 6.80$	52.7	54.6	$\theta = 4.30$	58.4	61.9	$\theta = 4.25$
Top 10% emp. share	46.3	46.9	$\eta = 0.37$	65.7	66.0	$\eta = 0.27$	72.7	74.1	$\eta = 0.30$
Top 20% emp. share	63.5	61.5		79.0	77.0		85.9	83.3	
Top 40% emp. share	84.1	78.5		90.8	87.0		95	90.3	

In this calibration, we choose parameters  $\psi$ ,  $p$ , and  $\chi$ , and  $\theta$  to match the percent of firms with credit, the non performing loans ratio, the bank overhead costs to total assets ratio and the employment share distribution.



TABLE A.7  
COMPARING THE BASELINE MODEL AND THE CALIBRATED MODEL USING OVERHEAD COSTS

		Participation cost $\psi$			Borrowing constraint $\lambda$			Intermediation cost $\chi$		
		GDP(%)	TFP(%)	Gini	GDP(%)	TFP(%)	Gini	GDP(%)	TFP(%)	Gini
Uganda	Baseline	5.79	5.76	-0.0210	18.05	11.01	-0.0029	0.69	0.33	0.0014
	Overhead costs	5.90	6.83	-0.0299	17.93	9.35	-0.0047	0.73	0.33	0.0015
Kenya	Baseline	5.76	7.99	-0.0324	13.02	9.39	-0.0155	1.17	0.36	0.0065
	Overhead costs	5.16	7.72	-0.0350	12.73	8.21	-0.0126	2.35	0.20	0.0132
Mozambique	Baseline	12.73	11.53	-0.0292	10.40	4.97	0.0206	0.62	0.25	0.0023
	Overhead costs	12.68	12.92	-0.0520	9.61	4.58	0.0101	0.80	0.25	0.0022
Malaysia	Baseline	8.74	10.69	-0.0713	4.51	2.97	0.0060	0.86	0.23	0.0007
	Overhead costs	8.60	11.78	-0.0658	4.59	3.00	0.0066	1.41	0.42	0.0039
Philippines	Baseline	2.69	3.52	-0.0170	21.17	16.38	-0.0337	0.92	0.38	0.0023
	Overhead costs	2.15	3.62	-0.0217	20.78	14.53	-0.0318	1.46	0.64	0.0024
Egypt	Baseline	6.81	11.80	-0.0630	7.90	6.66	0.0031	0.42	0.19	0.0021
	Overhead costs	7.68	7.55	-0.0231	7.24	5.67	-0.0003	0.73	0.08	0.0027

Note: In all cases, we consider financial inclusion that moves the country to world financial sector frontier for one of the three parameters.