ENTREPRENEURSHIP AND FINANCIAL FRICTIONS:
A MACRO-DEVELOPMENT PERSPECTIVE

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ABSTRACT

We review both the theoretical and empirical literature on entrepreneurship and financial frictions, with an emphasis on the heterogeneous and dynamic micro-level implications of financial frictions for macro development.

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1 Introduction

Entrepreneurs—individuals developing private firms—are central actors in modern economies. The anemic growth of firms and their plants is one of the unfortunate features of underdeveloped economies (Hsieh and Klenow, forthcoming). Poor countries also have low levels of financial development, with much less access to formal financial services, such as savings accounts or bank loans, and measures of external finance to GDP that can be an order of magnitude smaller than those of advanced economies (King and Levine, 1993; Banerjee and Duflo, 2005). A common explanation for the poor performance of entrepreneurs in developing economies is their inability to obtain credit to expand their scale of operation.

The issues involving entrepreneurship and financial frictions are wide-ranging, and the literature is vast. For the purpose of this review, we necessarily narrow our focus. We concentrate on two issues that have received attention in both the theoretical and empirical literature more recently. First, there is a great variety of entrepreneurs, who differ considerably in the productivity of their enterprises and the optimal scale of the technologies or sectors in which they operate. Financial frictions have different implications, depending on the type of entrepreneurs and the distribution of entrepreneurs across various types. Second, financial frictions have implications for firms' growth dynamics. These dynamics matter for both the aggregate and individual consequences of financial frictions and they can also be used to evaluate models. Indeed, an advantage of focusing on these two topics is that they are natural areas in which the lessons from theory and empirics can be closely linked.

One of the primary tasks of a literature review is to propose an organization of the literature. We have decided to do so thematically, rather than paper by paper. That is, starting with a representative model in the literature, we evaluate various ideas or lessons. We then discuss the literature in terms of its contribution to and harmony or variance with these ideas or lessons. We attempt to address the most relevant theoretical, quantitative, and empirical work, both from the micro and macro literature.

Taking the literature as a whole, we note several key findings. First, productivity varies widely across entrepreneurs, with the most productive entrepreneurs making a sizable share of investments. Small relaxations of financial constraints tend to promote entry among entrepreneurs of marginal productivity and smaller scale enterprises that do not exhibit much growth after entry. It is more productive entrepreneurs whose enterprises expand more significantly in response to the relaxation of financial constraints. Second, financial frictions have a greater impact on entry in large-scale sectors, where production technologies require large setup costs. This distortion of entry into large-scale sectors or investment in large scale technologies can lead to substantial productivity losses and exacerbate inequality. In fact, a small relaxation of financial constraints across all sectors may end up tightening (through general equilibrium effects) the financial constraints that potential entrepreneurs in large-scale sectors face, while increasing access to large loans can only help them. Third, the saving and investment behavior of both existing and potential entrepreneurs is important for understanding the impacts of financial frictions. Saving rates are higher among both active entrepreneurs (especially new, highly productive ones) and soon-to-be entrepreneurs. Over time, through savings, entrepreneurs can escape financial constraints, and the eventual self-financing of investment through savings can undo much, though not all, of the long-run and aggregate consequences of external financing constraints. This is especially true for small-scale technologies. Finally, quantitative models that incorporate heterogeneity and forward-looking dynamic saving decisions can lead to individual poverty traps, but not aggregate poverty traps. Aggregate output, while lowered by financial frictions, is not dependent on initial conditions such as inequality, for example. Financial innovation can make progress in eliminating or lessening the individual poverty traps in a stationary equilibrium, in ways that a one-time wealth redistribution can not.

Our narrow focus nevertheless relates to a much broader literature on entrepreneurship and financial frictions.[1] The role of entrepreneurs has been shown to be a potential explanation for the large concentration of wealth observed in the right tail of wealth distributions (Cagetti and De Nardi, 2006; Quadrini, 2000). Given the success of models of entrepreneurship and financial frictions in producing reasonable wealth distributions vis-à-vis the data, these models have been used to analyze the impacts of tax policy (Amand, 2012; Cagetti and De Nardi, 2009; Kitao, 2008; Lee, 2012; Meh, 2005; Scheuer, 2014). They have also been used to analyze business cycle fluctuations, particularly in the aftermath of the 2008 financial crisis (Achdou et al., 2014b; Buera et al., 2014a; Buera and Moll, 2012; Bassetto et al., 2013; Kiyotaki and Moore, 2012; Shourideh and Zetlin-Jones, 2014), where private entrepreneurs play a special role relative to corporations because of the interaction of consumption, saving, and risk that is linked with investment.[2] There is also a literature that focuses on the consumption smoothing and self-insurance behavior of entrepreneurs (Angeletos, 2007; Buera and Shin, 2011; Karaivanov and Townsend, 2014; Moskowitz and Vissing-Jorgensen, 2002). Although incomplete insurance markets are clearly one important form of financial frictions, we do not consider insurance markets. A literature exists on the role of both formal and informal insurance in entrepreneurial activities, but much of the work focuses on agricultural investments (Braverman and Stiglitz, 1986; Cai et al., 2009; Cole et al., 2013; Karlan et al., 2012; Mobarak and Rosenzweig, 2012). Financial frictions can lead to a relationship between wealth and entrepreneurship as noted by the seminal work of Evans and Jovanovic (1989). This relationship and the welfare consequences of the nepotistic management it can engender have also been examined (Caselli and Gennaioli, 2013; Bloom et al., 2013).

We organize our discussion as follows. In the next section, we introduce a simplified benchmark model and use it to fix ideas and discuss alternative formulations. In Section 3, we review the importance of heterogeneity in the productivity and scale of entrepreneurial establishments for understanding the impact of financial frictions. Section 4 evaluates the

[1] Some of these macroeconomic issues are covered in Quadrini (2009)'s excellent review article.

[2] These contrast with models in which financial constraints apply to firms that either do not have entrepreneurs or have entrepreneurs with linear preferences. In such models, investment and production decisions are not directly linked to consumption and saving decisions—e.g., Arellano et al. (2012), Cooley et al. (2004), Khan and Thomas (2013), Jermann and Quadrini (2012).

dynamic implications of financial frictions for entrepreneurship, starting with entry and age-dependent growth, before finally evaluating poverty traps and policy implications. We conclude in Section 5 and suggest areas for future research.

2 Benchmark Model

In order to fix ideas and develop intuition, we sketch a model following Buera and Shin (2013) and Buera et al. (2011) with heterogeneous producers and dynamic decisions regarding entrepreneurship and investment. Although the concepts are more general, fixing ideas and notation will allow us to more easily illustrate these concepts. We also discuss alternatives to the assumptions in the model.

Consider an economy populated by individuals who are heterogeneous in terms of their productivity as entrepreneurs z. As entrepreneurs, they use capital and hire labor to produce a common final output according to a diminishing returns to scale production function $zk^{\alpha}l^{\theta}$, with $\alpha + \theta < 1$. The entrepreneurial productivity follows a Markov process.

Individuals choose their consumption, c, next period's asset holding, a', and whether to be an entrepreneur, $e \in \{0, 1\}$, in every period. Operating a technology may entail a fixed cost (κ units of output), and entrepreneurs must also choose the levels of their capital k and labor input l. For simplicity, we assume that financial wealth can be accumulated, but all capital is rented at the competitive rate of $r_t + \delta$ through an intermediary using a within-period capital rental or "credit" contract, and this contract is subject to a quantity limit. Taking the path of interest rate r_t and wage w_t as given, the problem of an individual with wealth a and entrepreneurial productivity z at time t is summarized by the following Bellman equation:

$$\begin{aligned} v_t(a,z) &= \max_{c,a',k,l\geq 0,e\in\{0,1\}} \frac{c^{1-\sigma}}{1-\sigma} + \beta\mathbb{E}_{z'}\left[v_{t+1}(a',z')\,|z\right] \\ \text{s.t.} \quad & c + a' \leq e[zk^{\alpha}l^{\theta} - \kappa - (r_t+\delta)\,k - w_t l] + (1-e)w_t + (1+r_t)\,a \\ \text{and} \quad & k + (1+r_t)\,\kappa \leq \bar{k}_t(a,z;\phi)\,. \end{aligned}$$

One can easily consider the decisions of a single individual taking prices as given, whether it is a small open economy where the interest rate is fixed but the wage is determined by market clearing in the labor market, or a fully general equilibrium, where the interest rate must clear the market for capital. Although the idiosyncratic shocks in the model will yield plenty of churning in any given equilibrium, one can consider either a stationary equilibrium where aggregates and prices are nonetheless constant over time or a dynamic equilibrium where they transition over time.

This simple yet flexible model has key features that are important for understanding the relationship between entrepreneurship and financial frictions.

First, the choice of whether to be an entrepreneur is endogenous and therefore responds to financial frictions, comparative advantage in entrepreneurship (i.e., productivity), and equilibrium prices. One alternative is to assume an exogenous division between workers and entrepreneurs (i.e., entrepreneurs and workers as two separate types) as done in Erosa and Hidalgo Cabrillana (2008) and Moll (2014), for example. When the occupation of individuals is exogenously fixed, financial frictions and interventions can lead to strong movements in some variables (e.g., entrepreneurs' profits). These movements may be an overstatement, however, and the inelastic occupation choice certainly precludes any analysis of the impacts on entry decisions and the number of entrepreneurs. The opposite extreme is to follow Hopenhayn (1992) and assume that the supply of firms is perfectly elastic as in, for example, the models of Melitz (2003), who studies the productivity gains of openness along entry and exit margins, or Barseghyan and DiCecio (2011), who evaluate the productivity effects of entry costs. Although entry requires resources in these models, entrepreneurial ability itself is not a scarce resource *ex ante*. The distribution of productivity that all entering entrepreneurs draw from is invariant and independent of the number of entrepreneurs. In these models, prices may respond too little (and indeed there is no *ex ante* entrepreneurial rent) to financial frictions, but entry and the number of firms in an economy may respond too strongly.

Relative to these models, our assumption of a finitely elastic supply of entrepreneurs enables us to capture the impact of financial frictions on the number and the productivity distribution of active entrepreneurs and the returns to entrepreneurship. Finally, we model the entrepreneur-worker occupation as a discrete choice. Although there is ample evidence that people and certainly households, especially those in developing countries, often have multiple sources of income even over relatively short periods (Townsend, 2010), any element of fixed costs in changing activities will add a discrete nature to the time allocation problem.

Second, individuals are heterogeneous not only in their wealth but also in their entrepreneurial productivity, and this productivity is persistent. Earlier papers examining entrepreneurship and financial frictions, such as those of Aghion and Bolton (1997), Banerjee and Newman (1993), and Piketty (1997), abstracted from such heterogeneity, but this dimension is important to understand the different ways in which financial frictions affect individuals as we discuss in the next section. Heterogeneity will also aid quantitative assessment, as it allows theory to be more easily mapped to data. Note that the current idiosyncratic productivity of individuals is known to them. This again distinguishes the model from the above papers, where heterogeneity in entrepreneurial productivity arises after entry. The choice of becoming an entrepreneur is therefore made with some knowledge of one's own productivity and allows for interesting selection into entrepreneurship, the empirical observation of which we will discuss.

Of course, although useful, the simplifying assumption of *full* knowledge is an abstraction. This abstraction has been relaxed in Nyshadham (2014), who notes that transitions in and out of entrepreneurship are common in Thailand and empirically examines the process by which agents learn about their productivity as entrepreneurs relative to their productivity as workers (in agriculture).[3] Fully exogenous productivity is another simplifying assumption. Cole et al. (2012), Lopez-Martin (2013), and Midrigan and Xu (2014) are examples of preliminary attempt to endogenize entrepreneurial productivity—modeled as the choice of technologies—in the presence of financial frictions, but this is an area where more research is certainly needed. At a very minimum, however, the modeling of capital in the production function captures some role of productivity-enhancing endogenous investment.

Third, and related, the entrepreneurship choice is dynamic in that people can decide to become entrepreneurs at any point in time, and they can make forward-looking decisions about their saving behavior. Again, this distinguishes the model from those with one or two-period-lived agents, where people make one-time decisions about entrepreneurship (Amaral and Quintin, 2010; Banerjee and Newman, 1993). Moreover, the saving decisions here are modeled differently from the popular warm-glow bequest motives (Banerjee and Newman, 1993; Caselli and Gennaioli, 2013; Ghatak and Jiang, 2002; Giné and Townsend, 2004; Jeong and Townsend, 2008, 2007; Lloyd-Ellis and Bernhardt, 2000), in that they respond to changes in incentives to save or invest. Models with two or three-period-lived agents preclude rich saving behavior or quantitative predictions that can be easily assessed with data from short-term experiments. All of this will be crucial to our examination of firm dynamics in Section 4.

Fourth, we model a production function with smooth decreasing returns to scale. This diminishing returns to scale technology is essentially a span-of-control model of Lucas (1978), where the distribution of entrepreneurial productivity is the key determinant of the firm size distribution. Other variants that allow for easier analysis have been proposed in the literature. First, in models with monopolistic competition and constant returns to scale, downward sloping demand determines optimal firm size. These models have a large degree of isomorphism with competitive span-of-control models, and even their calibrated quantitative versions yield similar results (Hopenhayn, 2014). In a sense, Banerjee and Newman (1993) and Erosa and Hidalgo Cabrillana (2008) model an extreme form of diminishing returns, since firms had hard constraints on scale—two people in the case of Banerjee and Newman. Alternatively, Moll (2014) assumes constant returns to scale technologies, which means a nontrivial distribution of firm size depends on the presence of financial frictions. If $\kappa > 0$, the benchmark model yields U-shaped average cost curves with a region of increasing returns to scale. With $\kappa > 0$, we consider variations in efficient scale across industrial sectors in Section 3.2.

Finally, as shown by the second constraint of the benchmark individual problem, financial frictions are modeled as limits to the amount of physical capital that entrepreneurs can rent. This upper bound $\bar{k}(a, z; \phi)$ potentially depends on the entrepreneur's asset a, productivity z, and a parameter ϕ indexing the strength of financial institutions. The assumption is that

[3] Nyshadham (2014)'s treatment of financial frictions is rather stylized, abstracting from endogenous wealth dynamics and self-finance. If it takes time for entrepreneurs to learn their true talent, self-finance will be a better substitute for credit to the extent that positive signals and the availability of internal funds are correlated. A richer model of learning and wealth dynamics is needed to explore this conjecture.

$\bar{k}$ is (weakly) increasing in a, z, and ϕ. We set up the model such that, as ϕ varies from zero to one, it spans the spectrum from financial autarky to perfect credit markets. Buera et al. (2011) show how this can be developed from a simple limited-enforcement problem.

The constraint has flexibility and buys simplicity, but it does rely on some important assumptions. Notice first that working capital for labor payments does not need to be financed. If it did, financial constraints could potentially have more bite, since labor input choices would also be potentially distorted.

As an example of its flexibility, note that if the borrowing constraint does not respond to z and is linear in a, then it simplifies to the simple collateral constraint of Evans and Jovanovic (1989) and Buera and Shin (2013). Such a constraint might arise if z were unobservable or if, under limited enforcement, the intermediary could not pursue income sources of the borrower in the event of default. Under the latter assumption, Banerjee and Newman (1993) and Lloyd-Ellis and Bernhardt (2000) derive simple linear collateral constraints. In such cases, financial frictions generally have stronger impacts on more productive firms and therefore aggregates, since available credit is independent of entrepreneurial productivity but capital demand is increasing in it.

If the borrowing constraint that the intermediary offers is increasing in both a and z, this implies that both are at least partially observable to the intermediary. It is less controversial to assume that lenders have some knowledge of borrowers' assets, but in practice financial intermediaries generally try to assess future cash flow/ability to pay (z) in addition to existing assets (a). Brooks and Dovis (2013) refer to the dependence on existing assets as a "backward-looking" financial constraint and dependence on future cash flow as a "forward-looking" constraint. They use firm-level data and a trade liberalization episode in Colombia as an experiment to test whether debt limits respond to future profit opportunities and they answer in the affirmative. Aguirre (2011) also considers forward looking constraints and shows that financial frictions tend to bind less when individuals or countries are far from their steady state.

As stated, the credit constraint is agnostic about the underlying reason that entrepreneurs face financial frictions, except to the extent that we assume no variation in interest rates across them. Of course, there are many potential reasons for financial frictions, including moral hazard, adverse selection, contracting problems such as limited commitment, limited enforcement, or costly state verification, and these reasons are not necessarily mutually exclusive. The classic paper of Evans and Jovanovic (1989) estimated a structural model of limited liability. Paulson et al. (2006) use structural techniques on panel data in rural and semi-urban Thailand to distinguish whether entrepreneurs face frictions stemming from limited liability, moral hazard, or some combination. They note that with limited liability, increases in wealth increase available borrowing, as we assumed, and eventually relax constraints. With moral hazard, increases in wealth lead to less borrowing and all borrowers remain constrained. The authors identify moral hazard as the dominant source of constraints, and they are able to reject the hypothesis that limited liability alone can explain the Thai data.[4]

The constraint is also purely static. One aspect is that long-term contracts are ruled out. Albuquerque and Hopenhayn (2004) solve a firm's dynamic contracting problem over time under limited commitment, while Clementi and Hopenhayn (2006) address dynamic contracts with i.i.d. private information. Cole et al. (2012) consider the case with persistent, but partially absorbing, private information, where lenders have the option of paying a cost to verify these reports, as in Townsend (1979)'s costly state verification. Another aspect is that the constraint does not rely on the history of default. If credit history affected access to loans, entrepreneurs would build dynamic strategies into their borrowing and repayment decisions. Karaivanov and Townsend (2014) extend the analysis in Paulson et al. (2006) to dynamic environments, testing alternative dynamic mechanism design models with financial/information constraints. The strength of the static constraint is of course simplicity, and can be justified in an environment with limited commitment if agents cannot be excluded from entering into new debt contracts (Rampini and Viswanathan, 2010; Buera et al., 2011).

2.1 Perfect Credit Benchmark

The equilibrium under a perfect credit market provides a benchmark for models with financial frictions. Under perfect credit, the use of capital is independent of entrepreneurs' wealth and capital is efficiently allocated across entrepreneurs, with their marginal product of capital equalized to the user cost of capital, $r_t+\delta$. Labor is likewise efficiently allocated. Substituting in the unconstrained capital and labor choices given r_t and w_t, the occupation choice is simply that an individual becomes an entrepreneur if and only if his profits exceed the forgone wage as a worker,

$$(1-\alpha-\theta)\, z^{\frac{1}{1-\alpha-\theta}} \left(\frac{\alpha}{r_t+\delta}\right)^{\frac{\alpha}{1-\alpha-\theta}} \left(\frac{\theta}{w_t}\right)^{\frac{\theta}{1-\alpha-\theta}} - \kappa \geq w_t.$$

The left-hand side (entrepreneurial profits) depends on productivity z but is completely independent of wealth. Threshold productivity levels therefore exist, such that only those whose productivity is higher than the threshold choose entrepreneurship. The dotted line in Figure 1 illustrates the occupational choice graphically in wealth-productivity space. The vertical threshold line shows that the occupational choice is independent of wealth.

FIGURE 1 HERE

[4] Karlan and Zinman (2009) run an experiment using consumer loans to workers in South Africa to identify the importance of moral hazard and adverse selection. They randomized interest rates at various stages. They found strong evidence for moral hazard and evidence for adverse selection among female borrowers. These results for consumer loans are therefore consistent with those from Paulson et al. (2006).

3 Heterogeneous Entrepreneurship

The recent literature has emphasized that not all entrepreneurs or businesses are alike. Heterogeneity matters in thinking about which entrepreneurs are likely constrained and what the aggregate and distributional consequences of these constraints are. Entrepreneurs differ in important ways both in their inherent productivity and in the scale of production dictated by the technology they use or the sectors they enter. We discuss each in turn.

3.1 Heterogeneous Productivity

The classic paper of Lucas (1978) placed heterogeneity in entrepreneurial productivity at the forefront of understanding entrepreneurship and firm size distributions.[5] An early paper with financial frictions, Evans and Jovanovic (1989), emphasized the considerable variance in entrepreneurial ability as an important finding.

Nevertheless, many earlier contributions that introduced financial constraints into entrepreneurship decisions assumed that all entrepreneurs had the same technology and were equally productive. Banerjee and Newman (1993) and Piketty (1997) are two well-known examples. The idea in these models is that the impact of financial frictions on occupational choice has implications for not only inequality but also aggregate output. In these papers, unless fixed costs played a prohibitive role, an equal distribution of wealth would be income-maximizing, since it would allow entrepreneurs to maximize their total production by equalizing marginal products (Piketty) or maximizing entry into entrepreneurship (Banerjee and Newman).

An exercise in Banerjee and Duflo (2005) took the homogenous productivity model to the data with the implicit assumption that variation in firm size and marginal products is solely explained by variation in wealth rather than inherent productivity. Their calibrations find it difficult to simultaneously generate large losses in aggregate output from financial frictions and a realistic firm size distribution.

The quantitative work by Restuccia and Rogerson (2008) and the empirical work of Hsieh and Klenow (2009) showed that, on its own, the distribution of capital and labor across establishments was not enough to understand the importance of resource misallocation: When they looked at the distribution of resources in conjunction with the underlying distribution of heterogeneous productivity, they found that misallocation had important negative consequences for aggregate productivity. Financial frictions are one important source of misallocation. Compared with other sources of misallocation, it is one that is relatively well understood and well measured.

Partial Equilibrium We demonstrate the role of entrepreneurial productivity heterogeneity and financial frictions in misallocation by considering the entrepreneur's problem under

[5] Similarly, Roy (1951) viewed heterogeneity in productivity to be important in understanding occupational choice and income inequality.

binding credit constraints. We first consider partial equilibrium, where we keep the interest rate and wage constant.

If the credit constraint is binding—i.e., $k = \bar{k}(a, z; \phi)$—the marginal product of capital is higher than it otherwise would be, and so is the average marginal product of capital, which now exceeds $r + \delta$. Using randomized grants to entrepreneurs in Sri Lanka, McKenzie et al. (2008) find average annual real returns to capital of 55–63 percent, substantially higher than the sum of real market interest rates of 12–20 percent and depreciation. Moreover, they find higher returns to capital for those with fewer assets, which is consistent with the model, where $\bar{k}$ increases with a. Using similar techniques, McKenzie and Woodruff (2008) find large returns to capital among small-scale retailers in Mexico, 20–30 percent per month or three to five times market interest rates. Similarly, the increase in profits that Fafchamps et al. (2011) measure in response to their randomized grants to micro-entrepreneurs in Ghana implies very large returns to capital, 7–10 percent and roughly 25 percent *per month* for cash and in-kind grants, respectively.[6]

Now consider how the marginal product of capital varies across entrepreneurs of different productivity, z. For any given capital input, the marginal product of entrepreneurs should be increasing in z. Moreover, in the case of a pure collateral constraint where $\bar{k}$ does not increase with z, it is also true that, for any given wealth level, the marginal product of constrained entrepreneurs should be higher, the higher their productivity. McKenzie and Woodruff's high returns in Mexico are concentrated among entrepreneurs who self-report they are "financially constrained." Additional evidence on this is presented in de Mel et al. (2008), who find larger impacts on profits for those with higher cognitive ability, measured by schooling completion or a quick digit recall diagnostic score. Also, Fafchamps et al. find larger returns for women whose businesses were already more profitable. It is unlikely that these results were driven by more skilled entrepreneurs or more profitable businesses having less baseline capital (an omitted control in these studies), and hence these results are fairly strong evidence of productivity leading directly to higher returns to capital. Nonetheless, a cleaner empirical specification, motivated by the model, would be to evaluate how the marginal product of capital varies with productivity or profitability *conditional on baseline capital* and likewise how the marginal product of capital varies with baseline capital *conditional on productivity or profitability*. Indeed, Fafchamps et al. find larger impacts on profits for businesses with *more* capital. This finding is likely driven by the analysis confounding capital and productivity, which are likely positively correlated. Using data in Thailand, Paulson and Townsend (2004) run regressions with ability (education) and wealth using self-reports of being "financially constrained," and find a relationship that is consistent with the theory.

The importance of financial frictions for the occupational choice decision also varies by entrepreneurial productivity, z. Even under credit constraints, entrepreneurial profits are increasing with productivity. First, there is the direct effect that a higher productivity

[6] In a much smaller study in Ghana, Karlan et al. (2014) find only short-lived increases in scale and no increase in profits, however.

increases profits for any given level of capital. Second, if the partial derivative of $\bar{k}$ with respect to z is strictly positive, it means that, for any given level of wealth, more productive entrepreneurs have access to more capital from intermediaries. Thus, entrepreneurial profits are larger for more productive entrepreneurs. Although for any given wealth level, the most productive entrepreneurs are likely to be constrained at the intensive margin (i.e., choice of capital input), those likely to be constrained at the extensive margin (i.e., occupational choice) are the marginal entrepreneurs. We illustrate this with the dashed line in Figure 1, which shows the impact of introducing the $k \leq \bar{k}$ constraint in partial equilibrium, i.e., keeping wages and interest rates at the level of the perfect credit benchmark.

At very high levels of wealth, the constraint does not bind, and so occupational choice is undistorted for the very wealthy. Similarly, occupational choice is unaltered for the most productive entrepreneurs. Instead, it is the low-wealth, marginal-ability entrepreneurs whose occupational choice is impacted. The constraint, in partial equilibrium, acts to increase the average ability of active entrepreneurs, although it also lowers the total number of entrepreneurs.

In partial equilibrium, the impacts of tighter credit constraints on firm size are therefore ambiguous. On the one hand, the composition of entrepreneurs shifts to higher average productivity, and labor demand is increasing in productivity. On the other hand, tighter constraints lower the capital used by anyone for whom the constraint is binding.

General Equilibrium The solid line in Figure 1 shows how the effects of financial constraints change in general equilibrium. Recall that in partial equilibrium, financial constraints make some poor, marginal-ability entrepreneurs switch their occupation from entrepreneur to worker. Thus, the demand for workers declines, while the supply increases. In equilibrium, a lower wage is necessary to clear the labor market. Similarly, the demand for capital is constrained and accordingly declines—the supply of capital can increase as we will see in Section 4. As a result, the interest rate and the cost of capital go down. The lower wage and interest rate increase the profitability of entrepreneurship, shifting the thresholds for entrepreneurship to the left. Relative to the perfect credit benchmark, some low-productivity, high-wealth individuals enter, replacing poor, marginal-productivity entrepreneurs. These low-productivity, high-wealth entrepreneurs are unconstrained at the intensive margin.

In general, in this one-sector model, the net effect of financial frictions on entrepreneurship rates (i.e., the number of entrepreneurs divided by the population size) is ambiguous. In Moll (2014), financial frictions unambiguously lead to an increase in the entrepreneurship rate in general equilibrium. Recall that Moll assumes constant returns to scale in order to enable analytical tractability. This assumption leads to only one firm producing in the absence of financial frictions; without diminishing returns, the most productive entrepreneur hires all the capital and labor in the economy. Introducing financial frictions prevents this, lowering the interest rate and wage in general equilibrium in order to induce more entrants. With diminishing returns the opposite result can be obtained, as existing unconstrained entrepreneurs absorb some of the excess capital and labor.

Returning to the illustrative model, note that the wealthy may actually benefit from financial constraints: They are likely to be entrepreneurs, and lower wages and capital rental rates translate into higher entrepreneurial profits. (For those who are net savers rather than borrowers, the lower interest rates hurt their interest income.) Erosa and Hidalgo Cabrillana (2008) see in this a political economy explanation for why the wealthy have incentives to oppose financial system reforms.

At the same time, lower input prices mean a larger unconstrained scale of production for all entrepreneurs. The region of high-productivity, low-wealth entrepreneurs who are constrained in their use of capital is larger in general equilibrium with the lower input prices. Indeed, high-productivity, low-wealth individuals who remain as entrepreneurs are more constrained than they would have been in partial equilibrium, while the high-wealth, low-productivity entrepreneurs who enter because of the lower input prices tend to be unconstrained. Commensurate with the lower interest rate, these unconstrained entrepreneurs have a lower marginal product of capital than in the partial equilibrium. Overall, the dispersion of marginal product of capital across entrepreneurs is greater in general equilibrium, reflecting greater misallocation of capital among entrepreneurs.

The impacts of financial frictions on aggregate total factor productivity (TFP) potentially come from three fronts. First, capital is misallocated among the active entrepreneurs because their marginal products are not equalized. At this intensive margin, financial frictions lower TFP, especially in general equilibrium. The impact at the extensive margin, i.e., the change in aggregate TFP that comes from changing the set of active entrepreneurs, consists of two channels: the number and the composition of entrepreneurs. *Ceteris paribus*, in general equilibrium, TFP is increasing in the number of entrepreneurs: A larger number of entrepreneurs implies that entrepreneurs operate at smaller scales on average, and given diminishing returns to scale technology, this shows up as higher TFP. If fixed costs are non-zero, e.g., a positive opportunity cost of their time, the efficient scale of production is bounded away from zero and TFP is non-monotonic in the number of entrepreneurs. The composition of entrepreneurs also changes with financial frictions, as discussed above. Here, the presence of low-productivity entrepreneurs induced into entry because of the lower factor prices in general equilibrium contributes to larger TFP losses than in partial equilibrium.

In sum, in general equilibrium, we see wealthy, low-productivity entrepreneurs enter and poor, marginal-productivity entrepreneurs exit because of credit constraints. Similarly, the regions of constrained entrepreneurs expand among existing entrepreneurs, but a new region of unconstrained entrepreneurs arises. Finally, as for productivity, we see a greater dispersion in marginal product of capital across agents leading to larger misallocation of capital at the intensive margin. Relative to partial equilibrium, there are more entrepreneurs, who are less talented on average, and there is more misallocation of capital among them.

Whether there are more or fewer constrained entrepreneurs in general equilibrium depends on the joint distribution of wealth and entrepreneurial productivity. Similarly, in comparing the financially constrained economy in general equilibrium with the perfect-credit benchmark, whether active entrepreneurs are more or less talented on average and whether there are more or fewer entrepreneurs also depend critically on the wealth-productivity distribution. These are quantitative questions that need to be addressed using both data and models.

Quantitative Results and Empirics A great deal of work has gone into quantifying the relationship between financial intermediation and the number of entrepreneurs, entrepreneurial productivity, and aggregate TFP. Although exogeneity and controls are elusive, raw cross-country empirics provide some insight. In the cross-section of countries, comparable data directly measuring entrepreneurship are limited, but wealthier countries tend to have larger firms (measured by employment) on average, which likely implies lower rates of entrepreneurship. Likewise, financial intermediation is highly correlated with measured TFP in the cross-section of countries (Buera et al., 2011; Greenwood et al., 2013; King and Levine, 1993).

Model-based work tends to have the common feature of relying critically on the properties of the cross-sectional distribution of entrepreneurial productivity and wealth in equilibrium. For example, to quantify the impacts in Figure 1, one needs to integrate over this joint distribution and make projections for any changes in the distribution induced by financial frictions. Typically, the productivity distribution is pinned down by the firm dynamics and firm size distribution in the data, while wealth distributions, which are an endogenous outcome of individual saving behavior in the face of credit constraints, target key moments of the empirical income and wealth distribution.

Recent steady state evaluations of the potential impacts of financial frictions—for example, Buera et al. (2011), Buera and Shin (2013), Midrigan and Xu (2014), and Moll (2014)—all allow individuals to make optimal saving decisions. For the negative impact of financial frictions on aggregate TFP, they find numbers between 20 and 30 percent in closed-economy, one-sector models.[7] With a model similar to the one in Section 2, Buera and Shin (2013) and Buera et al. (2011) use the U.S. as a benchmark and identify the distribution of productivity from the U.S. establishment size distribution and the frequency of shocks to productivity from the U.S. data on exit rates of establishments. In a one-sector version of their model, they find that financial frictions can reduce aggregate TFP by 30 percent. Rates of entrepreneurship respond non-monotonically to the degrees of financial frictions, and the effects are quantitatively small. Midrigan and Xu model the decision to enter a "modern", capital intensive sector by paying a one-time sunk cost, but abstract from capital in the traditional sector. They choose this cost and the productivity shock process to match the average establishment size and the autocorrelation of establishment growth rates in panel data from Korea. In the closed economy version of their model, they find

[7]Earlier steady-state evaluations included Caselli and Gennaioli (2013), who evaluated the impact of nepotistic entrepreneurial dynasties in a model with warm-glow preferences, and Amaral and Quintin (2010), who quantified impacts in an overlapping-generations model with three-period life-cycles.

that overall financial frictions can reduce TFP by 25 percent, 10 percentage points of which come from the intensive-margin misallocation of capital among entrepreneurs. They find that financial frictions greatly reduce the fraction of producers in the modern economy, a measure of entrepreneurship rates. Moll uses micro panel data of Chilean and Colombian manufacturing plants to measure productivity directly and then estimates the distribution and autocorrelation of shocks to productivity. He concludes that financial frictions can lower TFP by 20 percent.

Model-based studies have analyzed the impacts of relaxing borrowing constraints over time as well. Notably, Giné and Townsend (2004) apply the model of Lloyd-Ellis and Bernhardt (2000) to the Thai experience with financial deepening. Following Lloyd-Ellis and Bernhardt, they model entrepreneurial productivity as heterogeneous entry costs. They use detailed micro data on entry into entrepreneurship and wealth holdings to estimate the productivity and wealth distributions, which are assumed to be uncorrelated with each other. An exogenous quadrupling in the fraction of population served by financial institutions is found to increase entrepreneurship rates by 4 percentage points. Jeong and Townsend (2007) evaluate the impacts on TFP during the same Thai growth experience. They find that 70 percent of the overall Thai TFP growth from 1976 to 1996 can be explained by financial deepening. Buera and Shin (2013) also look at time-series data for numerous miracle economies, but rather than looking at the impacts of financial deepening, their emphasis is on the transition dynamics after growth-enhancing reforms in environments where financial frictions are prevalent. Using a model similar to the one in Section 2, they find that a model economy with financial frictions converges to the new steady state slowly after a reform that triggers efficient reallocation of resources: The transition speed is half that of the conventional neoclassical model. Furthermore, in their model economy, investment rates and total factor productivity are initially low and increase over time, consistent with the experience of miracle economies.[8]

3.2 Heterogeneous Scale

We now consider a version of the model with two sectors that differ in their fixed cost κ. One can think of the two sectors as being either two different technologies for producing the same good—e.g., traditional vs. modern as in Banerjee and Newman (1993), Midrigan and Xu (2014), and Kaboski et al. (2014)—or two different industries where production is best done with, respectively, small-scale technologies (e.g., services and non-tradables) and large-scale technologies (e.g., manufacturing and tradables) as in Buera et al. (2011). Buera and Kaboski (2012) show that services and manufacturing differ in their optimal scale of production. Holmes and Stevens (2014) show that the manufacturing sector itself can be split into large-scale plants producing standardized goods and small-scale plants making

[8] Buera and Fattal-Jaef (2014) show that some of the features of the data of miracle economies can also be explained by a related model of entrepreneurship and endogenous innovation, while abstracting from financial frictions.

custom or specialty goods. How one views the distinction would influence how one models the demand for the two outputs. In the modern vs. traditional, the elasticity of substitution of demand could be infinite, while in the case of manufacturing vs. services it is generally low. The latter interpretation leads to interesting relative price movements across sectors.

Scale differences that arise from fixed or setup costs are of particular interest. First, these costs may need to be financed. Rajan and Zingales (1998) emphasize differences in external financial dependence across industries, which Buera et al. (2011) link to scale differences at the broad sectoral level. Moreover, they show that even at a more disaggregate level, scale varies considerably across industries and is predictive of industry TFP gaps in countries with lower levels of financial development. Second, fixed or entry costs are important non-convexities that can give rise to interesting investment dynamics and even poverty traps, as we examine in Section 4. This is a point stressed by Banerjee and Newman (1993) and Banerjee and Duflo (2005).

Quantitatively, if we consider the large-scale sector to be the industrial sector, large-scale entrepreneurs are few in number. First, the share of manufacturing or tradables in total employment is not particularly large in most countries (Buera and Kaboski, 2012). Moreover, the fact that establishments and firms in these sectors are large (i.e., have many employees) immediately implies that the number of establishments and firms must be small.

Partial Equilibrium The impacts of financial frictions in a large-scale sector are qualitatively similar, but quantitatively stronger, since the profitable scale of operation is bigger and fixed costs need to be financed as well. This is true at both the intensive and extensive margins. For instance, because of the fixed cost and, hence, the large profitable scale, it takes longer for poor entrepreneurs to self-finance away from financial constraints. Moreover, the region of poor, marginal-ability entrepreneurs who are now excluded from entrepreneurship is larger, given the difficulties of financing the fixed costs and the efficient amount of capital. This last point is illustrated with the dashed lines in Figure 2. In the left panel, we illustrate the occupational choice in the small-scale sector, which basically reproduces the occupational choice map in Figure 1. The right panel shows the occupational choice map in the large-scale sector. One-time sunk entry or setup costs lead to even larger impacts than per-period fixed costs, even if they had the same net present value, because of the difficulty of larger financing needs upfront (Buera et al., 2011; Midrigan and Xu, 2014).

FIGURE 2 HERE

When the investment involves implementing a modern technology rather than a traditional technology, entrepreneurial productivities in these two technologies are generally assumed to be highly correlated. In such cases, the interesting margin is entrepreneurs' choice of large-scale vs. small-scale technology, not one of worker vs. entrepreneur. However, if the large-scale and small-scale investments represent different industrial sectors (e.g., manufacturing vs. services), an entrepreneur's productivity in the two sectors may be less correlated. Here, for most individuals, the real decision is either large-scale entrepreneur vs. worker or small-scale entrepreneur vs. worker. In other words, an entrepreneur's sector choice is mostly undistorted, while whether he should be an entrepreneur at all may well be.

General Equilibrium In general equilibrium, there are now three prices to consider: the wage, interest rate, and the price of large-scale output relative to small-scale output—when the two are not perfect substitutes. Again, in order to clear the labor and capital markets in general equilibrium, the wage and interest rate must fall with financial frictions. Moreover, because the large-scale sector is more distorted, the relative price of large-scale output must increase in order to clear the goods markets. The lower input prices induce entry into both sectors, while the rising relative price of the large-scale sector reinforces entry into the large-scale sector but depresses entry into the small-scale sector, all compared with partial equilibrium.

TFP losses are larger overall, compared with the results of one-sector models, and this is driven by disproportionate losses in the large-scale sector. Buera et al. (2011) find aggregate TFP losses of 36 percent from financial frictions in a model with large-scale and small-scale sectors. (In a comparably calibrated one-sector model with fixed costs, the losses are only 30 percent.) In the small-scale (i.e., service) industry, sector-level TFP is reduced by up to 25 percent when moving toward financial autarky, and almost all of this distortion comes from the intensive margin. In the large-scale (i.e., manufacturing) industry, the losses are much larger, up to 55 percent, and the majority (over 30 percentage points) comes from the extensive margin. The importance of productivity losses from distorted entry in the large-scale sector is another chief takeaway. Midrigan and Xu (2014) find similarly that distorted adoption of modern technologies requiring a large setup cost can lead to sizable TFP losses.

Changes in aggregate and sector-level TFP can be mapped into changes in relative prices, and Buera et al. (2011) can explain 25 percent of the observed relationship between relative prices and financial development observed across countries. The change in relative prices can further impact output if investment goods disproportionately consist of the large-scale sector output. Erosa and Hidalgo Cabrillana (2008) also address this channel, as a theoretical point, while Castro et al. (2009) give a related explanation emphasizing that investment sectors are more financially dependent because of their higher cyclical volatility. The higher relative price of investment goods has been linked to lower capital stocks in poor countries (Hsieh and Klenow, 2007; Jones, 1994).

The larger reduction in TFP also leads to a larger reduction in the wage, which then impacts entrepreneurship decisions by raising entrepreneurial profits and lowering the opportunity cost of entrepreneurship. Unlike in the one-sector model, the two-sector model gives a clear implication for the impact of financial frictions on entrepreneurship rates: There are more entrepreneurs in financially underdeveloped economies, which is overwhelmingly because of higher entrepreneurship rates in the small-scale sector, where entry costs are small. Moving from perfect credit to financial autarky increases the rate of entrepreneurship by roughly 30 percent in Buera et al. (2011), whereas it was relatively flat in their one-sector model. However, these effects could only explain a small part of the overall differences in entrepreneurship rates between developed and developing countries. Negative labor shocks have been used in other models to induce higher rates of entrepreneurship that match the data (Buera et al., 2012; Allub and Erosa, 2014). In general equilibrium, when financial frictions are severe, the higher rates of entrepreneurship raise the importance of small-scale vs. large-scale decisions, with potentially distorted sector choices among entrepreneurs.

Empirics Empirical studies have emphasized the importance of considering the heterogeneity among entrepreneurs. Using data in the U.S., where firms are relatively large, Hurst and Pugsley (2011) show that only a quarter of new entrepreneurs desire to eventually "be big" and expect to have at least 10 employees after five years. Even fewer bring new ideas to the market. These patterns vary across industrial sectors, however, with construction and traditional service industries constituting most of the small-business owners. These sectors have higher fractions of entrepreneurs who do not hire any other employee than manufacturing, information technology, agriculture, mining, and utilities.

Paulson and Townsend (2005) evaluate the change in the number and composition of entrepreneurs during and immediately after the 1997 Thai financial crisis. The crisis was accompanied by an increase in the entrepreneurship rate from 11 percent to 30 percent in Thailand. Businesses started during the crisis required a median setup cost of just \$50, much lower than the median of \$1,470 before the financial crisis. (The latter is more or less the median annual income of nonbusiness households before the crisis.) Many of these new businesses were started by households with lower education levels and, even after the crisis, they had less business investment and earned lower profits than the typical new business in the pre-crisis period. These findings not only underscore the heterogeneity in types of businesses, but also mesh with the assumption that high entrepreneurship rates in developing countries are driven at least partly by need (i.e., lack of decent employment opportunities). Across a broad set of countries, Poschke (2013) finds that "out of necessity" entrepreneurs constitute nearly 30 percent of entrepreneurs and even more in poorer and high entrepreneurship countries. On average, they are less educated than the average entrepreneur, and their firms are smaller with lower growth rates.

Finally, Buera et al. (2011) provide some evidence on the impact of financial frictions on firm size. They find that industries that are small-scale in the U.S., such as transportation and retail, are even smaller scale in Mexico, while industries that are large-scale in the U.S., e.g., heavy manufacturing, are actually even larger scale in Mexico. In a general equilibrium model, average scale in a sector is inversely related to the number of entrepreneurs, so this would be consistent with financial frictions in Mexico leading to fewer, larger entrepreneurs in large-scale sectors, but more, smaller entrepreneurs in small-scale sectors.

McKenzie and Woodruff (2006) attempt to directly measure the importance of non-convex returns to capital using ENAMIN data, a non-experimental small-firm dataset in

Mexico. They emphasize that the setup costs are relatively small, with at least 25 percent of firms using less than one-month's median earnings as setup capital. They also estimate marginal returns to capital that fall monotonically with the level of assets: high for small firms but comparable to market returns for larger firms. They interpret this as evidence against the importance of non-convex entry costs. A limitation of the analysis, however, is that the survey includes only small firms. Non-convex costs may well be important in the choice of industry—e.g., services over manufacturing, where measured setup costs and scale are larger. Similarly, financial frictions may also distort the choice of production technology, e.g., small-scale handicraft vs. large-scale manufacturing, and the small-scale businesses in the survey may precisely be those who opted out of non-convex investments.

Recent experimental work by McKenzie (2014) examines the impact of large grants given to entrepreneurs in Nigeria. The paper is exciting because a randomization component was built into the business plan contest for the funds, and winners received an average of $\$50,000$, or roughly 100 times the size of the grants discussed in Section 3. Grants were given to both new and existing businesses. Preliminary results from this ongoing research are that after two years, the grants significantly increased entrepreneurial activity, including entry, survival, employment, and profits. The probability of new firms having at least 10 workers increased by 29 percentage points, or roughly 4 times as high. Still, implicit rates of return on the grant were not particularly high, 4-15 percent by the end of the second year.

These results might challenge the idea that non-convexities are important, but the theory also suggests another explanation. First, entrepreneur heterogeneity may be quite important. In Figure 2, individuals who are financially constrained constitute a small fraction of the population, especially if the optimal number of large-scale producers is small. If additional loans were offered at market interest rates, then only the few poor, high-ability entrepreneurs would apply. Grants, however, may attract a much broader sample of the productivity distribution. Although McKenzie's grantees were highly selected, only about the top-third of applicants, screening may not have been particularly informative, as returns were uncorrelated with business plan contest scores. Alternatively, lower measured returns after a year or two may underestimate true returns because of unmeasured investments, such as changing business practices and innovation (both of which increased significantly) that may pay off in the longer term.

4 Self-Financing and Dynamic Implications

The extent to which wealth may cause entrepreneurship or entrepreneurship may lead to greater wealth is debated, and the model with financial frictions can provide useful insights. As shown in Figures 1 and 2, in the presence of financial frictions, wealth is an important determinant of occupation choice. At the same time, the higher returns to entrepreneurship and capital that stem from financial constraints, along with the fact that wealth can be leveraged as collateral to relax these constraints, give additional incentives to save. Financial frictions therefore have implications for saving and wealth dynamics before and after entry and, in turn, for firm growth.

Firm growth rates and firm size distributions vary across countries. For example, not only the average firm size but also the average growth rates of firms are strikingly smaller in India and Mexico than in the U.S., as shown by Hsieh and Klenow (forthcoming). We explore the dynamic implications of financial frictions with a view to explaining such facts.

Self-financing motives rely critically on the persistence of entrepreneurial or firm productivity. Pawasutipaisit and Townsend (2011) find that returns on assets among rural Thai entrepreneurs are highly persistent. Midrigan and Xu (2014) find the same for employment and capital of Korean manufacturing plants, while Moll (2014) finds high persistence in the estimated TFP of Chilean and Colombian manufacturing plants. The term "productivity" or "ability" is therefore appropriate for describing the persistent trait impacting profitability, scale, and measured TFP.

There is ample evidence for the self-financing motive of entrepreneurs. Entrepreneurs in the U.S. have substantially higher wealth-to-income ratios than non-entrepreneurs—8.1 for entrepreneurs in 1989 vs. 3.6 for non-entrepreneurs. These stark differences remain even after controlling for lifecycle dynamics and income (Gentry and Hubbard, 2004; Quadrini, 1999). These higher wealth ratios reflect a combination of higher saving rates and higher returns on saving. Gentry and Hubbard show that roughly half of entrepreneurs' wealth is directly business assets. Quadrini shows that entrepreneurs target higher wealth-to-income ratios. In Thailand, Pawasutipaisit and Townsend (2011) show both saving rates and levels of saving are significantly higher for households with higher returns on business assets and higher measured TFP. Together, saving rates and returns on assets explain roughly 80 percent of the variation in wealth dynamics in their seven-year panel.

4.1 Dynamics of Entry

We now focus on new entrants rather than continuing entrepreneurs. The emphasis on financial frictions and entry patterns dates back to at least Evans and Jovanovic (1989), who estimate a structural model using U.S. data from the NLSY. Through structural estimation, they interpreted the observed positive correlation between wealth and entry into entrepreneurship—even after controlling for the potential correlation between wealth and heterogeneous productivity, which they find to be negative—as evidence of financial frictions bearing on that decision.

Follow-up work in the U.S. has refined these results and their interpretation. Using PSID, NLSY and HRS data, Hurst and Lusardi (2004) provide several pieces of evidence against the importance of borrowing constraints in the U.S., attributing the wealth and entrepreneurship correlation to variation in ability, preference, and family background. First, they point out that the relationship between wealth and entry is relatively flat except at high levels of wealth, beyond the 97th percentile of the wealth distribution. Even for businesses in sectors with high startup costs (i.e., non-service, non-construction), they find wealth only matters at high levels, above the 90th percentile. Quadrini (1999) shows that households accumulate more assets leading up to entry into entrepreneurship. Buera (2009) writes down an explicit dynamic model of self-financing saving behavior both in anticipation of and after entry. Consistent with that model, he shows that among younger households, the saving rates of future entrepreneurs are higher than those of existing entrepreneurs and non-entrepreneurs. The model also predicts that entry should be non-monotonic in wealth: High-wealth individuals who have not yet entered tend to have low ability, so the probability they enter is lower. Buera finds evidence for this hump shape among the young, while Mondragon-Velez (2009) finds hump shapes more broadly within education and age cells.

Financial frictions are likely to be more important for entry in developing countries. In Thailand, a country with an imperfect yet relatively well-developed financial system, Townsend and his coauthors have detailed evidence on business starts and entry in rural and semi-urban regions. Paulson and Townsend (2005) find that both wealth and access to finance are important determinants of starting businesses before the 1997 financial crisis but not afterward, which they interpret as a sign that financial frictions got reduced over time. Nyshadham (2014) also finds that wealth is not an important determinant of occupational choice in the post-crisis period.

Broader representative datasets are scarce unfortunately in other developing countries. In a stationary environment, exit rates must equal entry rates. Hsieh and Klenow (forthcoming) show that in India, exit rates are relatively low (less than 5 percent) and flat as a function of age, except for the very old firms (35 years or more) exhibiting higher exit rates. In the U.S., in contrast, exit rates are higher for young firms and decline with age, especially over the first 15–20 years. The same pattern exists in Mexico, although it is steeper with even higher exit rates at younger ages relative to the U.S. but lower exit rates at older ages. Low exit rates in India may reflect low entry rates, which is consistent with financial constraints, since wealth moves more slowly than entrepreneurial productivity. A declining age-exit rate profile may be indicative of binding financial constraints and lower profitability for young firms. It may also reflect imperfect knowledge about one's own entrepreneurial productivity or firm-level learning curves.

4.2 Self-Financing and Firms' Age-Growth Profile

Another implication of financial frictions at the intensive margin is that they are particularly important for younger businesses, because, if productivity is stable over time, entrepreneurs can accumulate wealth and self-finance away from financial constraints. If productivity is subject to large transitory shocks and therefore is not persistent enough, this age dependence is weaker and financial frictions may matter even for older firms. The importance of post-entry self-financing and the age-dependence of financial frictions has been stressed by many authors intuitively (Evans and Jovanovic, 1989; Gentry and Hubbard, 2004), theoretically (Buera, 2008; Banerjee and Moll, 2010), and in quantitative work (Buera and Shin, 2013; Buera et al., 2011; Midrigan and Xu, 2014).

Related, Cooley and Quadrini (2001) emphasize that financial frictions provide a theory for why young firms grow faster conditional on size. The left panel of Figure 3 illustrates this last point for the model in Buera et al. (2011).

FIGURE 3 HERE

The idea that financial frictions bind early on is a feature of the static constraint and short-term borrowing in the model of Section 2. This feature extends to models with dynamic contracts as well, however. Albuquerque and Hopenhayn (2004) solve the optimal dynamic contract in the presence of limited enforcement, showing how firms are constrained but only in the short run. Clementi and Hopenhayn (2006) show a similar result for dynamic contracts under iid asymmetric information (moral hazard on the part of the entrepreneur). Cole et al. (2012) analyze the case with persistent private information and costly state verification. Intermediaries have incentives to relax constraints over time, but the constraints dictate the types of technology and the growth paths that firms can choose. More severe financial frictions can dictate that technologies with higher short-term payoffs, at the expense of longer-term performance, be chosen.

Midrigan and Xu (2014) analyze age-growth profiles of Korean manufacturing plants to empirically evaluate the importance of credit constraints at the intensive margin. Consistent with theory, they find that output, labor, and capital growth is roughly 10 percent (not percentage points) faster for plants less than 5 years old relative to plants more than 10 years old. These differences are small relative to predictions from models without an equity market for firms, however, so Midrigan and Xu deduce that firms enter close to their desired size. They also estimate that productivity is highly persistent. They therefore attribute relatively small costs to credit constraints at the intensive margin among plants in the modern sector, five percent from moving to financial autarky in an open economy and 10 percent in a closed economy. They cannot speak to potential losses in the traditional sector, however, since the traditional technology abstracts from capital.

The relationship between financial frictions and the relative growth of young vs. old firms is non-monotonic though. When financial markets are very underdeveloped, an increase in the amount of financial resources allows young firms to leverage more and grow faster. Eventually, as financial markets become very developed, new firms will enter very close to their unconstrained scale. In this case, an additional amount of financing will only result in an increase in the initial scale and lower growth thereafter.[9] This non-monotonic relationship is illustrated in the right panel of Figure 3. The non-monotonicity is particularly important in the large-scale sector (solid line), where the entry of wealthy-but-unproductive entrepreneurs is more pronounced. These wealthy-but-unproductive entrepreneurs enter close to their unconstrained scale and, hence, exhibit little growth.

[9] More formally, if we assume entrepreneurs save a constant fraction s of their profits, $a' = s[\max_{k \leq \lambda a} zk^{\alpha} - (r+\delta)k]$, then the growth rate of the capital input is an increasing function of λ provided the collateral constraint is binding in the second period and a decreasing function otherwise.

If self-financing can undo much of the impacts of financial frictions, especially for small investments at the intensive margin, it is puzzling that the empirical work reviewed in Section 3.1 finds high returns on small grants to small-scale entrepreneurs. If entrepreneurs can save, why are these small, high-return investments not realized in the absence of these grants? One possibility is that agents face obstacles to saving, either due to their particular environments (e.g., high crime, informal tax on savings from relatives, friends or spouses) or their own impatience (e.g., hyperbolic discounting). In such environments, commitment devices for saving can be beneficial. The role of these in entrepreneurial activities has been examined both empirically (Dupas and Robinson, 2013; Fafchamps et al., 2011; Greaney et al., 2013) and theoretically (Kaboski et al., 2014).

4.3 Poverty Traps

The possibility that financial frictions can lead to poverty traps by distorting entrepreneurs' entry decisions has been shown formally in various settings, e.g., Aghion and Bolton (1997), Banerjee and Newman (1993), Ghatak and Jiang (2002), and Piketty (1997).[10] These models led not only to individual poverty traps but also to aggregate poverty traps. Initial distributions affected aggregate dynamics through their general equilibrium impacts. In the Banerjee and Newman or Ghatak and Jiang models, the equilibrium wage is low if the distribution of income allows few agents to afford the fixed costs needed to become modern entrepreneurs. The low wage leads to high entrepreneurial profits, so inequality and low output become mutually perpetuating. In the Aghion and Bolton and Piketty models, it is the interest rate that drives the poverty trap. In the former, if wealth is too concentrated and few people can initially afford to undertake entrepreneurial investments, the supply of capital is high relative to the constrained demand and the interest rate is low. If savings rates are also low, the low interest rate can limit the ability of individuals to save their way out of poverty over time. Piketty's mechanism is similar, except that here the set of entrepreneurs is fixed and the impact on the interest rate all comes from the intensive margin.[11]

Qualitatively, the mechanisms emphasized in the above papers (lower interest rates and wages from constrained entrepreneurial borrowing) are present in the benchmark model of Section 2, and with the self-financing motive, the impact on interest rates can in fact be exacerbated. The model also contains non-covexities in production, which can generate multiple equilibria. Nonetheless, when mapped to the data, the quantitative versions of these models do not lead to aggregate poverty traps—e.g., Giné and Townsend (2004) and Buera et al. (2011). Instead, these mechanisms lead to slower convergence to a unique stationary equilibrium, the main point of Buera and Shin (2013).[12] The difference comes

[10]See Matsuyama (2011) for an excellent review of related results.

[11]In these models, financial constraints arise from and exacerbate the moral hazard problem of entrepreneurs. Ghatak et al. (2001) study a setting in which financial frictions can actually be efficiency-*enhancing* because rents to future entrepreneurship motivate young workers and help alleviate moral hazard in the labor market.

[12]See also Moll (2014) for a theoretical analysis of this point.

from many of the simplifying assumptions invoked in the above literature in order to yield tractable analytical results. For example, Aghion and Bolton or Piketty lack an extensive margin for capital that would soften the impact of the wealth distribution on the interest rate. Similarly, Banerjee and Newman and Ghatak and Jiang lack an intensive margin in the demand for labor that would make the equilibrium wage respond continuously. Any labor market at all in Piketty's model would completely eliminate the impact of financial frictions. Similarly, some of these models lack productivity shocks that satisfy a mixing condition for the distribution of wealth and ability that favors uniqueness. Most important and relevant to the earlier discussion, each of the models exogenously imposes saving rules on individuals through warm-glow bequest motives and abstracts from any self-financing motive among entrepreneurs.[13]

The model of Section 2 does have individual-level poverty traps, however: Individuals with identical productivity can converge toward different wealth levels (and occupational choice) depending on their initial wealth. Here the self-financing motive drives the poverty traps. Buera (2008) and later Banerjee and Moll (2010) show this formally. Initial wealth determines how quickly self-financing would materialize, and individuals do not find it optimal to save for too long. Given the lower interest rates, those with no intention of becoming entrepreneurs instead dissave.

The solid lines in Figure 2 demonstrate how the saving/dissaving threshold varies with wealth and productivity, and how they differ by the scale of investment needed to operate in the sector (left and right panels). Those to the right (left) of the solid lines save (dissave). Especially in the large-scale sector (right panel), even among high-productivity individuals, the wealthy save while the poor dissave. The dashed lines are the occupational choice thresholds discussed earlier. The intersection of the occupational choice and poverty trap lines indicates that there are workers who are saving to eventually escape poverty and become entrepreneurs, while there are rich entrepreneurs who will eventually become poor. Of course, idiosyncratic shocks to productivity can alter these dynamics, so that these "poverty traps" are *not* absorbing states in the long run.

4.4 Policies

The productivity losses and poverty traps that arise from financial frictions motivate anti-poverty policy interventions. Programs that grant assets to the poor may help them escape poverty traps. Microfinance has been promoted as a means of promoting entry and expansion of businesses. We discuss each in turn.

Asset Grant Programs If the poor have high returns but lack sufficient resources to invest, one possible solution is to simply increase their resources through grants. Uncondi-

[13] This discussion is based on our experience solving a large class of quantitative models of entrepreneurship with financial frictions. This leaves the door open to a more exhaustive search over the parameter space of these models that may uncover regions with aggregate poverty traps. This exploration would be a valuable addition to the literature.

tional grants targeted toward the very poor have become an increasingly common policy, particularly a program called the Ultra Poor Program (UPP), which started in Bangladesh but has spread to many other countries.[14] Using a randomized control trial in Bangladesh, where the grants were between one and three times annual wages, Bandiera et al. (2013) find that the grants increased entrepreneurship (mainly in livestock rearing) rates by 15 percentage points and earnings by 33 percent. These impacts persist (or even grow somewhat) 4 years after treatment, and the increase in earnings amounts to about a 20 percent annual return on the grants.[15] In India (West Bengal), 18 months after randomized grants, Banerjee et al. (2011) find that consumption of recipients increased 25 percent and assets are higher, among adults who do report earning income from their activities. Higher incomes appear to derive from enterprises operated by the household, but they find no significant effect on non-farm economic activity. Related impacts were measured in other studies with the exception of Morduch et al. (2012), who find no impact on consumption, income, or assets after 12 months.

Buera et al. (2014b) simulate the long-run impact of asset grants in general equilibrium. They find that the positive initial impacts on entrepreneurship, earnings, and aggregate TFP are all short-lived in their simulations. They explain that quantitatively the impacts are small and short-lived unless carefully targeted, because fewer than one in five recipients are in the region of high entrepreneurial productivity and low wealth, in which grants alter their occupational choice, and less than one percent are shifted over the savings threshold of Figure 2.

In a world with aggregate poverty traps, one-time redistributions can have long-run consequences, but if a unique stationary distribution exists, the impacts are temporary (Aghion and Bolton, 1997). In Buera et al. (2014b), convergence is relatively rapid, in part because the low equilibrium interest rates imply that most recipients have a strong incentive to dissave. Within 10 years, the distribution of wealth is indistinguishable from the original distribution. Bleakley and Ferrie (2013) find no impact on the left tail of the wealth distribution, but impacts on the right tail 18 years after sizable, randomized grants from the Cherokee land lottery in the 19th century U.S. From the standpoint of quantitative theory, it is the long-lasting impacts on the right tail that are puzzling, which may be reconciled with large fixed costs.

Microfinance Microfinance is another popular program designed to address financial constraints. Although mission drift is a practical problem, in principle, microfinance makes small amounts of credit available to the broad population, including households in the left tail of the wealth distribution. The programs are funded through governments, NGOs, and even for-profit financial institutions. The one well-established success of most microfinance

[14]These countries currently include Ghana, Haiti, Honduras, India (3 programs), Ethiopia, Pakistan, Peru, and Yemen

[15]The experiment is not purely a grant program, however, since recipients also receive health care, training, and access to saving services.

institutions is high repayment rates relative to predecessor programs that provided credit to the poor.

In the micro-development literature, microfinance has been evaluated many times, including both convincing IV approaches and a multitude of recent randomized control trials. These have included rural and urban settings in Bangladesh (Pitt and Khandker, 1998), Bosnia-Herzegovina (Augsburg et al., 2015), Ethiopia (Tarozzi et al., 2015), Kenya, Tanzania, Uganda (Greaney et al., 2013), India (Banerjee et al., 2015a, 2014a; Field and Pande, 2008; Field et al., 2013), Mexico (Angelucci et al., 2015), Mongolia (Attanasio et al., 2015), Morocco (Crepon et al., 2015), the Philippines (Karlan and Zinman, 2010), and Thailand (Kaboski and Townsend, 2011, 2012). It has been difficult to generalize findings, but a few key messages emerge.[16] First, take-up rates are usually fairly low. Second, none of the microfinance programs report miracles of large, dramatic or sustained increases in entrepreneurship, investment, income or consumption. Third, as first shown by Kaboski and Townsend (2011), impacts are heterogeneous across households (Angelucci et al., 2015; Banerjee et al., 2015a, 2014a; Crepon et al., 2015). Fourth, impacts across the programs themselves vary substantially. This is likely due in part to variations in the environments and measurement, but some of it is explicitly due to program details (Attanasio et al., 2015; Field and Pande, 2008; Field et al., 2013; Greaney et al., 2013). Finally, there is mixed evidence on the extent to which microfinance is used for business activities rather than for consumption or consumption smoothing, but several studies have found impacts on entrepreneurship, investment, and business income (Attanasio et al., 2015; Banerjee et al., 2014a,b; Field et al., 2013; Greaney et al., 2013).

Buera et al. (2012) assess both the micro and macroeconomic effects of microfinance in the context of an entrepreneurship model like that presented in Section 2. In understanding the microeconomics, only a small segment of the population borrows, unless microfinance can be used for consumption or labor market distortions cause an overabundance of entrepreneurs of necessity, as in Poschke (2013). This is consistent with Kaboski and Townsend (2011)'s finding that few people have lumpy high-yield investment opportunities that are inframarginal to small loans. Banerjee et al. (2014a) find substantial long-term impacts on earnings, but only for established entrepreneurs. Second, entrants tend to be marginal borrowers. Banerjee et al. (2015a) also find a decline in the quality (profitability, size) of the median entrepreneur.

On the macro side, Buera et al. (2012) show that the chief macroeconomic impact of microfinance is to increase the opportunity cost of work and therefore the wage. Relative to the small segment of the population directly accessing microfinance, a much larger fraction of the poor gain from the rising wage.[17] The higher wage effectively redistributes from wealthy entrepreneurs to poorer workers, and microfinance actually has much more substantial long-

[16]A special volume presents a subset (six) of these randomized control trials in a way that allows for improved comparability of outcomes across studies. Banerjee et al. (2015b) discuss some common lessons.

[17]Kaboski and Townsend (2012) find a positive and substantial impact of microfinance on wages in rural Thai villages. Focusing on a smaller intervention, Crepon et al. (2015) do not find an impact on wages in rural Moroccan villages, however.

term redistribution impacts than one-time transfer programs. However, the redistribution depresses aggregate capital accumulation. With financial frictions, entrepreneurs tend to have high saving rates (for self-financing reasons) and workers largely dissave (given the low equilibrium returns on saving in financially underdeveloped economies). The redistribution is essentially from high savers to low savers, which depresses aggregate saving and investment. On net, although the welfare for most increases with the introduction of economy-wide microfinance, aggregate output is largely unaffected. Finally, heterogeneity in scale again plays a role: Microfinance decreases the relative price of small-scale output and increases the relative price of investment goods produced with large-scale technologies. Relative to micro loans, larger "macro" loans that enable entry into the large-scale sector would lower the relative price of investment goods and increase capital accumulation.

5 Concluding Remarks and Directions for Future Research

In this paper, we have reviewed the recent quantitative macro literature studying how entrepreneurship and financial markets interact, with a special emphasis on developing countries. While some of these studies already explicitly connect the structure of micro-founded, macro models with the findings of empirical micro-development studies, we hope that this review highlights the potential large gains from trade between the micro-development literature and the macro-development literature. The wealth of recent micro-experimental evidence provides invaluable information with which we can evaluate the predictions of macro models, while quantitative theory is a natural guide to interpreting and extrapolating the micro-evidence.

The importance of heterogeneity in quantitative theory motivates several avenues for future empirical work. More work needs to be done to empirically examine the relationship between financial frictions and firm size, firm age, industry or technology proxies for non-convexities. Much empirical work has started with the presumption that the smallest or newest firms are the most constrained, but heterogeneity in productivity and technology could undo this. Natural or randomized experiments that trace out the impact of large wealth changes would therefore be informative about the importance of technological non-convexities that we have highlighted as key model ingredients. The work by Bleakley and Ferrie (2013) and McKenzie (2014) are recent examples in this direction. Since there could be important challenges to implementing experiments that are large scale in nature, an alternative would be to do more structural or case studies of particular industries/technologies in developing countries.

An important lesson of dynamic quantitative models of entrepreneurship with financial frictions is that self-finance is a powerful, although not perfect, substitute to credit, especially when technological non-convexities are not important. More evidence testing empirically this mechanism would be very welcome. For instance, one can envision the random introduction of a capital-intensive new technology and study its adoption over time in the spirit of the recent study by Atkin et al. (2014). Finally, in a world of heterogeneity, the growth patterns of very large firms are of particular importance (see for example, Luttmer (2011)). It underscore the insights that more representative panel firm data in developing countries, especially data sets capturing larger and/or fast growing firms, would enable.

In our review of the macro-quantitative literature we discuss various studies exploring a host of different mechanisms, e.g., multi-sector models, setup costs, innovation and forward looking borrowing constraints. A fruitful direction for future research is to quantitatively assess models that incorporate a rich class of mechanisms, quantifying the relative importance of each and any potential complementarities. The challenge to implementing this line of research is the substantial computational burden associated with exploring a rich class of models. Recent continuous-time methods developed by Achdou et al. (2014a) to analyze models with heterogeneous agents and financial frictions seem like promising tools.

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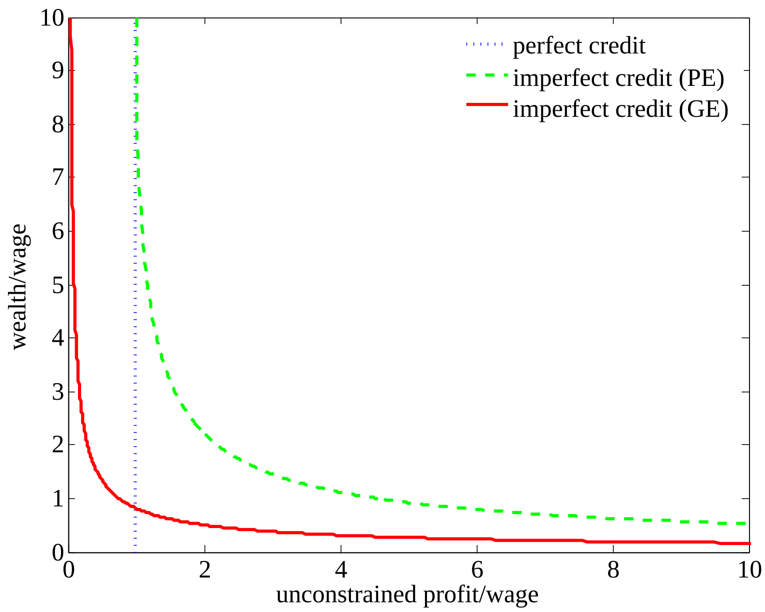

Figure 1: Occupational Choice Map. Those to the right (left) of the respective line choose to be entrepreneurs (workers). We follow the parametrization and calibration in Buera and Shin (2013). In particular, for the cases with financial frictions we assume a simple collateral constraint $k \leq a/(1-\phi)$, with $\phi = 0.26$. The dotted and dashed lines use the prices in the stationary equilibrium with perfect credit. The horizontal axis shows the productivity as the ratio of unconstrained entrepreneurial profits to wage, calculated using the prices from the stationary equilibrium with perfect credit. The veritcal axis measures the wealth-to-wage ratio, again, using the wage in the stationary equilibrium with perfect credit. The solid line is calculated using the prices in the stationary equilibrium with $\phi = 0.26$.

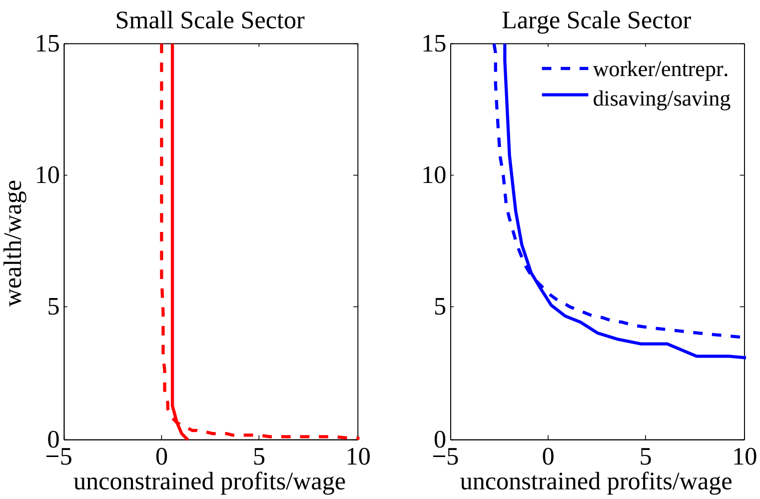

Figure 2: Occupational and Saving Map, Small and Large Scale Sectors. Those to the right (left) of the respective dashed line choose to be entrepreneurs (workers). We follow the parametrization and calibration in Buera et al. (2011). In particular, the financial friction arises endogenously from a limited commitment problem parametrized by the share of profits that can be recovered by the lender upon default, ϕ. We use $\phi = 0.12$, which implies a ratio of external finance to GDP of 0.3, the typical value for a low-income country, and the prices in the corresponding stationary equilibrium. The horizontal axis measures the productivity as the ratio between the unconstrained profits in the sector and the wage. The vertical axis measures the wealth to wage ratio.

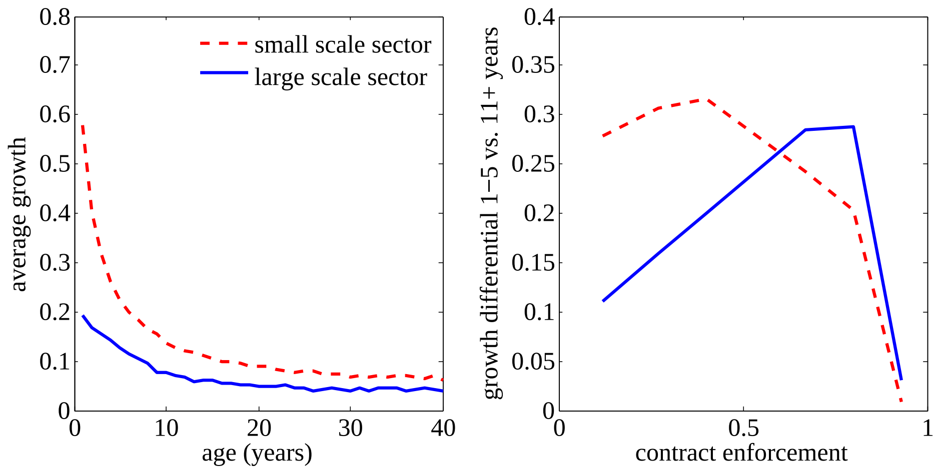

Figure 3: Employment Growth by Age. We follow the parametrization and calibration in Buera et al. (2011). In particular, the financial friction arises endogenously from a limited commitment problem parametrized by the share of profits that can be recovered by the lender upon default, ϕ. In the left panel we use $\phi = 0.12$, which implies a ratio of external finance to GDP of 0.3, the typical value for a low income country, and the prices in the corresponding stationary equilibrium.