The Macroeconomics of Microfinance*

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Abstract

What is the aggregate and distributional impact of microfinance? To answer this question, we develop a quantitative macroeconomic framework of entrepreneurship and financial frictions in which microfinance is modeled as guaranteed small-size loans. We discipline and validate our model using recent empirical evaluations of small-scale microfinance programs. We find that the long-run general equilibrium impact is substantially different from the short-run effect. In the short-run partial equilibrium, output and capital increase with microfinance but total factor productivity (TFP) falls. In the long run, when general equilibrium effects are considered, as should be for economy-wide microfinance interventions, scaling up microfinance has only a small impact on per-capita income, because an increase in TFP is offset by lower capital accumulation. However, the vast majority of the population benefits from microfinance directly and indirectly. The welfare gains are larger for the poor and the marginal entrepreneurs, although higher interest rates in general equilibrium tilt the gains toward the rich.

Keywords: Microfinance, entrepreneurship, general equilibrium effect

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Over the past several decades, microfinance—i.e., credit targeted toward the poor who may otherwise lack access to financing—has become a pillar of economic development policies. In recent years, there has been a concerted effort to expand such programs with the goal of alleviating poverty and promoting development.[1] Between 1997 and 2013, access to microfinance grew by 19 percent a year, reaching a scale at which macroeconomic considerations become relevant. The Microcredit Summit Campaign reports 3,098 institutions serving 211 million borrowers as of 2016. For several countries, microfinance loans represent a significant fraction of their GDP.[2]

A flurry of microevaluations of microfinance programs in various countries have given us growing clarity on the impacts of smaller-scale micro-credit programs on their borrowers. Although these microcredit interventions can lead to increases in credit, entrepreneurial activity, and investments, they tend to have relatively low take-up rates and have been much less successful in leading to higher income or consumption. Village fund programs that are publicly subsidized, with lower interest rates and higher take-up rates, are the only programs to *consistently* show impact on consumption and income.[3]

As opposed to the microevaluations, the macroeconomic effects of economy-wide microfinance have been unexplored. In this context, our paper has two main contributions. First, we use a quantitative dynamic general equilibrium model to explore the aggregate and distributional implications of expanding microfinance along the intensive margin, i.e., by increasing the size of the loans provided, and the extensive margin, i.e., by making microfinance more widely available. We pay particular attention to the long run and general equilbrium (GE) effects of the program. Second, we use the results from recent microevaluations to discipline and validate our quantitative model, and use the model to interpret and explain the seemingly discordant results from various microevaluations, highlighting the potentially large gains from "intellectual trade" between quantitative macroeconomics and micro-development economics.

The overarching theme of our findings is that the effects of microfinance programs in the short run, which can be substantially positive if programs are expanded, are materially different from, and even opposite of, the aggregate and distributional effects microfinance will have in the long run, when scaled up to the entire economy.

[1]The United Nations, in declaring 2005 as the International Year of Microcredit, called for a commitment to scaling up microfinance at regional and national levels in order to achieve the original Millennium Development Goals.

[2]Examples are Bangladesh (0.03), Bolivia (0.09), Kenya (0.03), and Nicaragua (0.1), as calculated from the Microfinance Information Exchange (MIX) data and domestic price GDP from the Penn World Tables.

[3]A special issue of the *American Economic Journal: Applied Economics* contains several studies of formal microfinance institutions, which are summarized in the overview article, Banerjee et al. (2015c). Buera et al. (2019) presents a broader review including evidence on village funds.

The model is consistent with the relatively beneficial but small impacts measured in the microevaluation studies—mostly because the studied interventions are typically small-scale in both intensive and extensive margins. Nevertheless, the model predicts that microfinance, when made widely available in an economy, has significant aggregate and distributional long-run impacts that are quantitatively and qualitatively different from the short-run effects. In the short-run partial equilibrium (PE), when microfinance loan sizes become larger, output and investment rise. The allocative efficiency suffers, because more capital is allocated to entrepreneurs with below-average productivity, who benefit more directly from microfinance. However, over time, the economy-wide availability of microfinance leads to less saving and hence a lower supply of capital, which pushes up the interest rate. This drop in capital is largely offset by the improvement in allocative efficiency (and TFP), but, in some instances, output per capita falls in the long run. Nevertheless, considering the full time paths, the welfare effects of microfinance are positive for the vast majority, and especially for the poor—who take out small consumption loans and also benefit from higher wages early on—and poor marginal entrepreneurs—who take out small production loans. A small subset of entrepreneurs is made worse off by microfinance because the higher wage and interest rate in GE cut into their profit. The biggest beneficiaries of economy-wide microfinance are, surprisingly, the very wealthy: The higher interest rate implies a higher return on wealth, a channel missing in PE by definition.

To develop the analysis, we start from a model of entrepreneurship and income shocks in which financial development has been shown to have significant aggregate impacts (Buera et al., 2011). In this model, financial frictions—modeled as endogenous collateral constraints founded on imperfect enforceability of credit contracts—distort the allocation of entrepreneurial talent and capital in the economy, although their effects are mitigated by individuals' forward-looking saving decisions and self-financing by entrepreneurs.

Into this environment, we introduce microfinance in a way that captures the narrative of microfinance as credit for both entrepreneurial capital and intertemporal consumption smoothing. We model microfinance as a financial intermediation technology that guarantees access to and full repayment of a loan up to a limit, regardless of collateral or productivity. Everyone has access to it in principle, but it is the choice set of the poor that is most affected by microfinance. Constrained consumers and marginal entrepreneurs—including those who would have chosen not to run their own business in the absence of microcredit—are affected in the most direct way.

We discipline and validate our quantitative analysis in two steps. First, we require our model to match Indian data on standard macro aggregates, the size distribution and dynamics of establishments, earning dynamics, and the ratio of external finance to GDP, which together pin down the technology and financial constraint parameters of the model. Second, in what is essentially an out-of-sample validation, we ask how the short-run PE predictions of our calibrated model for appropriately-sized microfinance interventions compare with the estimates from two recent microevaluations of microfinance in India (Banerjee et al., 2015b) and Thailand (Kaboski and Townsend, 2011, 2012).

The short-run PE case is the relevant comparison because these empirical studies evaluate small-scale (relative to the aggregate economy) programs that are evaluated after one or two years. When comparable microfinance loans are introduced, the model is consistent with the estimated magnitudes of the overall credit expansion, the increase in investment and entrepreneurship, and the increase in consumption. The model also affirms the microevidence that impacts are concentrated among marginal entrepreneurs.

Next we simulate and quantify the long-run effects of economy-wide microfinance on key macroeconomic measures of development—output, capital, TFP, wage, and interest rates—and its distributional consequences. Both the long-run and GE aspects of the analysis turn out to be important. Our short-run PE analysis shows that, although the marginal impacts of the interventions typically evaluated may be small, the total impact of microfinance with larger loan sizes (e.g., equal to annual wages) is not negligible. When compared to an economy with no microfinance, income and capital are 8 percent higher in the short run as microfinance enables more people to invest, but TFP is 3 percent lower, since microfinance encourages the entry of low productivity entrepreneurs and a larger fraction of aggregate capital is allocated to them.

In GE, by definition, the wage and interest rate are allowed to respond to the economy-wide availability of microfinance. Even in the short-run, the wage and interest rate both rise to clear markets, given the increased demand for credit caused by microfinance. The capital stock decreases slightly as saving rates fall, but TFP actually rises, because higher factor prices limit the entry of low productivity entrepreneurs, leading to higher output. In the long run GE, the lower saving accumulates over time, pushing up the interest rate and reducing the demand for capital (a 13 percent decline). With higher factor prices, microfinance has only a negligible effect on the number of entrepreneurs. TFP rises 1 percent as microfinance enables the average quality of entrepreneurs to improve and capital to be more efficiently allocated among them. Higher TFP and lower capital offset so that the impact of microfinance on output is negligible but can even be negative.

From a welfare perspective, nearly everyone gains. While the direct, PE effect of microfinance favors the poor and the marginal entrepreneurs, the GE effect favors the poor and the workers, as well as the very wealthy. The largest direct gains accrue to those who are marginal entrepreneurs (who take out microloans for production) and the poor (who take out microloans for consumption). Except those who become entrepreneurs because of microfinance, the relaxation of credit constraints leads nearly everyone to increase consumption and cut back on saving. In GE, additional forces are at work. The higher interest rate implies more gains for the very wealthy through higher returns on their wealth, and this comes at the expense of those who borrow and pay more in interest. Workers also benefit, as wages unambiguously increase in the short-to-medium run as microfinance generates more entrepreneurship. This gain from wage increases is smaller with subsidized microfinance loans, which depress capital formation even more and result in a lower wage in the long run. A small subset of entrepreneurs is made worse off by microfinance, because the higher wage and interest rate in GE cut into their profit.

While our benchmark model lacks some variations of real-world microfinance programs, the ease of considering counterfactuals or alternative scenarios is a strength of our quantitative framework. We consider several extensions, which include (i) subsidized credit (which leads to much higher take-up rates and short-run increases in consumption but also exacerbates the decline in saving); (ii) a small open economy facing a fixed international interest rate (which leads to a small aggregate capital decline but requires an inflow of capital as saving declines considerably); (iii) microfinance as quasi "grants" with a less demanding repayment schedule (which leads to a significant increase in the number of entrepreneurs and a more pronounced drop in saving and capital stock); and (iv) a two-sector version where one of the sectors has larger scales of operation (which leads to non-linear and non-monotonic effects of microfinance on aggregate variables, depending on whether the microloan limit is large enough to effectively help those in the large-scale sector).

The rest of the paper is organized as follows. Section 1 provides empirical motivation by summarizing important microfinance programs and reviewing the literature. In Section 2, we develop the model, including the microfinance intervention. Section 3 describes the calibration, short-run PE predictions, and a comparison with empirical evaluation studies of microfinance programs. We then analyze the short-run and long-run PE and GE effects of microfinance in Section 4, and work out extensions in Section 5. Section 6 concludes.

1 Empirical Motivation

This section documents the main characteristics of microfinance and other credit programs targeted toward small-scale entrepreneurs and review the existing studies on microfinance.

1.1 Microcredit Programs

Microfinance programs and other credit programs targeted toward small-scale entrepreneurs are prevalent and still growing fast. The Microcredit Summit Campaign reports 3,098 institutions with loans to 211 million clients throughout the world as of 2013. For comparison, the numbers in 1997 were 618 institutions and 13 million clients. The five-fold increase in the number of institutions and the sixteen-fold increase in the number of borrowers over this period certainly overstate the actual growth because of an increase in survey participation, but the growth is still real and dramatic.[4] By the same token of incomplete survey participation and coverage, these numbers certainly understate the actual numbers.

Microloans are small and short-term (i.e., one year or shorter), and they have high repayment rates. A broad vision of the structure of microcredit can be gleaned from the MIX dataset, which provides comparable data over 2,917 microfinance institutions (MFIs) in 123 countries, totaling 87 billion dollars in outstanding loans and 114 million borrowers in 2014. The average loan balance per borrower is 768 dollars in 2014, but because loans are typically in poor countries, for the average institution the average loan balance is about 97 percent of per-capita (annual) gross national income. Moreover, since microfinance is often targeted toward the poorer segments of the economy, the average loan amounts to a substantially larger fraction of the income of actual borrowers. The variation in this ratio of the average loan size to per-capita income across institutions is quite large, however, with a median of 0.27 and a 90/10 split of 1.51/0.06.

An important achievement of microfinance is its success in providing uncollateralized loans with relatively low default rates. In 2014, only 4 percent of loan portfolios were more than 90 days delinquent.[5]

Table 1 reports various statistics on microcredit as of 2009 for the top five countries in terms of the number of borrowers as a fraction of the population, as well as Benin, which has the most penetration in Africa, and India, which has the largest absolute number of microfinance clients. For these countries, the expansion of microfinance is reaching highly significant levels, with up to 16 percent of the population being active borrowers, and the value of total outstanding microfinance loans can be as large as 8 percent of GDP.[6] In Table 1 we also see that the expansion of microfinance is particularly important among the poorest

[4]For example, the clientele of a single program, the National Bank for Agriculture and Rural Development in India, grew from 146,000 to 55 million during this period (Daley-Harris, 2009; Reed et al., 2015).

[5]There is also significant heterogeneity in delinquency rates across countries. In the MIX data, roughly 28 percent of the countries report 1 percent or less of loans as delinquent, while about 7 percent of the countries report more than 10 percent of loans in this category.

[6]The MIX data are reported in current U.S. dollars. Here we bring GDP numbers from the Penn World Tables 9.0 forward to 2014 using the U.S. Personal Consumption Expenditures deflator.

Country	Fraction of Borrowers	MF Loans to GDP	Average Loan Size	Per-capita Income	Total Credit to GDP
Mongolia	0.16	0.069	4,996	547	0.57
Cambodia	0.15	0.082	1,710	1,410	0.48
Paraguay	0.13	0.028	1,815	4,658	0.46
Peru	0.13	0.028	2,452	1,776	0.44
Bolivia	0.11	0.082	4,538	1,024	0.47
Benin	0.04	0.003	143	803	0.24
India	0.03	0.001	190	1,154	0.82
Mean	0.02	0.008	4,399	8,070	0.46
Std. Dev.	0.03	0.015	18,320	746	0.39

Table 1: Microfinance Facts from the MIX Data. All data are for 2014, the most recent common year across datasets. The data on microfinance is from MIX Market Database. Population and real income per capita data are PWT 9.0 data. Since the MIX data are reported in current US dollars and the GDP data from the PWT are in 2011 US dollars, we bring these PWT data forward to 2014 using the US Personal Consumption Expenditures deflator. Total credit to GDP data are from the Financial Structure and Development Dataset, June 2016 (Beck et al., 2000), where total credit is the sum of private credit and private bond market capitalization.

countries, where credit markets are very underdeveloped, as measured by the ratio of total credit to GDP. In countries like Cambodia and Bolivia, microcredit accounts for about 17 percent of all private credit.[7]

1.2 Existing Literature

This paper is the first to quantitatively evaluate the short-run and long-run aggregate and distributional impact of microfinance as a targeted form of financial intermediation.[8] Our analysis builds on an extensive quantitative macro literature studying financial frictions and development, reviewed in Buera et al. (2015). We follow this literature by evaluating microfinance within a model that incorporates occupational choice, endogenous wages and interest rates, and forward-looking saving decisions.[9]

Microfinance has typically been viewed as a technological or policy innovation enhancing the repayment probability of uncollateralized loans. Alternative theories of the precise nature

[7]The microfinance institutions in the MIX data include a mix of nongovernmental organizations (NGOs) and private for-profit institutions. For-profits constitute less than half of the institutions, but more than half of the borrowers and credit. Government organizations are a third source of microfinance, and many of these are important but not included in the MIX data. For example, including the Indian government's rural development bank into the data in Table 1, the number of borrowers as a fraction of the population in India increases to 6 percent, and the value of outstanding loans is close to 1 percent of GDP.

[8]The NBER working paper version of this paper is dated March 2012 (Buera et al., 2012).

[9]Ahlin and Jiang (2008) provide a theoretical analysis of the aggregate impact of microfinance within the context of Banerjee and Newman (1993).

of this technology have been proposed, including joint liability lending (Besley and Coate, 1995), high-frequency repayment (Jain and Mansuri, 2003; Fischer and Ghatak, 2010), and dynamic incentives (Armendariz and Morduch, 2005). Unfortunately, empirical tests of the relative importance of these alternative mechanisms have not produced a clear answer as to what leads to high repayment rates (Ahlin and Townsend, 2007; Field and Pande, 2008; Gine and Karlan, 2010; Carpena et al., 2010; Attanasio et al., 2011). We take an agnostic approach to the nature of this technology and simply model it as an innovation that, while costly, enables the full repayment of uncollateralized loans of certain sizes.

There is a growing empirical literature evaluating microfinance programs. The closest related studies are Kaboski and Townsend (2012) and Breza and Kinnan (2016), who find substantial localized wage effects of microfinance studying an expansion in Thailand and a contraction in India, respectively. Neither study emphasizes impacts on interest rates. The rest of this literature has focused on estimating short-run partial equilibrium impacts of relatively small interventions. The special issue of *American Economic Journal: Applied Economics* reports randomized evaluations in Bosnia-Herzegovina, Ethiopia, India, Mexico, Mongolia, and Morocco.[10] The studies tend to find: (i) relatively low take-up rates; (ii) increases in credit overall; (iii) increases in business activity, but (iv) little impact on overall measures of income or consumption, although they find effects on their composition. The sign of the effects tend to be consistent across studies, but statistical significance only appears in a subset of them. Still, as the authors caution, the low take-up rates "present statistical power challenge," and many of the insignificant results "are part of confidence intervals that contain economically meaningful effects." All above studies emphasize the heterogeneous impacts of microfinance. We perform a more critical comparison of these empirical findings with our model predictions in Section 3.3.

Methodologically, we complement Kaboski and Townsend (2011), who use a structural model to evaluate the impact of the Thai Million Baht Village Fund program, and Lagakos et al. (2018), who estimate parameters of their model of migration using a randomized controlled trial in Bangladesh. Rather than using micro evaluation results to estimate or calibrate our parameters, we calibrate independently, and use the micro evaluation results as additional moments to test the model out-of-sample.

[10]The individual studies summarized are Augsburg et al. (2015); Tarozzi et al. (2015); Banerjee et al. (2015b); Angelucci et al. (2015); Attanasio et al. (2011); Crépon et al. (2015), respectively. Karlan and Zinman (2011) is an additional randomized evaluation.

2 Model

In this section, we introduce the baseline model with which we evaluate the aggregate and distributional impacts of microfinance.

There is a measure N of infinitely-lived individuals, who are heterogeneous in their wealth, a, their labor productivity, x, and the quality of their entrepreneurial idea or productivity, z. Their wealth is determined endogenously by forward-looking saving behavior. The labor productivity or efficiency units of labor is assumed to follow a two-state Markov chain, $x \in \{x_l, x_h\}$, with a symmetric transition matrix with diagonal element π_x. The entrepreneurial idea is drawn from an invariant distribution with cumulative distribution function $\mu(z)$. Entrepreneurial ideas "die" with a constant hazard rate of $1-\gamma$, in which case a new idea is drawn from $\mu(z)$ independently of the previous idea; that is, γ controls the persistence of the entrepreneurial idea or productivity process. The labor efficiency shock and the entrepreneurial productivity shock are mutually independent.

In each period, individuals choose their occupation: work for a wage or operate a business as entrepreneur. The occupation choice is based on their productivity as an entrepreneur/worker and their access to capital. The labor productivity shock gives rise to "necessity entrepreneurs," i.e., those who start businesses not because they are particularly productive as entrepreneur (high z), but because their labor productivity is low (x_l). This is motivated by the high observed rates of small-scale, often informal, entrepreneurs in developing countries, who are entrepreneurs simply because they lack good labor market opportunities. Access to capital is determined by their wealth through an endogenous collateral constraint, founded on the imperfect enforceability of contracts. We model microfinance as an innovation that guarantees the access to and repayment of uncollateralized credit of certain sizes regardless of one's wealth or productivity. One entrepreneur can operate only one production unit (establishment) in a given period. Entrepreneurial ideas are inalienable, and there is no market for entrepreneurial talent.

2.1 Preferences

Individual preferences are described by the following expected utility function over sequences of consumption c_t:

$$U(c) = \mathbb{E}\left[\sum_{t=0}^{\infty} \beta^t u(c_t)\right], \quad u(c_t) = \frac{c_t^{1-\sigma}}{1-\sigma}, \tag{1}$$

with β as the discount factor and σ as the coefficient of relative risk aversion. The expectation is over the realizations of entrepreneurial ideas and labor productivity (x, z).

2.2 Technology

At the beginning of each period, an individual with entrepreneurial idea or productivity z, labor productivity x, and wealth a chooses whether to work for a wage, earning wx, or operate a business. An entrepreneur with productivity z produces using capital (k) and labor (l) according to:

$$zf(k,l) = zk^{\alpha}l^{\theta},$$

where α and θ are the elasticities of output with respect to capital and labor and $\alpha + \theta < 1$, implying diminishing returns to scale in variable factors at the establishment level.

With factor prices w (wage) and R (rental rate of capital), an entrepreneur's profit is $\pi(k,l) = zk^{\alpha}l^{\theta} - Rk - wl$. For later use, we define the unconstrained optimal level of capital and labor input for an entrepreneur with productivity z:

$$(k^u(z), l^u(z)) = \arg\max_{k,l} \left\{ zk^{\alpha}l^{\theta} - Rk - wl \right\}.$$

2.3 Credit Markets

We first describe credit markets in the absence of microfinance. Individuals have access to competitive financial intermediaries, who receive deposits and rent out capital k at rate R to entrepreneurs. In the benchmark model without microfinance, we restrict the analysis to the case where credit transactions are within a period—that is, individuals' financial wealth is restricted to be non-negative ($a \geq 0$) and credit means renting capital for production. The zero-profit condition of the intermediaries implies $R = r + \delta$, where r is the deposit rate and δ is the depreciation rate.

Capital rental by entrepreneurs is subject to a collateral constraint, which arises from imperfect enforceability of contracts. In particular, we assume that, after production has taken place, entrepreneurs may renege on capital rental contracts. In such cases, entrepreneurs keep a fraction $1-\phi$ of the undepreciated capital and the revenue net of labor payments: $(1-\phi)\left[zf(k,l) - wl + (1-\delta)k\right]$, $0 \leq \phi \leq 1$. The only punishment is the garnishment of their financial assets deposited with the financial intermediary, a. In the following period, the entrepreneurs in default regain access to financial markets and are not treated any differently, despite their history of default. Given this assumption, the labor productivity (x) of individuals does not affect their capital rental limit.

This one-dimensional parameter ϕ captures the extent of frictions in the financial market owing to imperfect enforcement of credit contracts. This parsimonious specification allows for a flexible modeling that spans economies with perfect credit markets ($\phi = 1$) and no credit or 100-percent self-financing ($\phi = 0$).

We consider equilibria where the borrowing and capital rental contracts are incentive-compatible and are hence fulfilled. In particular, we study equilibria where the rental of capital is quantity-restricted by an upper bound $\bar{k}(a, z; \phi)$, which is a function of the subset of the individual state (a, z). We choose the rental limits $\bar{k}(a, z; \phi)$ to be the largest limits that are consistent with entrepreneurs choosing to abide by their credit contracts. Without loss of generality, we assume $\bar{k}(a, z; \phi) \leq k^u(z)$, where k^u is the profit-maximizing capital input in the unconstrained problem. The following proposition, proved in Buera et al. (2011), characterizes the set of enforceable contracts and the rental limit $\bar{k}(a, z; \phi)$.

Proposition 1 *Capital rental k by an entrepreneur with wealth a and productivity z is enforceable if and only if the following is satisfied.*

$$\max_{l} \{zf(k, l) - wl\} - Rk + (1 + r)a \geq (1 - \phi)\left[\max_{l} \{zf(k, l) - wl\} + (1 - \delta)k\right] \quad (2)$$

The upper bound on capital rental that is consistent with entrepreneurs choosing to abide by the contracts can be represented by a function $\bar{k}(a, z; \phi)$, which is increasing in a, z, and ϕ.

Condition (2) states that an entrepreneur must end up with (weakly) more economic resources when he fulfills his credit obligations (left-hand side) than when he defaults (right-hand side). This static condition fully characterizes enforceable allocations because we assume that defaulting entrepreneurs have access to financial markets in the following period.

This proposition also provides a convenient way to operationalize the enforceability constraint into a simple rental limit $\bar{k}(a, z; \phi)$. Rental limits increase with the wealth of entrepreneurs, because the punishment for defaulting (loss of collateral) is larger. Similarly, rental limits increase with the entrepreneurial productivity because defaulting entrepreneurs keep only a fraction $1 - \phi$ of the output.

2.4 Microfinance

We model microfinance as an innovation in financial technology that guarantees individuals' access to and repayment of financing up to a given amount, denoted b_{MF}.[11] Microfinance entails a per-unit financing wedge or spread of ν denominated in units of capital, which could reflect either intermediation costs ($\nu > 0$) or external subsidies ($\nu < 0$). Thus, enforcement is costly, and in equilibrium the interest rate for microfinance loans will differ from that on assets and conventional loans: $r_{MF} = r + \nu$, but after intermediation costs (net of subsidies), intermediaries earn the same return on microfinance loans as on traditional loans. We allow individuals to divide up the microfinance limit to be used for consumption and future capital

[11] As discussed in Section 1.2, the exact nature of this innovation is a subject of debate and is understood to take the form of dynamic incentives, joint liability, and/or community sanctions.

rental. Consumption loans are modeled as intertemporal borrowing that allows assets to be negative in order to finance current consumption, but a must satisfy $a \geq -b_{MF}$. That is, non-microfinance loans cannot be used as consumption loans. The remaining microfinance limit can be used next period to finance intra-period capital rental through microfinance, k_{MF}, which must satisfy $k_{MF} \leq \bar{k}_{MF}(a; b_{MF}) \equiv b_{MF} + \min\{a, 0\}$.[12]

In financing capital, microfinance naturally interacts with the conventional capital market. The rental rates of microfinance, $R_{MF} = R + \nu$, and conventional capital, R, can differ, just as the interest rates differ. Since microfinance loans are perfectly enforceable, to be consistent they are assumed to be senior to conventional capital rental, and the intermediary takes this into account when offering conventional capital. Given the microfinance capital, k_{MF}, if the intermediary is willing to lend additional capital, the rental limit for conventional capital is the maximum k_{CL} satisfying the following modified enforcement constraint:

$$\begin{aligned} &\max_{l}\{zf(k_{MF} + k_{CL}, l) - wl\} - Rk_{CL} + (1+r)a \\ &\geq (1-\phi)\left[\max_{l}\{zf(k_{MF} + k_{CL}, l) - wl\} + (1-\delta)(k_{MF} + k_{CL})\right] - (1-\delta)k_{MF}. \end{aligned} \tag{3}$$

which implicitly defines a $\bar{k}_{CL}(a, z; \phi, b_{MF})$. Note that although in principle everyone has access to microfinance, the use of microfinance lowers $\bar{k}_{CL}(a, z; \phi, b_{MF})$, effectively offsetting the available conventional capital for those with access to conventional capital. Hence, microfinance relaxes the overall capital rental constraints disproportionately for those with little to no access to conventional capital. However, the take-up decisions—i.e., whether or not to use microfinance and, if so, how much—are made for both production and consumption purposes, which we explicitly analyze in Section 3.3.

2.5 Recursive Representation of Individuals' Problem

Individuals maximize (1) by choosing sequences of consumption, financial wealth, occupation, and entrepreneurial capital/labor inputs, subject to a sequence of period budget constraints and rental limits. At the beginning of a period, an individual's state is summarized by his wealth a and his entrepreneurial/worker productivities z and x. He then chooses whether to be a worker or an entrepreneur for the period. The value for him at this stage, $v(a, x, z)$, is the larger of the value of being a worker, $v^W(a, x, z)$, and the value of being an

[12] In the early days (for example, the pioneering by Grameen Bank), microfinance programs were specifically targeted for entrepreneurship and production activities. Many programs nowadays also finance consumption either explicitly or implicitly, since the use of funds are not always monitored (Banerjee et al., 2015c). For an analysis without the possibility of using microfinance for consumption, see the earlier working paper version of this paper (Buera et al., 2012). Consumption loans predominantly benefit the poor. Aggregate effects remain qualitatively similar.

entrepreneur, $v^E(a,x,z)$:

$$v(a,x,z) = \max\left\{v^W(a,x,z), v^E(a,x,z)\right\}. \tag{4}$$

Note that the value of being a worker, $v^W(a,x,z)$, depends on his entrepreneurial productivity z, which may be implemented at a later date. We denote the optimal occupation choice by $o(a,x,z) \in \{W, E\}$.

A worker chooses consumption c and the next period's assets a' to maximize his continuation value subject to the period budget constraint:

$$\begin{aligned} v^W(a,x,z) &= \max_{c, a' \geq -b_{MF}} u(c) + \beta \mathbb{E}_{x',z'}\left[v'(a',x',z')\,|x,z\right] \qquad (5) \\ \text{s.t. } c + a' &\leq wx + (1+r)\, a\mathbf{1}_{a\geq 0}(a) + (1+r_{MF})\, a\mathbf{1}_{a<0}(a), \end{aligned}$$

where wx is his labor income and $\mathbf{1}_A : [-b_{MF}, \infty) \to \{0,1\}$ is the indicator function that is 1 if $a \in A$ and 0 otherwise. The continuation value is a function of the end-of-period state (a', x', z'), and the expectation operator $\mathbb{E}_{x',z'}$ stands for the integration with respect to the distributions of x' and z'. It has $v(a', x', z')$ in it, because the worker can change his occupation based on (a', x', z'). Note that b_{MF} affects the worker's intertemporal constraint, and the interest rate on assets depends on whether they are positive or negative—because a negative quantity means microfinance, and microfinance has the interest rate wedge ν.

Alternatively, individuals can choose to be an entrepreneur, whose value is as follows.

$$v^E(a,x,z) = \max_{c, a', k_{MF}, k_{CL}, l} u(c) + \beta \mathbb{E}_{x',z'}\left[v(a',x',z')\,|x,z\right] \tag{6}$$

$$\text{s.t. } c + a' \leq zf(k_{MF} + k_{CL}, l) - R_{MF}k_{MF} - Rk_{CL} - wl$$

$$+ (1+r)\, a\mathbf{1}_{a\geq 0}(a) + (1+r_{MF})\, a\mathbf{1}_{a<0}(a) \tag{7}$$

$$k_{CL} \leq \bar{k}_{CL}(a, z; \phi, b_{MF}) \tag{8}$$

$$k_{MF} \leq \bar{k}_{MF}(a; b_{MF}) \equiv b_{MF} + \min\{a, 0\} \tag{9}$$

$$a' \geq -b_{MF}$$

An entrepreneur's income is given by period profits $zf(k,l) - R_{MF}k_{MF} - Rk_{CL} - wl$ plus the return to his wealth. In addition, capital rental choices are affected by the financial development and the generosity of microfinance, respectively captured by ϕ and b_{MF}. The division of microfinance into consumption loan ($a < 0$) and capital rental (k_{MF}) is in (9).

2.6 Stationary Competitive Equilibrium

A stationary competitive equilibrium is composed of an invariant distribution of wealth and worker/entrepreneurial productivity with joint distribution $G(a,x,z)$ and the marginal distribution of z denoted by $\mu(z)$, individual decision rules on consumption, asset accumulation, occupation, labor input, and capital input, $c(a,x,z)$, $a'(a,x,z)$, $o(a,x,z)$, $l(a,x,z)$, $k_{MF}(a,x,z)$, $k_{CL}(a,x,z)$, and prices w, R_{MF}, R, r_{MF}, and r such that:

1. Given w, R_{MF}, R, r_{MF}, and r, the individual decision rules $c(a,x,z)$, $a'(a,x,z)$, $o(a,x,z)$, $l(a,x,z)$, $k_{MF}(a,x,z)$, and $k_{CL}(a,x,z)$ solve (4), (5) and (6);

2. Financial intermediaries break even: $R = r + \delta$, $R_{MF} = r_{MF} + \delta$ with $r_{MF} = r + \nu$;

3. Capital, labor, and goods markets clear (demand on the left and supply on the right):

$$\int k(a,x,z)\,G(da,dx,dz) = \int aG(da,dx,dz) \tag{Capital}$$

$$\int l(a,x,z)\,G(da,dx,dz) = \int_{\{o(a,x,z)=W\}} xG(da,dx,dz) \tag{Labor}$$

$$C + \delta K + \nu(K_{MF} + B_{MF}) = \int_{\{o(a,x,z)=E\}} \left[zk(a,x,z)^{\alpha}\,l(a,x,z)^{\theta}\right] G(da,dx,dz) \tag{Goods}$$

where we define total capital demand $k(a,x,z) \equiv k_{MF}(a,x,z) + k_{CL}(a,x,z)$, aggregate consumption $C \equiv \int c(a,x,z)\,G(da,dx,dz)$, aggregate capital $K \equiv \int k(a,x,z)\,G(da,dx,dz)$, total microfinanced capital $K_{MF} \equiv \int k_{MF}(a,x,z)\,G(da,dx,dz)$, and total (microfinanced) consumption loan $B_{MF} \equiv \int_{a<0} aG(da,dx,dz)$;

4. The joint distribution of wealth and entrepreneurial productivity is a fixed point of the equilibrium mapping:

$$\begin{aligned}
G(a,x,z) = {} & \gamma\pi_x \int_{\{(\tilde{a},\tilde{x},\tilde{z})|a'(\tilde{a},\tilde{z})\le a,\tilde{x}=x,\tilde{z}\le z\}} G(d\tilde{a},d\tilde{x},d\tilde{z}) \\
& + (1-\gamma)\,\pi_x\mu(z) \int_{\{(\tilde{a},\tilde{z})|a'(\tilde{a},\tilde{z})\le a,\tilde{x}=x\}} G(d\tilde{a},d\tilde{x},d\tilde{z}) \\
& + \gamma(1-\pi_x) \int_{\{(\tilde{a},\tilde{x},\tilde{z})|a'(\tilde{a},\tilde{z})\le a,\tilde{x}\ne x,\tilde{z}\le z\}} G(d\tilde{a},d\tilde{x},d\tilde{z}) \\
& + (1-\gamma)(1-\pi_x)\,\mu(z) \int_{\{(\tilde{a},\tilde{x},\tilde{z})|a'(\tilde{a},\tilde{z})\le a,\tilde{x}\ne x\}} G(d\tilde{a},d\tilde{x},d\tilde{z}).
\end{aligned}$$

Although we only define stationary equilibria here, in our analysis of the short-run effects of microfinance and also the welfare effects, we compute the transitional dynamics to the new stationary equilibria. For this purpose, we define a competitive equilibrium in an analogous fashion as consisting of *sequences* of joint wealth-productivity distribution $\{G_t(a, x, z)\}_{t=0}^{\infty}$, policy functions, rental limits, and prices.

3 Calibration and Validation

To quantify the aggregate and distributional impact of microfinance, we calibrate our model using data from India on standard macro aggregates, the distribution and dynamics of establishments, earnings distribution, and the ratio of external finance to GDP.

Once we have the calibrated initial stationary equilibrium, in Section 3.2, we show how individuals' wealth and entrepreneurial and labor productivity determine their occupational choices and also saving behavior with and without microfinance. This helps us illustrate how microfinance affects different people in different ways.

We then conduct experiments to assess the effect of microfinance by varying b^{MF}, the maximum size of loans guaranteed by microfinance. We first document the short-run impact of microfinance with fixed prices—i.e., in partial equilibrium (PE). The model implications are then compared with empirical evaluations of microfinance, which by design capture short-run PE effects: The empirical studies evaluate small-scale (relative to the aggregate economy) programs after one or two years in existence. We show that the model matches key qualitative features found in microevaluations of microfinance programs, and that the quantitative magnitudes in the model are in line with the empirical estimates.

3.1 Calibration

We need to specify values for 10 parameters: 2 technological parameters, α and θ; the depreciation rate δ; 2 parameters describing the process for entrepreneurial talent, γ and η, where $\mu(z) = 1 - z^{-\eta}$; 2 parameters for the labor shock, which is modeled as a two-state Markov chain with symmetric transition matrix, x_l (low realization, with x_h normalized to 1) and π_x (the diagonal element of the symmetric transition matrix); the subjective discount factor β and coefficient of relative risk aversion σ; and the parameter for the imperfections in the conventional financial market, ϕ.

Of these, we fix δ, σ, and the relationship $\alpha/(1/\eta + \alpha + \theta)$ to standard values in the literature. We set δ to 0.06 and σ to 1.5. It can be shown that $\alpha/(1/\eta + \alpha + \theta)$ is the aggregate capital income share with perfect credit markets, which we set to 0.3.[13]

We have 7 remaining "degrees of freedom" (8 parameters but the capital share pins down

[13]In choosing a relatively low capital share we are accommodating the fact that some of the payments to capital in the data are actually payments to entrepreneurial input. We do report a robustness exercise with a higher capital share in Section 5.4.

the above relationship among 3 parameters). We calibrate them to match 7 relevant moments shown in Table 2: the external finance to GDP ratio; the employment share of the decile of largest establishments (in terms of the number of employees); the average establishment size; the share of earnings generated by the top 1 percent of earners; the annual exit rate of establishments; the serial correlation of wages; and the annual real interest rate.

We use these moments from India, a large developing country for which good data exist, specifically nationally representatitve data on firms and households from the Annual Survey of Industries (ASI), the National Sample Survey (NSS), and the 1997 Indian Economic Census. Another rationale for choosing India is that its level of financial development is typical of other developing countries. The ratio of external finance to GDP in India when averaged over the 1990s is 0.34, which happens to be equal to the average ratio across non-OECD countries over the same period in the data assembled by Beck et al. (2000). We target the 1990s because it immediately precedes the explosive proliferation of large-scale microfinance programs, and as microfinance is still small relative to the macroeconomy (see Table 1) even in recent years, we target an economy without microfinance, i.e., $b_{MF} = 0$.

Target Moments	Indian Data	Model	Parameter
Top 10-percentile employment share	0.58	0.58	$\eta = 2.80$
Top 1-percent earnings share	0.27	0.27	$\alpha + \theta = 0.54$
Average establishment size (employment)	2.41	2.40	$x_l = 0.7x_h$
Establishment exit rate	0.05	0.05	$\gamma = 0.93$
Auto-correlation in wages	0.88	0.88	$\pi_x = 0.94$
Interest rate	0.00	0.00	$\beta = 0.85$
External finance to GDP ratio	0.34	0.34	$\phi = 0.15$

Table 2: Calibration

Given the returns to scale, $\alpha + \theta$, we choose the tail parameter of the entrepreneurial talent distribution, $\eta = 2.8$, to match the employment share of the largest 10 percent of establishments in the 1997 Indian Economic Census, 0.58. We can then infer $\alpha + \theta = 0.542$ from the earnings share of the top 1 percent of earners. Top earners are mostly entrepreneurs (both in the data and in the model), and $1 - \alpha - \theta$ controls the fraction of output going to the entrepreneurial input. The average number of employees per establishment is 2.41, and the low realization of the labor productivity shock x_l can be used to match this number, since a lower x_l generates more small-scale "necessity" entrepreneurs. We find $x_l = 0.7$, with x_h normalized to 1. The parameter $\gamma = 0.93$ leads to an annual establishment exit rate of 5 percent in the model, which is the implied annual exit rate from 1994-1995 to 2010-2011 in the ASI and NSS combined.[14] The serial correlation of wages is 0.88 in the ICRISAT

[14]Given available data, we use a slightly longer time period corresponding to avoid cyclical fluctuations.

panel, which pins down the diagonal element of the two-state labor shock transition matrix $\pi_x = 0.5 \times (1 + 0.88) = 0.94$. The model requires a discount factor of $\beta = 0.849$ to match the interest rate of 0%. This equals a real interest rate on savings (nominal minus inflation) and is at the lower end of the real interest rate on government securities. Finally, the external finance to GDP ratio of 0.34 implies $\phi = 0.149$.

3.2 Occupational Choice and Saving with Microfinance

Into this baseline calibrated without microfinance, we introduce microfinance with different sizes, b_{MF}, and interest rate spreads, ν, and compare the outcomes in partial equilibrium, i.e., where the wage and interest rate are held constant at the no-microfinance levels.

Figure 1 illustrates the occupational and saving choices of individuals as a function of their entrepreneurial productivity and wealth, for two alternative values of their productivity as workers. The horizontal axis is entrepreneurial productivity in log and the vertical axis is wealth levels normalized by the equilibrium wage without microfinance (w_0). In the figure we show the choices in the initial stationary equilibrium and how these choices are affected by microfinance interventions with a low spread $\nu = 0.01$. This case corresponds to a subsidized publicly-funded microfinance programs, which is described in detail in the following section.

In the left panel, the four lines represent the threshold combinations of entrepreneurial productivity and wealth for the decision of whether to be a worker or entrepreneur at that point in time for four different cases. The gray lines are for those with low labor productivity (x_l) and the black lines are for those with high labor productivity (x_h). The dashed lines are for the initial stationary equilibrium without microfinance, while the solid lines represent the case with $b_{MF} = 0.34w_0$ and a low (ν=0.01) spread, holding factor prices at the initial stationary equilibrium level. Those to the right of the lines become entrepreneurs, while those to the left of the lines become workers. In a perfect credit economy, occupational choices are independent of wealth, so the fact that the lines slope downward reflects occupational choices distorted by financial frictions: individuals who are less productive as entrepreneur but wealthy become entrepreneurs, while some poorer but more productive (high z) individuals remain workers. As the comparison between the gray and the black lines shows, individuals with a lower opportunity cost of entrepreneurship, i.e., with a lower productivity as worker, require a significantly lower wealth/entrepreneurial productivity to choose entrepreneurship. What is of interest are the shaded areas between the dashed and solid lines, which represent those who switch their occupation from worker

Note also that $1 - \gamma$ is larger than 0.05, because a fraction of those hit by the idea shock chooses to remain in business. This difference is higher in India than the counterpart for the US (Buera et al., 2011) because financial frictions are more severe in India.

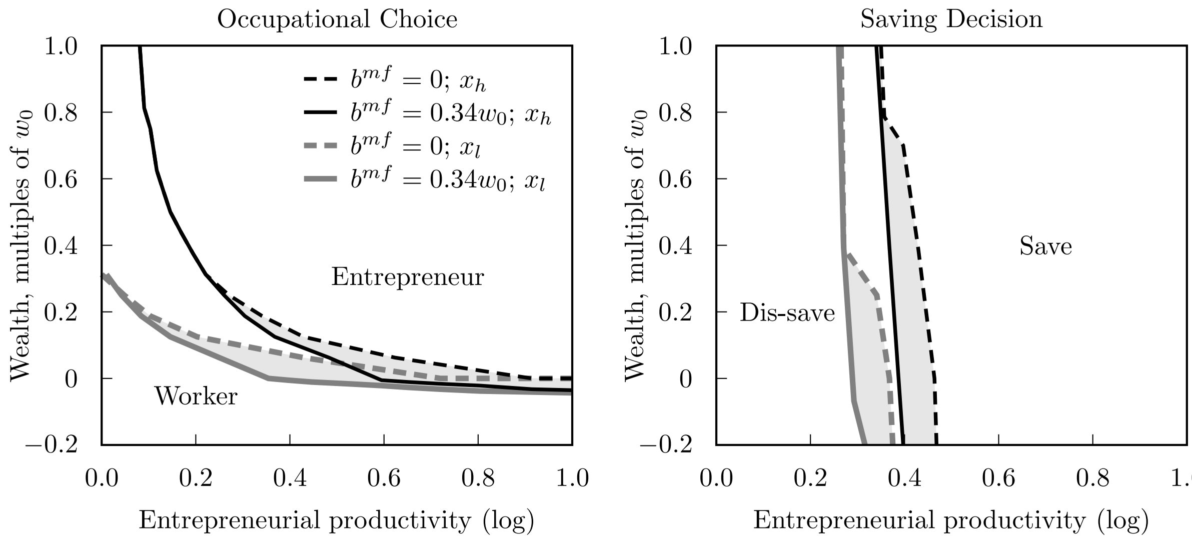

Fig. 1: Occupation Choice and Saving Decision. The left panel illustrates the worker-entrepreneur occupational choice. The right panel illustrates the set of individuals that choose to save in order to eventually become an unconstrained entrepreneur and those that choose to dis-save. Each line demarcates entrepreneurs/savers (right side of the line) and workers/dis-savers (left side of the line) for given wealth (vertical axis, normalized by the equilibrium wage without microfinance, w_0) and entrepreneurial productivity (horizontal axis, log of z). The gray lines are for those with low labor productivity (x_l) and the black lines are for those with high labor productivity (x_h). The dashed lines are for the initial stationary equilibrium without microfinance. In PE, when microfinance with $b^{MF} = 0.34w_0$ is introduced with a 1 percentage point interest rate spread, the occupation choice and saving decision are now represented by the solid lines. The light gray areas show those who switch their occupation choice (left panel) and saving decision (right panel).

to entrepreneur when microfinance is introduced, holding factor prices constant. They are mostly poor individuals with marginal entrepreneurial productivity. Those who are poor but have the highest entrepreneurial productivity run their businesses even without microfinance, partly because our endogenous collateral constraint for traditional capital, $\bar{k}(a, z; \phi, b_{MF})$, is increasing in z. The wealthy are not affected by microfinance since the microfinance limit is negligible relative to their existing wealth.

Although not shown in this figure, the solid lines shift in response to general equilibrium effects. For example, if wages and interest rates rise, the lines shift to the right. These general equilibrium effects will depend on credit spreads, the size of microfinance (b_{MF}), and transitional dynamics, and will be an important factor in our analysis.

The right panel shows a forward-looking threshold: the combination of entrepreneurial productivity and wealth such that individuals are indifferent between running down their assets and saving to become (or remain) entrepreneurs. Saving decisions are much more dependent on individual productivity z than they are on current wealth a, as indicated by how steep the lines are. Again, the gray lines are for those with low labor productivity (x_l)

and the black lines are for those with high labor productivity (x_h). The dashed lines are for the initial equilibrium without microfinance and the solid lines are for $b_{MF} = 0.34w_0$ in PE with a spread of 0.01. Individuals with entrepreneurial productivity and wealth to the left of this threshold are in a "poverty trap" and dis-save:[15] The utility cost of saving and investing to run businesses at efficient scales in the future outweighs the expected gains. The shaded areas between the lines point to those who switch from being dis-savers to savers because of microfinance. In fact, these poor individuals with marginal entrepreneurial productivity are affected by microfinance in a relatively permanent fashion: The small guaranteed credit takes them out of the poverty trap and onto an upward wealth trajectory that will last until they are hit by a sufficiently negative entrepreneurial productivity shock.

3.3 Comparison with Microevaluations

We now compare the predictions of our calibrated model with two recent microevaluations: the urban Indian Spandana study by Banerjee et al. (2015b,a) and the rural Thai Million Baht Village Fund program evaluation by Kaboski and Townsend (2011, 2012). The scale of these programs is small relative to the macroeconomy of either country, and hence a PE analysis is appropriate.[16] In addition, the microevaluations were conducted within a year or two of the launching of the programs, and hence we compare them with the short-run predictions of the model.[17]

These two empirical studies are chosen because they closely examine the patterns most relevant to our model—entrepreneurship, investment, and consumption/saving—but they have very different effective rates of subsidy. The Thai evaluation is representative of highly subsidized, lower-interest village fund microfinance, while the Indian evaluation is fairly representative of high-interest, for-profit microfinance.[18]

The Thai study was a large intervention introducing microfinance into environments where it existed only sparingly. The intervention involved a government transfer of 1 million baht of seed money to each selected rural village for the purpose of founding village lending

[15] Strictly speaking, there is no poverty trap in our model because of the churning introduced by the entrepreneurial productivity process: The parameter controlling its persistence γ is strictly less than 1.

[16] As we discuss below, the Thai program was sizable in that it affected all villages across the country and amounted to 1.5 percent of GDP. Still, 1.5 percent of GDP is not large enough for a meaningful GE effect in our analysis, so we view the PE analysis as providing a reasonable comparison with the Thai studies. Nevertheless, markets for rural villages are somewhat segmented, and for the smallest villages the intervention was relatively large. Significant localized wage effects were indeed detected is such villages (Kaboski and Townsend, 2012).

[17] In the India study, a longer run evaluation (up to 4 years) was done after Spandana began to move into control areas in May 2008. Spandana moved into treatment areas between April 2006 and April 2007.

[18] Cai et al. (2016) evaluate another example of the former, while studies of the latter include Augsburg et al. (2015); Tarozzi et al. (2015); Banerjee et al. (2015b); Angelucci et al. (2015); Attanasio et al. (2011); Crépon et al. (2015); Karlan and Zinman (2011).

funds.[19] Since villages differ in population and the size of economy, 1 million baht was tantamount to more than 25 percent of total annual income in the smallest village but less than 0.2 percent in the largest village, which is an important source of exogenous variation. The average loan sizes were about 20,000 baht, roughly equal to 11 percent of income per worker, and the typical annual nominal interest rates were about 6 percent.

Since impacts are measured as coefficients on continuous variables, we report impacts for the median village. The loans from the injected funds were 2,300 baht per capita (again dividing the total value of loans from this program by the total population size) or roughly 0.1 as a fraction of annual household expenditures. These loans constituted one-third of total credit in the median village. The point estimate of a 4-percentage-point increase in the rate of entrepreneurial entry is statistically insignificant, but the credit did lead to a 56-percent increase in business profits.[20] The injected credit had no measurable impact on the aggregate investment, but it significantly increased the probability of making discrete investments by 47 percent—from 0.11 to 0.15.[21] The credit led to a significant increase in per-capita consumption of 20 percent, with essentially no impact on durable goods consumption, and also an 11-percent increase in income by the end of the second year. These results are summarized in the second column of Table 3, in the "Microevaluation" column. To give a sense of the empirical precisions, we also present 90 percent confidence intervals for these mean normalized impacts constructed using the published results.[22] These confidence intervals are typically wide.

In the second column, labeled "Model", we have results from the simulation of our calibrated model for comparison. We introduce microfinance through the choice of two parameters. We simulate a model with a 1 percentage point interest rate spread on microcredit (i.e., $\nu = 0.01$) to match the difference between microfinance institution and commercial bank rates in the data. Starting from an economy without microfinance, we set $b_{MF} = 0.34w_0$ in order to match the average microloan size relative to income per worker in the data. Finally, we report the changes after 1 period (1 year), capturing the short-run nature of the microevaluation. Although there is evidence of some effects on wages in the data, since we will

[19]The results here are taken from Kaboski and Townsend (2012) with the exception of new business starts and business profits, which are from Kaboski and Townsend (2011).

[20]Buehren and Richter (2010) find a significant increase in the flow of workers to entrepreneurs. Their point estimate is a 5 percentage point increase in entrepreneurship. They use a larger, nationally representative sample, but do not have a baseline nor an instrument to address potential endogeneity.

[21]Kaboski and Townsend (2012) emphasize that a much larger sample is needed to estimate impacts on levels of investment given the infrequent, lumpy investments.

[22]Since the variance-covariance matrices are not available in the published results, we assume a zero covariance term and calculate standard errors using the available published standard errors on treatment effects. That is, to be conservative we ignore the uncertainty about the mean in the control group, i.e., the denominator in the mean normalized impacts.

focus on general equilibrium effects in Section 4.2, we hold initial wages and interest rates fixed here, which is consistent with the relatively small-scale nature of the evaluation in the aggregate economy. (Market clearing conditions are naturally ignored for this reason.)

Thailand	Microeval.	Model
Microloan credit spread	1%	1%
Avg. microloan size to GDP per worker (targeted)	0.11	0.11
Total microcredit relative to total expenditures	0.10	0.08
Total microcredit relative to total credit	0.23	0.26
Consumption	+20% [+3%,+37%]	+8%
Entrepreneurship	+4 p.p. [-1 p.p.,+9 p.p.]	+3 p.p.
Investment	-8% [-67%,+51%]	+41%
Investment prob.	+47% [+29%,+65%]	

Table 3: Short-Run PE Model Prediction vs. Microevaluation in Thailand. The microcredit limit in the model ($b_{MF} = 0.34w_0$) matches the average microloan size relative to per-worker GDP in Thailand. The 1 p.p. credit spread is the difference between the lending rates of microfinance institutions and commercial banks in the data. The five moments below them are not targeted. For the model, we report the change after one period, holding the initial equilibrium prices fixed, which is consistent with the short-run PE nature of the microevaluation. Since the variance-covariance matrices are not available in the published results, to calculate confidence intervals for percentage increases we assume that the baseline (control) values (in the denominator) are known and calculate standard errors from the available published standard errors on treatment effects. Our ignoring uncertainty in the denominator underestimates the interval width.

The model predictions are in line with the microevaluation. In all cases, the simulated results capture the signs of significant empirical impact estimates, and all of the results fall well within the confidence intervals of the empirical estimates, although the point estimates are off for consumption and investment. The simulated amount of total microcredit is slightly smaller than in the data when normalized by total expenditures (0.08 vs. 0.10), but slightly larger when normalized by total credit (0.26 vs. 0.23). The model predicts a milder increase in entrepreneurship (3 percentage points vs. 4 in the data). It also shows a short-run increase in investment. In the data, the point estimate on the overall impact on the level of investment is negative, but not precisely estimated. The impact on the probability of investing is better estimated empirically and has a similar order of magnitude (41 percent in the simulation vs. 47 percent in the data). Both the model and the data show an increase in consumption, though the point estimate is smaller in the model (8 percent vs. 20 percent in the data). In the model, about half (51 percent) of microfinance loans are used for consumption, and the rest for investment. (There is no data counterpart to this moment.)

The Indian study involves a randomized expansion of MFI branches across different neighborhoods in Hyderabad. The follow-up survey was conducted about 18 months after loans had been disbursed. The interest rates on microcredit were relatively high, with a spread of 12 percent relative to the commercial bank rates in India. The baseline level of microcredit in the data (from all MFIs) amounted to 2,400 rupees per capita (i.e., total microcredit loan value divided by the population size, including both borrowers and non-borrowers), or about 4 percent of total credit. (The per-capita numbers in the empirical studies are actually per adult equivalent.) The randomization led to an increase of roughly 1,300 rupees of microcredit per capita. After accounting for the increase in total credit, microcredit amounted to 6 percent of total credit after the intervention. In that sense, the intervention was small relative to the Thai intervention.

Though insignificant, the point estimates of the effect of loans on entrepreneurship is positive: Households in the treatment group were 1 percentage point more likely to open a new business from a baseline of 5 percent. The impacts on the revenues, assets, and profits of existing business owners were positive but statistically insignificant. However, the loans did produce a significant increase in durable goods purchases of 17 percent, some of which might have been purchased for business purposes, and a significant increase in businesses investment of 140 percent. The effect on total consumption expenditure is small and insignificant.[23] Even when significantly different from zero, however, the confidence intervals are wide. These results are summarized in the first column of Table 4.

We again simulate our calibrated model and present the results in the second column of Table 4. We focus on impacts one-period out, and we keep the wage and interest rate constant at their initial levels. Although the intervention is somewhat different, we again capture it using the parameters ν and b_{MF}. Given the relatively small increase in microcredit compared to existing microcredit, we simulate an increase in available microfinance from $b_{MF} = 0.1w_0$ to $b_{MF} = 0.15w_0$. With $\nu = 0.12$ we capture the higher interest rates on this for-profit microcredit. Together, these yield an increase in microcredit relative to total credit from 0.04 to 0.06 as in the data.

Although not targeted, the results from the model are not out of line with the microevaluation. They are not always on top of the microevaluation point estimates, but they

[23]The null effect on total consumption expenditure is explained by the fact that the increase in durables is compensated by large (and statistically significant) declines in the expenditure in temptation goods, and festivals and celebrations.

India	Microeval.	Model
Micro loan credit spread	12%	12%
Total microcredit relative to total credit (targeted)	$0.04 \rightarrow 0.06$	$0.04 \rightarrow 0.06$
Total microcredit relative to total expenditures	+1.8 p.p.	+1.1 p.p.
Consumption	+1% [-3%,+5%]	+1%
Entrepreneurship	+1 p.p. [-3 p.p., +5 p.p]	+1 p.p.
Investment		
Business investment	+140% [+15%, +265%]	+9%
Durables	+17% [+1%,+33%]	

Table 4: Comparison of Short-Run PE Model Prediction vs. Microevaluation in India. The Indian study reports the effect of the expansion of one of several microfinance institutions. To be consistent, the model computes the result of raising b_{MF} from $0.1w_0$ to $0.15w_0$, which raises the ratio of total microcredit to total credit from 0.04 (control group at endline) to 0.06 (treatment group at endline). The 12 p.p. spread is the difference between the lending rates of microfinance institutions and commercial banks in the data. Since the variance-covariance matrices are not available in the published results, to calculate confidence intervals for percentage increases we assume that the baseline (control) values (in the denominator) are known and calculate standard errors from the available published standard errors on treatment effects. Our ignoring uncertainty in the denominator underestimates the interval width.

fall inside the 90% confidence intervals, except for investment. The relatively small intervention leads understandably to smaller impacts than in the Thai case, even a bit smaller in the model. Specifically, the simulation predicts a smaller increase in microcredit relative to total expenditures (1.1 vs. 1.8 percentage points) and investment (9 vs. 17 percent in durable goods, which may be used for business purposes, and 140 percent in business investment), but the same increase in entrepreneurship (1 percentage point) and consumption (1 percent). In the model, because of the higher interest rate spread, only one-third of microfinance loans are used for consumption in the baseline ($b_{MF} = 0.1w_0$). With the expansion to $b_{MF} = 0.15w_0$, a slightly smaller fraction (30 percent) of the additional microfinance loans is used for consumption, so in the end 32 percent of microloans are used for consumption.

Banerjee et al. and Kaboski and Townsend, together with many other evaluations, emphasize the heterogeneous impacts of microfinance across the population. Take-up of microfinance is relatively low and concentrated among a small segment of the population, although it is somewhat more widely used in the case of village funds where interest rates are lower. Moreover, studies find that marginal entrepreneurs and investors are more likely to decrease consumption, in order to increase investment, while others are more likely to simply increase consumption.[24]

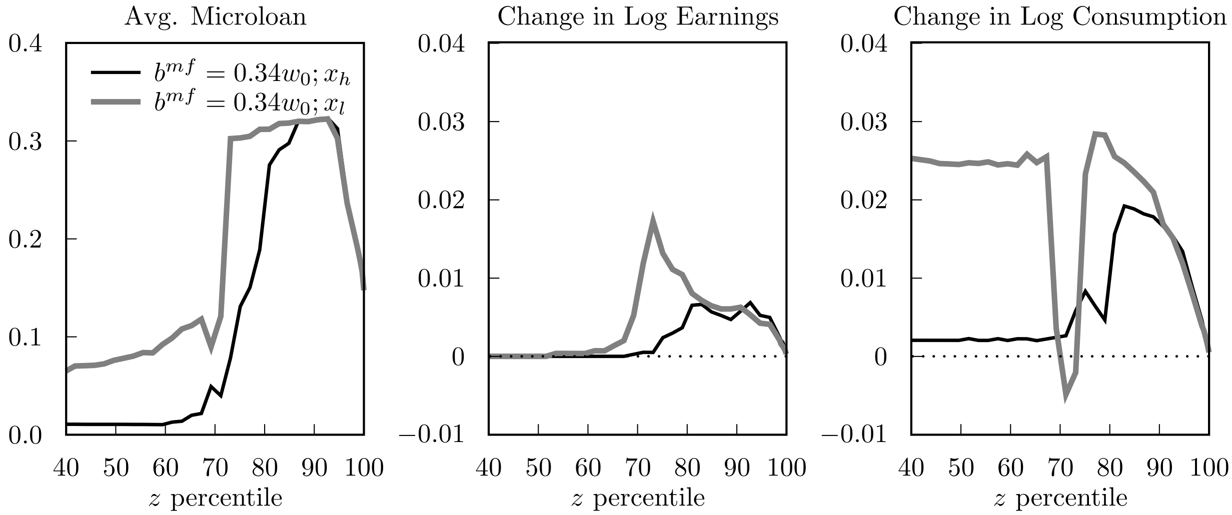

Fig. 2: Short-Run PE Effect of Microfinance by Entrepreneurial Productivity. The horizontal axes are the percentiles of z. The left panel shows the average microcredit loan relative to the initial wage for given z's (integrated over wealth, including those not using microfinance). The center panel shows the change in income (in log), and the right panel shows the change in consumption (in log). The microfinance limit is $b_{MF} = 0.34w_0$ and the spread is 12 percentage points. The gray lines are for low labor productivity (x_l), and the black line are for high labor productivity (x_h).

We demonstrate the heterogeneous impacts on credit, income, and consumption in our model in Figure 2, across individuals with different entrepreneurial productivity, and for two values of individual's worker productivity. We use the microfinance expansion $b_{MF} = 0.34w_0$, a conservative value relative to the MIX data presented in Section 1.1, and consider the spread in our benchmark exercise (12 percentage points). For a given z level, we integrate over the conditional wealth distribution, including even those who do not use microfinance. The gray lines are for low labor productivity (x_l), and the black lines are for high labor productivity (x_h). The positive impacts on income and consumption are larger for the individuals with the low labor productivity, since their microcredit usage is higher, but both cases show heterogeneous impacts across the z distribution. The much larger effect on credit usage (average microloans) and consumption for those with low labor and entrepreneurial productivities reflects their use of microfinance as consumption loans. For both credit usage and income, the impacts are concentrated among marginal productivity individuals, around the 70th percentile. Some of these marginal borrowers exhibit substantially smaller or even

[24]While Banerjee et al. look at marginal entrepreneurs in the data, Kaboski and Townsend have individuals on the margin of making discrete investments.

negative impacts on consumption. They are the ones who switch from dis-saving to saving in Figure 1: Their increased income goes into saving and investment, not consumption. This result is consistent with the findings in Kaboski and Townsend (2011). The impact of microfinance on income among the marginal entrepreneurs tends to be larger for the individuals with a low labor productivity. This is because they choose entrepreneurship at lower levels of wealth (left panel, Figure 1), and also because it is harder for them to accumulate wealth in anticipation of becoming entrepreneurs and, therefore, they tend to be more constrained when operating a business.

The concentration of the impact on marginal entrepreneurs manifests itself in another way as well. Our India exercise predicts that new entrants under expanded microfinance have 0.18 fewer workers on average (not shown in Table 4). This is similar to the finding of Banerjee et al. (2015b) that new entrants under expanded microfinance employ 0.2 fewer workers on average. Banerjee et al. also find that new entrants with microfinance are concentrated in small-scale, low fixed-cost industries, which we replicate in Section 5.3 using a two-sector version of our model.

In sum, although certainly not perfect, the mechanisms in the calibrated model matches the overall direction and the magnitudes of the impacts of microfinance documented in microevaluation studies. Moreover, these impacts are heterogeneous across individuals in ways that are consistent with the empirical evaluations. In the next section, we compare the simulation results for the short-run partial equilibrium with those for short and long-run general equilibrium. Almost by definition, microevaluations are not easily applicable to longer-run general equilibrium effects. They call for a dynamic macro modeling, and the model's short-run partial equilibrium predictions that are consistent with microevaluations give a degree of credence to its long-run general equilibrium predictions.

4 Main Results

We now present a quantitative exploration of the aggregate and distributional impact of microfinance for various credit limits on microloans, b_{MF}. We compare short-run, long-run, partial equilibrium, and general equilibrium counterfactuals. For expositional purposes, we focus our analysis on the case of the high interest rate spread ($\nu = 0.12$, the Indian case) on microloans, and consider the lower interest rate spread (the Thai case) in Section 5.1. This choice reflects the idea that highly subsidized microfinance may not be scalable to the macroeconomy.

4.1 Short-Run, Partial Equilibrium Impact of Microfinance

Figure 3 shows the major aggregates for the short-run, partial equilibrium simulations. Although these simulations closely follow the results discussed in Section 3.3, we go through them again for the sake of clarity and easier comparison.

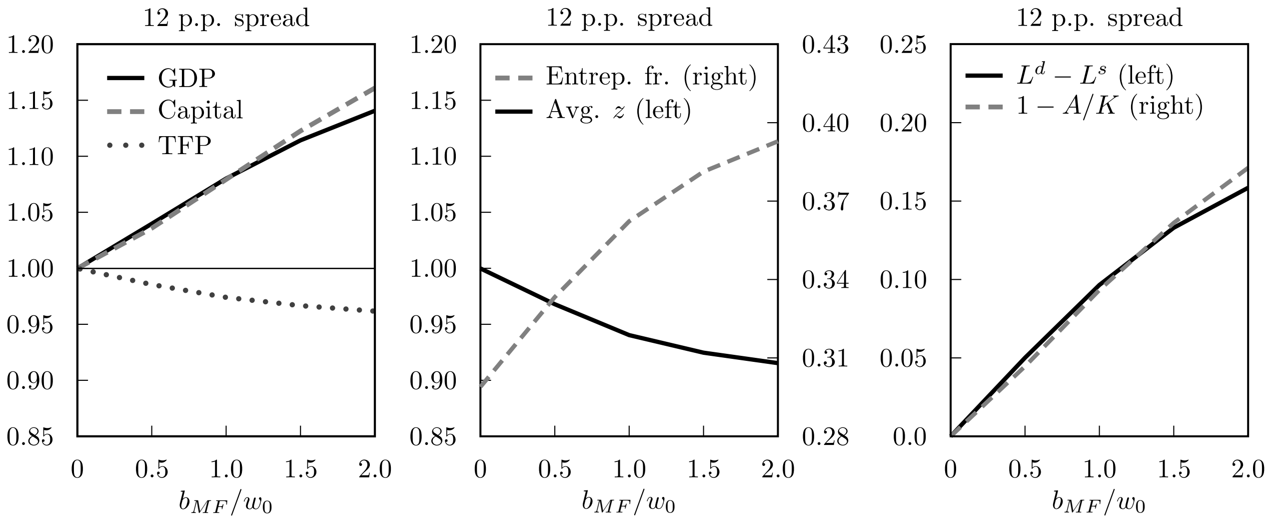

Fig. 3: Short-Run Effect of Microfinance in Partial Equilibrium. With a 12 p.p. spread on microloans and varying b_{MF} as multiples of the no-microfinance wage (horizontal axis). GDP, capital, TFP, and average z of active entreprenerus are normalized by their respective values in the initial stationary equilibrium without microfinance. Wage w and interest rate r are held constant at their no-microfinance levels. The dashed line in the right panel plots the fraction of productive capital owned by those outside the economy. The solid line in the right panel is the excess demand of labor (or workers from outside the economy), relative to the population size.

In the left panel of Figure 3, we show aggregate output, capital, and TFP for various levels of b_{MF}. Aggregate output here follows the GDP concept, inclusive of the contribution of the production factors from outside the economy, as the markets do not clear in partial equilibrium. No outside entrepreneur is allowed into the economy, though. The horizontal axis is b_{MF} divided by the equilibrium wage in the no-microfinance economy, which ranges from 0 to 2, consistent with the evidence in Section 1.1. The aggregate quantities are normalized by their respective levels in the $b_{MF} = 0$ equilibrium. The pattern is clear: Both capital and output increase monotonically with microfinance limit, by up to 16 percent. In contrast, total factor productivity (TFP) decreases by as much as 4 percent.

The center panel partly explains this decrease in TFP, although not in the expected way. In theory, TFP is determined by both the intensive margin (the allocation of capital across entrepreneurs) and the extensive margin (the set of entrepreneurs operating). The extensive margin can be further decomposed into the number of entrepreneurs and their productivity.[25] As shown in the center panel, the larger the microfinance limit (b_{MF}), the more entrepreneurs find it favorable to enter, and the fraction of entrepreneurs increases by up to 10 percentage points (dashed line, right scale). With decreasing-return-to-scale production for an entrepreneur, the rise in entrepreneurship leads to a higher measured aggregate TFP. However, with more entry of entrepreneurs, the average productivity level of active entrepreneurs falls, by as much as 8 percent (solid line, left scale), which reduces TFP. These two effects roughly cancel out and the extensive margin does not contribute to the drop in TFP. Instead, the decline in TFP is almost entirely accounted for by the increase in the fraction of capital allocated to relatively unproductive entrepreneurs, those marginal, less wealthy entrepreneurs who disproportionately benefit from microfinance.

The right panel shows that, when microfinance is present but prices do not adjust, the demand for capital K exceeds its supply (assets, A). Similarly, the demand for labor increases relative to the supply of labor (which drops as more individuals become entrepreneurs). In partial equilibrium, the additional capital and labor must come from outside the economy.[26]

In summary, in the short-run partial equilibrium, microfinance can have substantial impacts on business starts and capital input, leading to a significant increase in aggregate output. It requires an inflow of both labor and capital from outside the economy, however. Moreover, the overall efficiency of production suffers, because microfinance eventually leads to the entry of less productive entrepreneurs and a larger fraction of aggregate capital gets allocated to them. We show in the following section that these conclusions are substantially altered in general equilibrium.

4.2 General Equilibrium Impacts of Microfinance

Before we discuss the long-run GE effects of microfinance, we start by introducing the short-run (after one period) GE impacts, for various values of microcredit limit b^{MF}. The short-run results shown in Figure 4 are quite different from those from short-run PE. First, the aggregate impacts are quite muted relative to the impacts in PE, with output, for example, rising by at most 3 percent rather than 14 percent. Second, the impacts on TFP and capital are reversed. TFP actually increases in GE by up to 3 percent, while capital falls slightly. The fall in capital reflects a small decrease in asset holdings, as the aggregate saving declines in response to the availability of microfinance.

The center and right panels of Figure 4 give an insight into the increase in TFP. As expected, in order to clear the capital and labor markets, the wage and interest rates rise,

[25] This decomposition formula is in Appendix A.

[26] Since we use the GNP concept, not GDP, the increased labor payments do not show up in the income measures we report in Section 3.3.

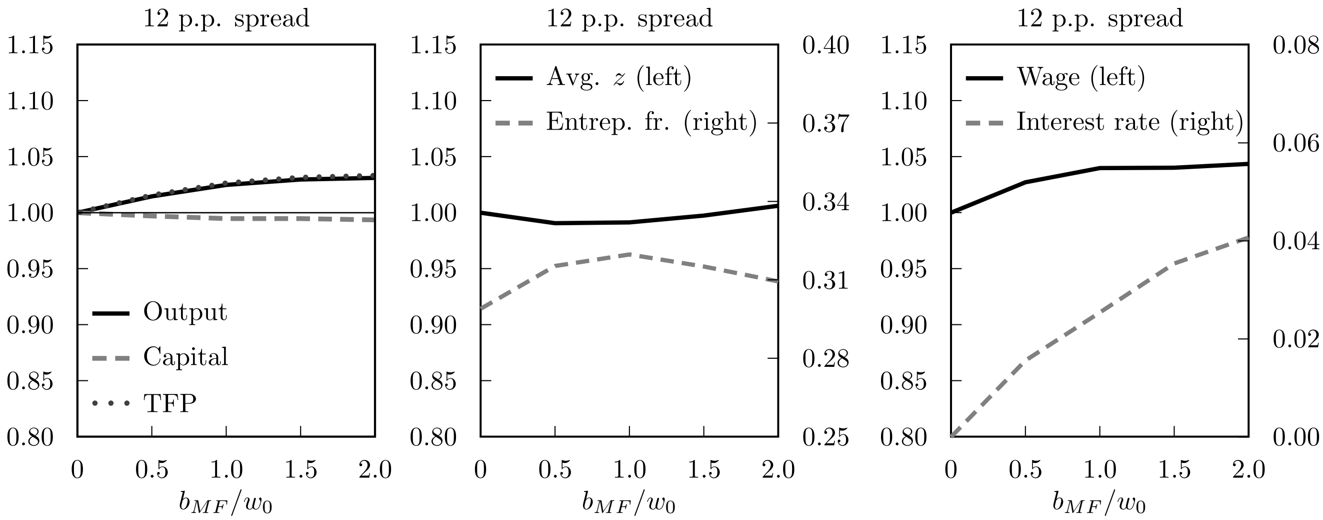

Fig. 4: Short-Run Effect of Microfinance in General Equilibrium. With a 12 p.p. spread on microloans and varying b_{MF} (horizontal axis). Output, capital, TFP, average z of active entreprenerus, and wage are normalized by their respective values in the initial stationary equilibrium.

as shown in the right panel. For large values of b_{MF}, interest rates rise by more than 4 percentage points, and wages by more than 4 percent. In the center panel, we see that the higher interest rates and wages dampen the impact along the extensive margin: The fraction of entrepreneurs in the population is non-monotonic with respect to b_{MF} and increases by no more than 2 percentage points, compared to 10 percentage points in PE. Moreover, the average productivity of those who enter remains stable, which implies that the increase in TFP is driven by the larger number of entrepreneurs and the better allocation of capital across them on the intensive margin.

The decrease in saving and its impact on capital in GE become substantially more important in the long run than in the short run, as the effect accumulates over time. Figure 5 presents the long-run results (i.e., new stationary equilibria). In the left panel, the decline in capital now becomes substantial, up to 8 percent of the initial capital stock. Output itself remains stable, however, since TFP increases as in the short-run GE case. Indeed, as the middle panel shows, the average entrepreneurial productivity actually increases modestly (solid line, center panel), because the higher interest rate (dashed line, right panel) deters the entry of less productive entrepreneurs and in general people have less wealth. The increase in interest rate is even larger in the long run, up to more than 5 percentage points, as capital becomes scarcer in the long run.

In sum, in GE, the impact of microfinance on entry is dampened by higher factor prices. Moreover, it leads to a decrease in capital, more so over time. In the long run, the increases in output are negligible, because the higher TFP offsets the fall in capital.

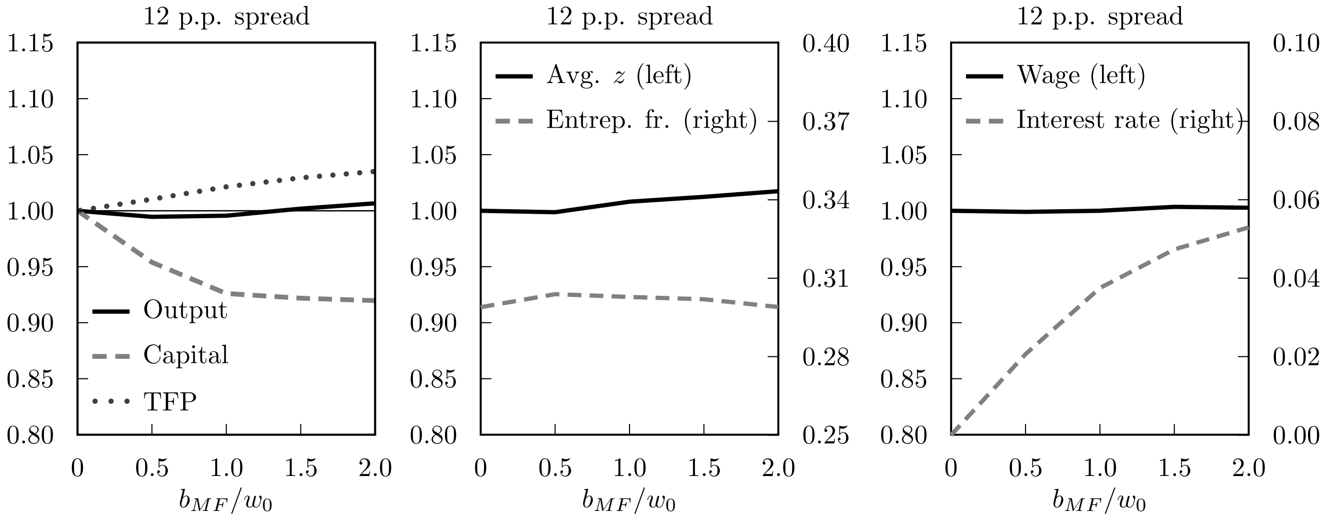

Fig. 5: Long-Run Effect of Microfinance in General Equilibrium. With a 12 p.p. spread on microloans and varying b_{MF} (horizontal axis). Output, capital, TFP, average z of active entrepreneurs, and wage are normalized by their respective values in the initial stationary equilibrium.

Of course, if output remains more or less constant but savings is lower in the stationary equilibrium, there is clearly a consumption increase that comes from microfinance, even in GE. Moreover, along the transition path, consumption is even larger because output is still higher but saving rates have fallen. Together, these lead to welfare gains.

The welfare gains are not evenly distributed, however, and the GE effects matter for the distribution of gains. Figure 6 shows the distribution of welfare gains across the wealth distribution (left panel) and the entrepreneurial and labor productivity distribution (right panel) in the initial period.[27] We present these gains for the case of $b_{MF} = 0.34w_0$, a conservative value relative to the MIX data presented in Section 1.1, and 12 p.p. spread. The gains are measured in equivalent consumption units, i.e., as the additional permanent fraction of consumption that would compensate the individual in the economy without microfinance. The dashed lines represent the long-run gains in PE, and the long-run gain in GE are illustrated by the solid lines. In the right panel, the black lines are for those with high labor productivity x_h at $t = 0$, and the gray lines are for low labor productivity x_l at $t = 0$. The economy is initially in the no-microfinance stationary equilibrium, and the microfinance is introduced unexpectedly at $t = 0$. The welfare calculations properly account for the transitional dynamics.

The figure shows that nearly everyone gains from microfinance.[28] In partial equilibrium,

[27] In the left panel, for a given wealth level, expected utility is integrated over the conditional distribution of entrepreneurial and labor productivity. In the right panel, for a given entrepreneurial and labor productivity, expected utility is integrated over the conditional wealth distribution.

[28] Microfinance cannot make anyone worse off in PE, where wages and interest rates are held constant. In GE, some productive entrepreneurs may be worse off because higher wages and interest rates reduce their

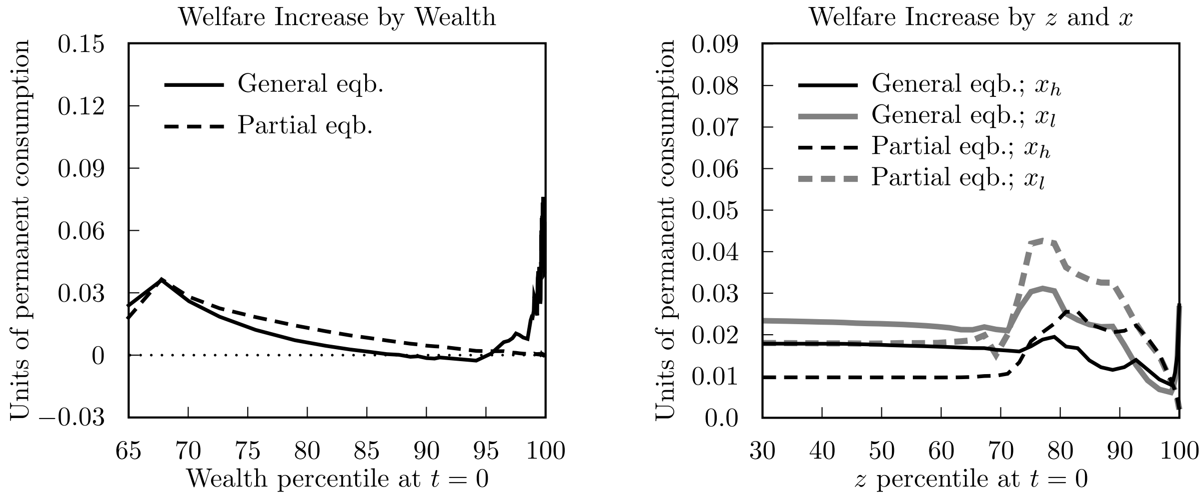

Fig. 6: Welfare Gains with Microfinance, by Wealth and Individual Productivity. The horizontal axis in the left (right) panel is the wealth (entrepreneurial productivity) percentiles in the initial equilibrium without microfinance. The vertical axis is the welfare gains from microfinance in units of permanent consumption, properly accounting for the transition dynamics. In the left panel, for each wealth level, the conditional entrepreneurial and worker productivities are integrated out. In the right panel, we separate high labor productivity (x_h, black lines) and low labor productivity (x_l, gray lines). We consider microcredit with $b_{MF} = 0.34w_0$ and 12 p.p. spread. In both panels, the solid lines are for GE and the dashed lines for PE.

the gains are largest for the relatively poor (gray line, left panel) and those with low labor productivity and marginal entrepreneurial productivity (i.e., x_l and between the 75th and 90th percentiles of z; dashed lines, right panel) when the microfinance is introduced ($t = 0$). The poor gain because their current consumption constraint is relaxed by the consumption loan dimension of microfinance. The marginally productive gain more because their consumption, occupation, and production decisions are affected by more in relative terms: For a highly productive entrepreneurs with large scales of operation, microfinance is too small to meaningfully affect their credit constraints. This relaxation of the capital constraint matters more for those with low labor productivity (x_l, gray dashed line, right panel), since they are more likely to be entrepreneurs with even more marginal values of z due to their lower earnings as worker, and less likely to have accumulated wealth when they were workers.

In GE, the marginally productive entrepreneurs do not gain as much—in the right panel, the gray solid and the black solid lines are below the gray dashed and the black dashed lines, respectively, approximately above the 70th percentile of z. This is because the higher factor prices reduce their entrepreneurial profits and discourage them from becoming entrepreneurs, especially during the transition. Those with low entrepreneurial productivity, to the contrary,

profits, although this gets offset by higher interest income on their wealth (solid line, right end of left panel). Figure A1 in Appendix B shows the set of individuals made worse off by the introduction of microfinance.

benefit more from microfinance in general equilibrium than in partial equilibrium—the black and gray solid lines are above the black and gray dashed lines, respectively, approximately below the 70th percentile of z. This is because the wage is higher during the transition in general equilibrium, as seen in the left panel of Figure 4, raising the earnings of those with low entrepreneurial productivity (especially when their labor productivity is high), who are likely to be workers.

However, the very wealthy benefit more than anyone else in general equilibrium (solid line, left panel), since higher interest rates mean higher returns on wealth. For the most productive entrepreneurs, their production decision is not directly affected by microfinance because microfinance is too small compared to their scale of operation and also because they tend to be wealthy and financially unconstrained. However, the higher interest rates on their wealth benefit them. This explains the divergence between the black and gray lines in the top percentiles of z (right panel).

In sum, we find substantial welfare gains, especially for the poor (more in general equilibrium because of higher wages) and the marginally productive entrepreneurs (less in general equilibrium because of higher factor prices). In addition, the higher interest rate in general equilibrium benefits the very wealthy significantly, through higher returns on their wealth.

5 Extensions and Robustness Checks

In this section, we consider the robustness of our results by working out variants of our benchmark model, including lower interest rate spreads (possibly subsidized microfinance), a small open economy, and alternative parameterizations.

5.1 Low Interest Rate Microfinance

In general, microfinance interest rates exceed the interest rates of commercial banks and other formal financing channels, which may reflect higher intermediation costs. However, some microfinance is also heavily subsidized. The Thai village fund program simulated in Section 3.3 is one example. We extend that simulation, where the interest rate spread was 1 p.p. ($\nu = 0.01$), in this section.

The long-run aggregate results in GE are presented in Figure 7. The patterns are similar to the results with the higher interest rate microfinance (Figure 5) in some dimensions, but there are a few notable exceptions. With a lower spread of microloans, there is substantially more borrowing for current consumption. Thus, the decline in saving and capital is much more dramatic, with capital in the steady state as much as 20 percent lower (dashed line, left panel), and interest rates rising as much as nearly 9 percentage points (dashed line, right

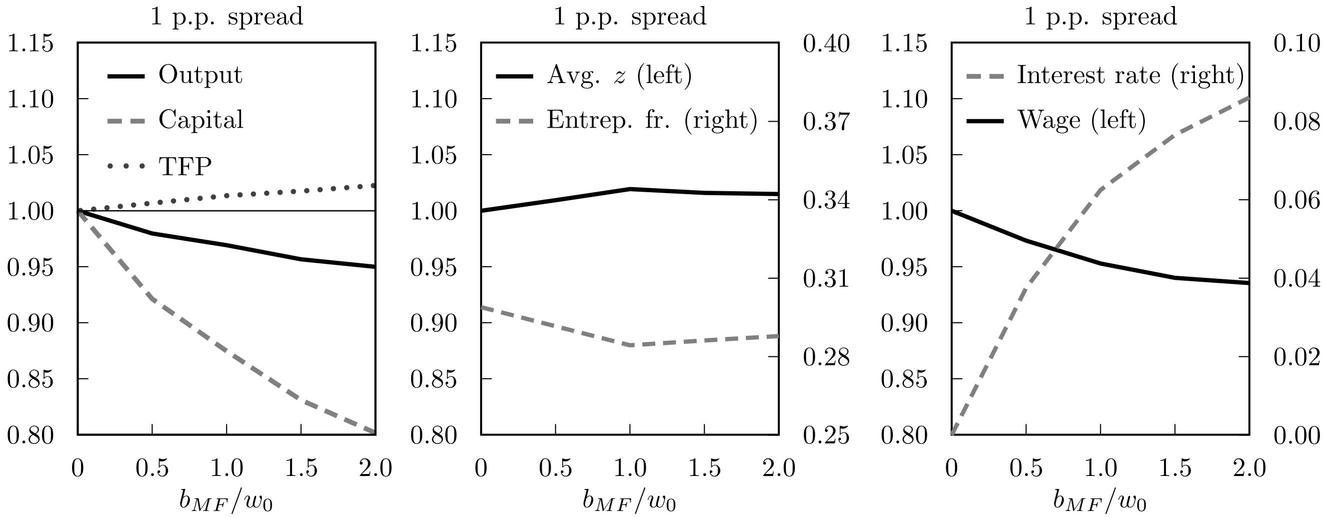

Fig. 7: Long-Run GE Implications of Low Interest Rate Microfinance. This figure is the 1 p.p. spread counterpart to Figure 5. Output, capital, TFP, average z of active entrepreneurs, and wage are normalized by their respective values in the initial stationary equilibrium.

panel). The corresponding figures with 12 p.p. spread are 8 for capital and 5 for interest rate. The higher equilibrium interest rates limit entry into entrepreneurship in the long run, which actually falls (dashed line, center panel). Although average productivity of entrepreneurs still increases, the net effect results in smaller TFP gains, about half the gains in the higher spread benchmark. The steep drop in capital and smaller gains in TFP together lead to a substantial *decline* in total output (solid line, left panel) and wages (solid line, right panel) in the long run, of up to 5 and 6 percent, respectively. The entrepreneurship rate drops despite the lower wages because of the decreased asset holdings, which is an important determinant of occupational choice (Figure 1). Because of the lower saving rates and asset holdings on average, credit constraints on the extensive and intensive margins of entrepreneurship bind more in the stationary equilibrium with microfinance than in the one without.

The distribution of welfare gains in this economy are shown in Figure 8, again for the case of $b_{MF} = 0.34w_0$. The distribution of welfare gains has some similarity with that from the higher interest rate microfinance (Figure 6)—for example, in partial equilibrium, the poor and the marginal entrepreneurs are more directly impacted by microfinance and hence benefit more from it than others. However, there are notable differences. First, the overall gains are larger, which is predictable, since the microfinance technology is better in the sense that the intermediation costs ν for producing microfinance is lower. Second, going from partial equilibrium to general equilibrium, the welfare gains tilt away more from the poor to rich (left panel) than in the 12 p.p. case: An even larger interest rate increase translates into a higher return on wealth. In fact, unlike in Figure 6, except for the very

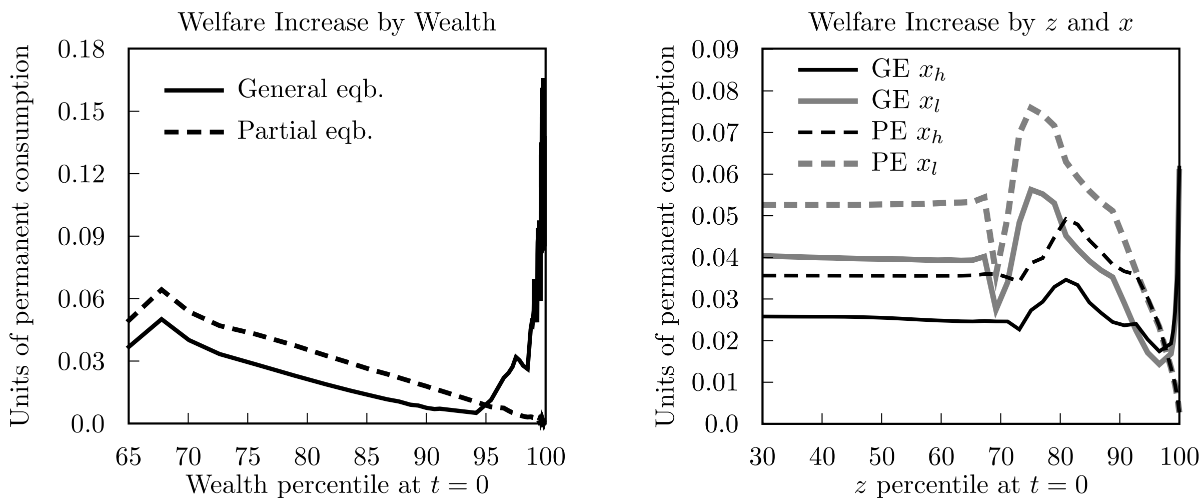

Fig. 8: Welfare Gains with Microfinance, by Wealth and Individual Productivity. The horizontal axis in the left (right) panel is the wealth (entrepreneurial productivity) percentiles in the initial equilibrium without microfinance. The vertical axis is the welfare gains from microfinance in units of permanent consumption, properly accounting for the transition dynamics. In the left panel, for each wealth level, the conditional entrepreneurial and worker productivities are integrated out. In the right panel, we separate high labor productivity (x_h, black lines) and low labor productivity (x_l, gray lines). We consider microcredit with $b_{MF} = 0.34w_0$ and 1 p.p. spread. In both panels, the solid lines are for GE and the dashed lines for PE.

wealthy, nearly everyone is better off in partial equilibrium than in general equilibrium. For the low productivity individuals, this is because of the lower wage in general equilibrium in the longer run, and for the marginal entrepreneurs, this is because of the much higher user cost of capital in general equilibrium.

5.2 Small Open Economy

We have focused on the full general equilibrium, where the change in interest rates has important aggregate and distributional impacts. Many developing countries are small and relatively open to capital inflows. Moreover, many sources of microfinance capital in developing countries are from abroad. We therefore consider the case of a small open economy that faces a fixed interest rate at which it can borrow and lend internationally to make up for any capital shortfall or surplus. We stick with the high spread case ($\nu = 0.12$), since highly subsidized microfinance is likely less scalable to the macroeconomy.

Figure 9 shows the results. The long-run impacts of microfinance on aggregate outcomes are small but negative, around 1 percent drop in capital, output, and TFP for $b_{MF} = 2w_0$. It may be surprising that capital falls, since the interest rate remains constant now and microfinance increases capital in the short-run partial equilibrium case (Figure 3). In this

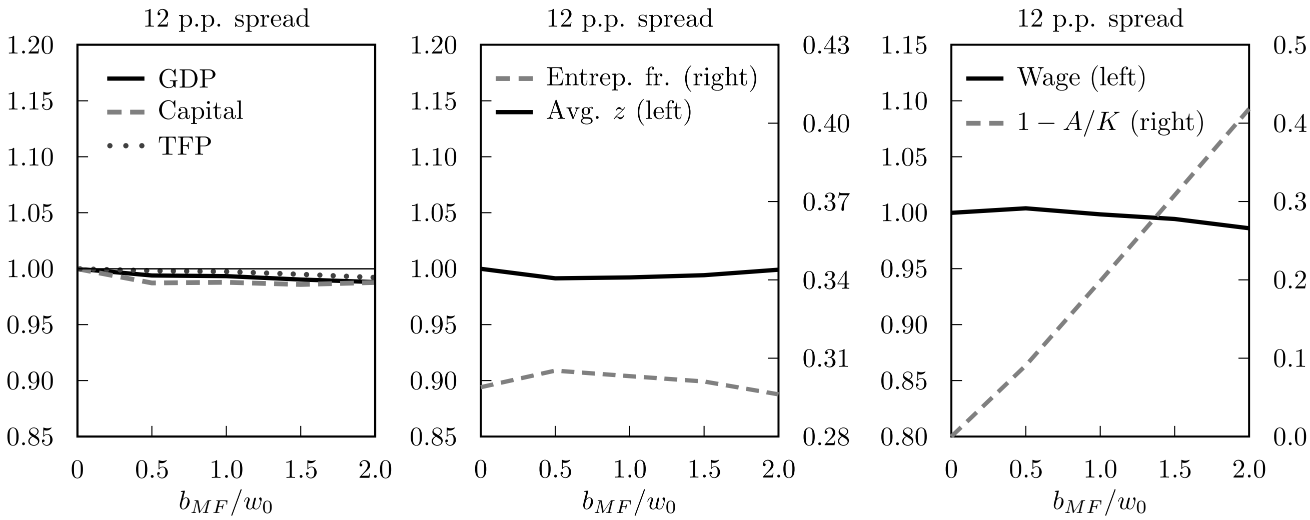

Fig. 9: Long-Run Effect of Microfinance for a Small Open Economy. With a 12 p.p. spread on microloans and varying b_{MF} (horizontal axis). Output, capital, TFP, average z of active entreprenerus, and wage are normalized by their respective values in the initial equilibrium without microfinance. The interest rate r is held constant at its no-microfinance level, unlike in GE. The dashed line in the right panel plots the fraction of productive capital owned by those outside the economy (right scale).

extension the relevant GE effect is on wages, which increase by more in the short run. The profits of productive entrepreneurs, and their accumulation decisions, are therefore affected. In the long run, less wealth (assets) is accumulated, and assets affect the demand for capital via the endogenous collateral constraint on capital rental. Thus, even when the interest rate is fixed, aggregate capital falls. In the long run wages fall slightly relative to the initial stationary equilibrium, as do the number of entrepreneurs and the average entrepreneurial productivity. In any case, the conclusion that microfinance does not have strong aggregate effects on output in GE is robust to the small open economy assumption.

5.3 Other Extensions

We offer a brief summary of two other extensions we have worked out. First, we explore even more heavily subsidized microfinance, which relates to the narratives of microfinance as quasi "grants" coming from international sources or donors.[29] Until now, we have modeled microfinance as a financial innovation that guarantees *access* to and *repayment* of small loans. In this extension, we ask which element is more responsible for the aggregate and distributional impact of microfinance in our benchmark. To pursue this, we relax full repayment by considering a version in which microfinance borrowers do not need to pay the full rental cost of capital nor the full principal of the consumption loan. Specifically, we

[29]See the discussion in chapter 9 of Armendariz and Morduch (2005).

assume that no rent is paid and only 90 percent of the undepreciated capital or principal is returned—in the context of our benchmark formulation, this means that the spread is negative: $\nu = -(r + \delta + 0.1)$.

Here we work with a small open economy version, given the motivation for this exercise. The immediate implication of this grant-like microfinance is that it has more direct and forceful redistributional effects favoring its users than the subsidized microfinance in Section 5.1. The direct beneficiaries are marginal entrepreneurs, raising the number of entrepreneurs. In the long-run small open economy equilibrium, with $b_{MF} = 2w_0$, the fraction of entrepreneurs increases by 3 percentage points and the average productivity of active entrepreneurs falls by 5 percent (the change was nearly zero for both variables in Section 5.2). This in effect is a redistribution of income from high-savers (high productivity entrepreneurs) to low-savers (marginal entrepreneurs), and together with the higher demand for subsidized consumption loans, it substantially reduces aggregate saving rates. In the long run, although the supply of capital is perfectly elastic for the small open economy, via the endogenous collateral constraint, the lower aggregate asset accumulation leads to lower aggregate capital and lower output (GDP): 4-percent and 3-percent drops respectively with $b_{MF} = 2w_0$ (the corresponding changes were around 1 percent in Section 5.2 for both output and capital). In summary, relaxing the full repayment requirement of microfinance loans leaves the general lessons from the benchmark analysis intact, although the redistributional effects are further strengthened by the explicit subsidy or grant-like nature of microfinance. This finding also suggests that modeling the exact mechanism through which microfinance programs attain high repayment rates (e.g., joint liability, community sanctions, high-frequency repayment schedule, dynamic incentives and so on) may not be crucial for our results.

For the second exercise, we consider a model with a large-scale sector and a small-scale sector. While small-scale establishments are pervasive in developing countries, especially in the service and informal sectors, large-scale establishments (measured by number of employees) dominate certain sectors of the economy such as manufacturing—investment goods production in particular—and less developed countries tend to have lower relative productivity and higher relative prices in these sectors (Hsieh and Klenow, 2007; Buera et al., 2011). This model introduces another general equilibrium channel: the relative price between large-scale sector output and small-scale sector output.[30]

We assume that there are fixed operation costs in the large-scale sector, which implies that the minimum profitable scale of operation in this sector is larger than in the other

[30] One can also think of our benchmark model with labor productivity shock as a two-sector model, in the sense that there are "necessity entreprenuers" (those with low labor productivity), who operate at small scales, and the others who operate at larger scales. In the benchmark model, however, they produce the same goods, and the relative goods price channel does not exist.

sector. With financial frictions, individuals will need much more collateral (wealth) to operate profitably in the large-scale sector than in the small-scale sector. The key result for this extension is that the effects of microfinance are strikingly non-linear and even non-monotone in the microloan limit, b_{MF}. At low levels of b_{MF}, microfinance predominantly finances entry into the small-scale sector, which is similar to how those with low labor productivity benefit more from microfinance in our benchmark model. This increases the relative price of investment goods produced by the large-scale sector and further reduces capital accumulation. However, when the microloan size is large enough to finance entry into the large-scale sector, it can lower the relative price of the investment goods. With large enough b_{MF}, microfinance can lead to higher levels of aggregate capital and output in the long run in GE. However, at such levels of large b_{MF}, it is not clear whether one can call it *micro*finance. We discuss this case in more detail in Appendix C.

5.4 Robustness to Select Parameter Values

In this section, we assess the robustness of our results to several key parameter values. In particular, we consider a higher capital income share, a thinner tail of the entrepreneurial productivity distribution, and a more persistent process for entrepreneurial productivity. To isolate the marginal effect of each parameter, in all three cases, we hold all other parameter values fixed at their respective benchmark calibration values.

Higher capital share In the benchmark calibration, the value of α is chosen so that the capital income share in the perfect-credit case of the model is 0.3, given the tail parameter of the entrepreneurial productivity distribution η and the span of control $\alpha + \theta$: $0.3 = \alpha/(1/\eta + \alpha + \theta)$. We now assess how the effects of microfinance will be different with a higher capital share. Holding all other parameters constant, including the span of control of the production function $\alpha + \theta = 0.542$, we increase α from 0.27 to 0.342 and decrease θ from 0.272 to 0.2. With these numbers, the capital income share in the perfect credit case will be 0.38, a substantial increase. There is an economic interpretation to this robustness exercise as well. If the high capital share captures a notion of human capital, a dimension absent in our model, then this exercise sheds some light on what the effect of microfinance would be in a model with human capital.

Starting from the stationary equilibrium with these new parameter values, not the benchmark calibration stationary equilibrium, we introduce microfinance with 12-p.p. spread and $b_{MF} = w_0$. We explore both the short-run partial equilibrium effects and the long-run general equilibrium effects. The short run partial equilibrium effects of microfinance with the higher capital share are nearly identical to the effect of the same microfinance intervention in the benchmark case (rows 1 and 2 of Table 5). One difference is that the entrepreneurship rates respond more (+7.7 p.p. relative to +6.3 p.p. in the benchmark). The reason is that with the high α and the low θ, workers are less important in production, and the no-microfinance stationary equilibrium has a higher entrepreneurship rate than the benchmark (38 percent of the population are entrepreneurs, compared to 29 percent). Since the Pareto density of the entrepreneurial productivity is decreasing in its level (z), a larger mass of people respond to microfinance, and at the same time the adverse effect on the average productivity of active entrepreneurs is smaller (a fall of 5 percent, compared with 6 percent in the benchmark).

Short-run PE effect of $b_{MF} = w_0$, 12-percent spread					
	GDP	Capital	TFP	Entrep. fr	Avg. z
Benchmark	+8.0%	+7.9%	-2.6%	+6.3 p.p.	-6.0%
High capital share	+8.0%	+7.8%	-2.9%	+7.7 p.p.	-5.0%
Thinner z tail	+11.8%	+12.6%	-2.4%	+7.9 p.p.	-4.6%
High z persistence	+1.7%	+1.4%	-0.7%	+1.6 p.p.	-1.9%

Table 5: Short-Run PE Effect of Microfinance, Robustness Exercises. For the benchmark and three other parameterizations, we show the short-run partial equilibrium effect of microfinance with 12 p.p.-spread and loan size $b_{MF} = w_0$. The reported changes are relative to *respective* no-microfinance stationary equilibria.

The long-run general equilibrium effects are broadly consistent with the benchmark, but the negative effect on capital accumulation is smaller (rows 1 and 2 of Table 6), because the larger importance of capital in production moderates the fall in saving due to microfinance. It is enough to overturn the small negative effect on output in the long run in the benchmark (+0.2 percent compared with -0.4 percent). Overall, we find the results with higher capital share, especially the message that the long run GE impacts on output are smaller because of lower capital accumulation, broadly similar to those in the benchmark, and the quantitative differences go in the expected direction.

Thinner tail of the entrepreneurial productivity distribution In the benchmark calibration, we use the employment share of the largest 10 percent of establishments in India in 1997. These largest establishments account for 58 percent of the total employment, and this pinned down the tail parameter of the entrepreneurial productivity (z) distribution, $\eta = 2.80$. n our model all firms are entrepreneurial firms, but in the data, not all establishments, especially the very large ones, belong to entrepreneurial firms. It is therefore reasonable to ask whether we are targeting too high a top concentration rate or equivalently too low an η. To address this concern, we consider a higher η or a thinner tail of the Pareto distribution of z, $\eta = 3.5$. We hold all other parameters constant, but decrease α from 0.27 to 0.248

Long-run GE effect of $b_{MF} = w_0$, 12-percent spread							
	GDP	Capital	TFP	Entrep. fr	Avg. z	Wage	Interest rate
Benchmark	-0.4 %	-7.4%	+2.1%	+0.4 p.p.	+0.8%	-0.0%	+3.8 p.p.
High capital share	+0.2%	-5.6%	+2.1%	+0.9 p.p.	+0.8%	+0.6%	+2.6 p.p.
Thinner z tail	+1.0%	-4.4%	+2.5%	+0.7 p.p.	+0.3%	+1.1%	+2.8 p.p.
High z persistence	+0.1%	-0.7%	+0.4%	+0.1 p.p.	-0.1%	+0.1%	+0.3 p.p.
Long-run GE effect of $b_{MF} = w_0$, 1-percent spread							
	GDP	Capital	TFP	Entrep. fr	Avg. z	Wage	Interest rate
Bechmark	-3.1%	-12.5%	+1.3%	-1.5 p.p.	+1.9%	-4.7%	+6.3 p.p.
High z persistence	-1.6%	-6.4%	+0.6%	+1.0 p.p.	-1.6 %	-0.7%	+2.1 p.p.

Table 6: Long-Run GE Effect of Microfinance, Robustness Exercises. For the benchmark and three other parameterizations, we show the long-run general equilibrium effect of microfinance with 12 p.p.-spread and loan size $b_{MF} = w_0$. The reported changes are relative to *respective* no-microfinance stationary equilibria. In the lower panel, we report the long-run general equilibrium effect of 1 p.p.-spread microfinance for the benchmark and the case of more persistent entrepreneurial productivity process.

and increase θ from 0.272 to 0.294, to maintain the capital income share $\alpha/(1/\eta + \alpha + \theta)$ and the span of control $\alpha + \theta$ in the face of a the higher η. With these parameter values, in the resulting no-microfinance stationary equilibrium, the employment share of the largest 10 percent of establishments is 0.45, a large drop. This exercise can be interpreted as the result of a calibration that targets a subset of Indian firms that are more likely to be affected by microfinance. The general equilibrium exercise then implicitly assumes that the factor markets for this subset of firms are segmented from the factor markets for the other firms that are too large to be affected by microfinace.

We again introduce a 12 p.p.-spread microfinance with $b_{MF} = w_0$ and evaluate the short-run partial equilibrium and long-run general-equilibrium effects. The short-run effect of microfinance on output, capital, and entrepreneurship is larger than in the benchmark. With a more compressed entrepreneurial productivity distribution, the productivity gap between marginal entrepreneurs and average entrepreneurs is smaller, and this explains the larger positive effects on output, capital, and entrepreneurship (rows 1 and 3 of Table 5). It also explains the more muted drop in the average productivity of entrepreneurs and TFP.

In the long-run general equilibrium, the compressed productivity distribution implies a higher rate of entrepreneurship than in the benchmark (38 percent vs. 29 percent), and the need for self-financing by entrepreneurs dampen the negative effect of microfinance on aggregate saving (-4.4 percent drop in capital stock compared with -7.4% in the benchmark). Combined with a significant increase in TFP (due to better intensive-margin capital allocation and the increases in the number of entrepreneurs and their average productivity), output of the economy is larger by one full percent with microfinance (compared to a drop of 0.4 percent in the benchmark). In summary, with a thinner tail of the z distribution, the positive effect of microfinance is larger than in the benchmark, both in the short-run partial equilibrium and in the long-run general equilibrium. This finding makes sense once one realizes that the production and occupation decisions of those in the right tail are not directly affected by microfinance because their scale of operation is too large relative to the modest microfinance limit and also because the endogenouse capital rental constraint in our model is an increasing function of the productivity z.[31] When fewer people are in the right tail, the aggregate effect of microfinance will be larger.

Higher persistence of entrepreneurial productivity Our entrepreneurial productivity process resembles a Poisson process, in the sense that one maintains his z until hit by a "reset" shock with probability $1-\gamma$. This process is an extreme version of a process with a skewed distribution of productivity growth (at the moment of the arrival of the Poisson shock). In our calibration, $\gamma = 0.93$ matches the establishment exit rate of 5 percent per year.[32] As shown by Buera and Shin (2011), when the shock is more persistent, entrepreneurs can save up and overcome financial constraints over time through self-financing. As a result, at any given point in time fewer people are affected by financial constraints, and these constraints have small aggregate effect. Accordingly, the impact of microfinance will be smaller.

To assess by how much the effect of microfinance diminishes, we consider an extreme case, $\gamma = 0.99$. At this level of persistence, financial frictions generate a negligible amount of resource misallocation. We first consider the short-run PE effects of a 12-p.p. spread microfinance with $b_{MF} = w_0$. Consistent with the fact that there are fewer people financially constrained in the no-microfinance stationary equilibrium with more persistent entrepreneurial productivity, the short-run effects are quite small, about a quarter of the effects on GDP, capital, TFP, and entrepreneurship rate in the benchmark (rows 1 and 4, Table 5).

The effects of microfinance are even smaller in the long run general equilibrium. Other than the 0.7 percent drop in capital and the 0.4 percent increase in TFP (row 4, Table 6), microfinance virtually has zero effects on all aggregate variables, because the no-finance stationary equilibrium has very little distortion in occupation and production decisions with

[31] This is not to say that those in the right tail of the productivity distribution are not affected by microfinance. As we saw in Figure 6, those with very high z's benefit from microfinance in the general equilibrium, because they tend to hold lots of wealth, and the returns to wealth (interest rate) goes up.

[32] In principle, longitudinal data on the income of entrepreneurs, or those in the top tail, would be greatly informative in disciplining a more general stochastic process of productivity along the lines of the one proposed by Luttmer (2011) and used by Jones and Kim (2018) for a US application, for example. Unfortunately, no comparable data are available for India, so we focus on coarser firm dynamic data, although we report some evidence on the skewness in the distribution of growth of establishments in India.

γ so close to one. Furthermore, while microfinance does allow for consumption loans, which are otherwise unavailable, no one takes advantage of it, because the interest rate is very high: nearly 24 percent per year, including the 12-p.p. spread, when the discount factor is $\beta = 0.85$.[33]

We explore this issue further by considering the long-run effect of subsidized microfinance. In the lower panel of Table 6, we report the long-run general equilibrium effect of 1-p.p. spread microfinance with the same limit, $b_{MF} = w_0$. With the highly persistent entrepreneurial productivity process, $\gamma = 0.99$, the effect is smaller than in the benchmark (with $\gamma = 0.93$) but far from zero. The effects on output, capital, and TFP are about half those in the benchmark. This is largely driven by the decrease in aggregate saving, since at the lower spread, many people borrow for consumption, especially since there is little precautionary saving motive given the high γ.

In summary, the extreme example of a highly persistent entrepreneurial productivity process shows that the effect of microfinance will be small if financial constraints are not binding for most people in the no-microfinance equilibrium. Even then, the consumption loan aspect of microfinance can have a significant effect, if the interest rate charged is not prohibitive. However, such an extreme persistence is at odds with the establishment exit rate and also the sizable variance and skewness of the establishment growth rates in the data.[34] While the effect of microfinance depends on the specification of productivity processes, which very much deserve a more careful consideration, as long as there is a meaningful degree of financial frictions, there will be a significant effect of microfinance.

6 Concluding Remarks

Microfinance programs are growing around the world and in some countries approaching levels where general equilibrium effects should be reckoned. This paper shows that such general equilibrium considerations are qualitatively and quantitatively important for the evaluation of the aggregate and distributional impacts of economy-wide microfinance programs, in ways that cannot be simply extrapolated from short-run partial equilibrium evaluations. We find small, and sometimes negative, aggregate impacts on output in general equilibrium in the long run, but overall positive welfare gains. The welfare gains especially favor the poor (through consumption loans and higher wages) and the marginal entrepreneurs (through

[33] With the probability of retaining one's productivity nearly one, the amount of precautionary saving in the economy is far lower than that in the benchmark. As a result, to clear the capital market, the interest rate rises to nearly 12 percent from 0 percent in the benchmark.

[34] In a panel of registered establishments in the ASI data from India, while the median of plant-level value-added growth rate (annual) is 3 percent, the 90th, 75th, 25th, and 10th percentiles are respectively 82, 34, -26, -73 percent.

small scale production loans), but the higher interest rates in long run general equilibrium tilt the welfare gains towards the rich (through higher returns on wealth).

We conjecture that our results may be applicable even to local-level microfinance interventions. In many developing countries, local markets are essentially segmented—see, for example, Townsend (1995)—because of high transportation/trade costs or information frictions. In such environments, even moderately-sized microfinance interventions may exhibit the important general equilibrium effects shown in the paper.

More broadly, this paper points to the large potential gains from "intellectual trade" between micro and macro development literature. The wealth of recent microevaluation evidence provides invaluable information with which to discipline and validate the predictions of macro models, while quantitative theory is a natural guide to interpreting and extrapolating the micro evidence.

References

Ahlin, C. and N. Jiang (2008): "Can Micro-Credit Bring Development?" *Journal of Development Economics*, 86, 1–21.

Ahlin, C. and R. M. Townsend (2007): "Using Repayment Data to Test Across Models of Joint Liability Lending," *Economic Journal*, 117, F11–51.

Angelucci, M., D. Karlan, and J. Zinman (2015): "Microcredit Impacts: Evidence from a Randomized Microcredit Program Placement Experiment by Compartamos Banco," *American Economic Journal: Applied Economics*, 7, 151–82.

Armendariz, B. and J. Morduch (2005): *The Economics of Microfinance*, Cambridge, MA: MIT Press.

Attanasio, O., B. Augsburg, R. De Haas, E. Fitzsimons, and H. Harmgart (2011): "Group Lending or Individual Lending? Evidence from a Randomised Field Experiment in Mongolia," Working Papers 136, European Bank for Reconstruction and Development.

Augsburg, B., R. De Haas, H. Harmgart, and C. Meghir (2015): "The Impacts of Microcredit: Evidence from Bosnia and Herzegovina," *American Economic Journal: Applied Economics*, 7, 183–203.

Banerjee, A., E. Breza, E. Duflo, R. Glennerster, and C. G. Kinnan (2015a): "Do credit constraints limit entrepreneurship? Heterogeneity in the returns to microfinance," MIT.

Banerjee, A., E. Duflo, R. Glennerster, and C. Kinnan (2015b): "The Miracle of Microfinance? Evidence from a Randomized Evaluation," *American Economic Journal: Applied Economics*, 7, 22–53.

Banerjee, A., D. Karlan, and J. Zinman (2015c): "Six Randomized Evaluations of Microcredit: Introduction and Further Steps," *American Economic Journal: Applied Economics*, 7, 1–21.

Banerjee, A. V. and A. F. Newman (1993): "Occupational Choice and the Process of Development," *Journal of Political Economy*, 101, 274–298.

Beck, T., A. Demirgüç-Kunt, and R. Levine (2000): "A New Database on the Structure and Development of the Financial Sector," *World Bank Economic Review*, 14, 597–605.

Besley, T. and S. Coate (1995): "Group Lending, Repayment Incentives and Social Collateral," *Journal of Development Economics*, 46, 1–18.

Breza, E. and C. Kinnan (2016): "Measuring the Equilibrium Impacts of Credit: Evidence from the Indian Microfinance Cisis," Manuscript, Northwestern University.

Buehren, N. and K. Richter (2010): "Microfinance on a Large-Scale: Evidence from the Thai Village Fund," Tech. rep., University College of London.

Buera, F. J., J. P. Kaboski, and Y. Shin (2011): "Finance and Development: A Tale of Two Sectors," *American Economic Review*, 101, 1964–2002.

——— (2012): "The Macroeconomics of Microfinance," Working Paper 17905, National Bureau of Economic Research.

——— (2015): "Entrepreneurship and Financial Frictions: A Macrodevelopment Perspective," *Annual Review of Economics*, 7, 409–436.

——— (2019): "Taking Stock of the Evidence on Micro-Financial Interventions," in *The Economics of Poverty Traps*, ed. by C. B. Barrett, M. R. Carter, and J.-P. Chavas, University of Chicago Press.

Buera, F. J. and Y. Shin (2011): "Self-insurance vs. Self-financing: A Welfare Analysis of the Persistence of Shocks," *Journal of Economic Theory*, 146, 845–862.

Cai, S., A. Park, and S. Wang (2016): "Microfinance Can Raise Incomes: Evidence from a Randomized Control Trial in China," Tech. rep., HKUST.

Carpena, F., S. Cole, J. Shapiro, and B. Zia (2010): "Liability Structure in Small-Scale Finance : Evidence from a Natural Experiment," Policy Research Working Paper Series 5427, The World Bank.

Crépon, B., F. Devoto, E. Duflo, and W. Parienté (2015): "Estimating the Impact of Microcredit on Those Who Take It Up: Evidence from a Randomized Experiment in Morocco," *American Economic Journal: Applied Economics*, 7, 123–50.

Daley-Harris, S. (2009): "State of the Microcredit Summit Campaign Report," Annual report, Microcredit Summit Campaign.

de Mel, S., D. McKenzie, and C. Woodruff (2008): "Returns to Capital in Microenterprises: Evidence from a Field Experiment," *Quarterly Journal of Economics*, 123, 1329–1372.

——— (2009): "Are Women More Credit Constrained? Experimental Evidence on Gender and Microenterprise Returns," *American Economic Journal: Applied Economics*, 1, 1–32.

Fafchamps, M., D. McKenzie, S. Quinn, and C. Woodruff (2010): "Using PDA Consistency Checks to Increase the Precision of Profits and Sales Measurement in Panels," CSAE Working Paper 2010-19, Centre for the Study of African Economies, University of Oxford.

Field, E. and R. Pande (2008): "Repayment Frequency and Default in Microfinance: Evidence From India," *Journal of the European Economic Association*, 6, 501–509.

Fischer, G. and M. Ghatak (2010): "Repayment Frequency in Microfinance Contracts with Present-Biased Borrowers," Economic Organisation and Public Policy Discussion Papers Series 021, London School of Economics.

Gine, X. and D. Karlan (2010): "Group versus Individual Liability: Long Term Evidence from Philippine Microcredit Lending Groups," Manuscript, Yale University, New Haven.

Hsieh, C.-T. and P. Klenow (2007): "Relative Prices and Relative Prosperity," *American Economic Review*, 97, 562–585.

Jain, S. and G. Mansuri (2003): "A Little at a Time: The Use of Regularly Scheduled Repayments in Microfinance Programs," *Journal of Development Economics*, 72, 253–279.

Jones, C. I. and J. Kim (2018): "A Schumpeterian Model of Top Income Inequality," *Journal of Political Economy*, 126, 1785–1826.

Kaboski, J. and R. Townsend (2011): "A Structural Evaluation of a Large-Scale Quasi-Experimental Microfinance Initiative," *Econometrica*, 79, 1357–1406.

Kaboski, J. P. and R. M. Townsend (2012): "The Impact of Credit on Village Economies," *American Economic Journal: Applied Economics*, 4, 98–133.

Karlan, D. and J. Zinman (2011): "Microcredit in Theory and Practice: Using Randomized Credit Scoring for Impact Evaluation," *Science*, 332, 1278–1284.

Lagakos, D., A. M. Mobarak, and M. E. Waugh (2018): "The Welfare Effects of Encouraging Rural-Urban Migration," Working Papers 24193, National Bureau of Economic Research.

Luttmer, E. G. J. (2011): "On the Mechanics of Firm Growth," *The Review of Economic Studies*, 78, 1042–1068.

Reed, L. R., D. S. K. Rao, S. Rogers, C. Rivera, F. Diaz, S. Gailly, J. Marsden, and X. Sanchez (2015): "Mapping Pathways out of Poverty: The State of the Microcredit Summit Campaign Report," Annual report, Microcredit Summit Campaign.

Tarozzi, A., J. Desai, and K. Johnson (2015): "The Impacts of Microcredit: Evidence from Ethiopia," *American Economic Journal: Applied Economics*, 7, 54–89.

Townsend, R. M. (1995): "Financial Systems in Northern Thai Villages," *Quarterly Journal of Economics*, 110, 1011–1046.

Appendix

A TFP Decomposition

In this appendix, we derive a decomposition that illustrates the three driving forces of TFP: average productivity of entrepreneurs, the number of entrepreneurs, and the allocation of capital among entrepreneurs. Using the optimal choice of labor input, $l(a,z) = (z\theta k(a,z)^{\alpha}/w)^{1/(1-\theta)}$, we can write aggregate output as:

$$Y = (\theta/w)^{\frac{\theta}{1-\theta}} \int_{\{(a,z):o(a,z)=E\}} z^{\frac{1}{1-\theta}} k(a,z)^{\frac{\alpha}{1-\theta}} G(da,dz).$$

We denote the aggregate labor input by $L \equiv \int_{\{o(a,z)=E\}} l(a,z)\, G(da,dz)$ and the aggregate total labor input by $N = L + N^E$, i.e., labor plus the un-weighted entrepreneurial input with $N^E \equiv \int_{\{o(a,z)=E\}} G(da,dz)$. Also, the aggregate capital input is K, and the share of capital employed by one entrepreneur of given wealth and productivity is defined as $\varkappa(a,z) = k(a,z)/K$. We can now rewrite aggregate output as:

$$Y = \frac{\left[\int_{\{(a,z):o(a,z)=E\}} z^{\frac{1}{1-\theta}} \varkappa(a,z)^{\frac{\alpha}{1-\theta}} G(da,dz)\right]^{1-\theta}}{N^{1-\alpha-\theta}} \left(\frac{L}{N}\right)^{\theta} K^{\alpha} N^{1-\alpha}. \tag{10}$$

We define TFP as output net of capital and broad labor inputs, raised to their respective income elasticities, α and $1-\alpha$,

$$TFP = \frac{Y}{K^{\alpha}N^{1-\alpha}} = \frac{\left[\int_{\{(a,z):o(a,z)=E\}} z^{\frac{1}{1-\theta}} \varkappa(a,z)^{\frac{\alpha}{1-\theta}} G(da,dz)\right]^{1-\theta}}{N^{1-\alpha-\theta}} \left(\frac{L}{N}\right)^{\theta}.$$

We view this to be the measurement of TFP that is closest to the one used in development accounting.

In addition, we define the "k-efficient" TFP, TFP^{kf}, as the hypothetical value of TFP attained if capital were to be efficiently allocated among existing entrepreneurs to equalize their marginal product. When capital is efficiently allocated across the existing entrepreneurs, the fraction of total capital employed by one entrepreneur of given z is:

$$\varkappa^{kf}(z) = \frac{z^{\frac{1}{1-\alpha-\theta}}}{\int_{\{(a,z):o(a,z)=E\}} z^{\frac{1}{1-\alpha-\theta}} G(da,dz)}, \tag{11}$$

and the aggregate output under this efficient allocation of capital, Y^{kf}, is obtained by substituting (11) into (10). We then formally write out the k-efficient TFP,

$$TFP^{kf} = \frac{Y^{kf}}{K^{\alpha}N^{1-\alpha}} = \left[\frac{\int_{\{(a,z):o(a,z)=E\}} z^{\frac{1}{1-\alpha-\theta}} G(da,dz)}{N^E}\right]^{1-\alpha-\theta} \left(\frac{N^E}{N}\right)^{1-\alpha-\theta} \left(\frac{L}{N}\right)^{\theta}.$$

Note that this measure is only a function of a geometrically-weighted average of active entrepreneurs' talent and the fraction of entrepreneurs and workers in the population.

Using the k-efficient TFP measure, we can decompose the change in TFP caused by the introduction of microfinance in terms of the allocation of entrepreneurs at the extensive margin (z-efficiency) and the allocation of capital across active entrepreneurs (k-efficiency). Here, $TFP(b^{MF})$ is the realized TFP with microfinance of a given b^{MF}, and $TFP(0)$ is the TFP in the initial equilibrium without microfinance.

$$\frac{TFP\left(b^{MF}\right)}{TFP\left(0\right)} = \underbrace{\frac{TFP^{kf}\left(b^{MF}\right)}{TFP^{kf}(0)}}_{z\text{-efficiency}} \underbrace{\frac{\frac{TFP\left(b^{MF}\right)}{TFP^{kf}(b^{MF})}}{\frac{TFP(0)}{TFP^{kf}(0)}}}_{k\text{-efficiency}}.$$

The z-efficiency term captures the TFP change from microfinance that is driven purely by the reallocation of entrepreneurial talent at the extensive margin. We obtain this counterfactual measure by calculating the change in TFP that would occur in a world where capital is allocated efficiently among active entrepreneurs with and without microfinance, $TFP^{kf}\left(b^{MF}\right)/TFP^{kf}\left(0\right)$. In computing $TFP^{kf}\left(b^{MF}\right)$ and $TFP^{kf}\left(0\right)$, capital is efficiently allocated by definition, and hence they can be different only if the set of entrepreneurs operating technologies is affected by microfinance. Note that z-efficiency below 1 implies a worse selection into entrepreneurship through microfinance, and the other way around for z-efficiency above 1. On the other hand, the k-efficiency term reflects the change in the allocative efficiency of capital at the intensive margin, and is calculated as the residual change in TFP necessary to account for the overall change in TFP.

B Welfare Losses from Microfinance

In general equilibrium, some individuals can be made worse off by microfinance, as evidenced by the solid line dipping below zero in the left panel of Figure 6. (This cannot happen in partial equilibrium, where prices are held constant.) In particular, certain productive entrepreneurs are made slightly worse off because higher wages and interest rates reduce their profits, although this gets partly offset by higher interest income from their wealth. Figure A1 shows the set of individuals (defined by wealth and entrepreneurial productivity at $t = 0$) who are made worse off by microfinance. The left panel is for those with low labor productivity x_l and the right panel is for high labor productivity x_h. The microfinance has a 12-p.p. spread and a limit of $b_{MF} = 0.34w_0$. We correctly account for the transitional dynamics.

In general, entrepreneurs are worse off, because of the higher factor prices, but for a given entrepreneurial productivity, the loss decreases with wealth (or turns into a welfare gain) since a higher interest rate means a higher return on wealth. This explains the bottom right

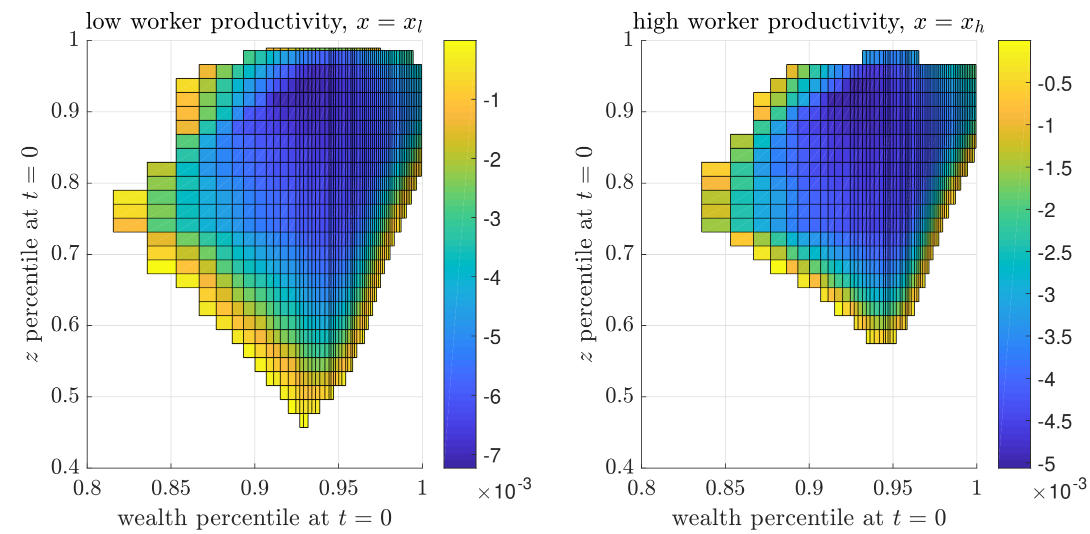

Fig. A1: Welfare Losses from Microfinance, by Wealth and Individual Productivity. The shaded regions in these figures show the set of individuals, in term of their initial wealth and entrepreneurial/labor productivity, made strictly worse off by the introduction of microfinance. The horizontal (vertical) axis is their wealth (entrepreneurial productivity) percentiles in the initial equilibrium without microfinance. The shades represent the magnitude of the welfare losses in units of permanent consumption, darker shades corresponding to larger losses. The left (right) panel correspond to individuals with a low (high) productivity as worker in the initial equilibrium without microfinance. We consider microcredit with $b_{MF} = 0.34w_0$ and 12 p.p. spread.

diagonal of the region. The orthogonal diagonal in the bottom left of the region closely follows the occupation choice line. For a given z, only people with high enough wealth become entrepreneurs. The lower z is, the higher is the wealth threshold for entrepreneurship. If you are a worker, you benefit from microfinance through the higher wage in general equilibrium. This also explains why the region of welfare loss is larger for low labor productivity (x_l) individuals: They are more likely to be entrepreneurs than those with high labor productivity (x_h) for a given entrepreneurial productivity and wealth combination, and hence are more adversely affected by the factor price increases. However, because they also have less wealth on average than high labor productivity individuals, and also because some marginal entrepreneurs directly benefit from the microfinance, when integrated over wealth holdings, the low labor productivity individuals benefit more from microfinance. This can be seen in the right panel of Figure 6, where the gray lines (x_l) lie above the black lines (x_h). Finally, we note that the magnitude of welfare loss is fairly small, no more than 0.7 percent of permanent consumption even in the worst case, especially relative to the typical welfare gains in Figure 6.

C Microfinance in a Two-Sector Model

We follow Buera et al. (2011) and introduce a second sector that requires a per-period fixed cost for production. We abstract from the labor productivity shock. Individuals draw a stochastic vector $\mathbf{z} \equiv \{z, z_L\}$, where z_L, their productivity in the large-scale sector, is distributed identically but independently of their small-scale sector productivity, z. Individuals choose between being a worker and operating a technology in either sector.

Quantitatively, we use the calibration of Buera et al. (2011), and in particular set the fixed cost in the large-scale sector to match the observed difference in average establishment size between manufacturing and services in the US. We assume that all capital is produced in the large-scale sector. In addition, we assume that the two goods enter a CES utility function with unitary elasticity of substitution between them. The calibration details can be found in an earlier working paper version of this paper (Buera et al., 2012). In this exercise, microfinance cannot be used for consumption, and there is no interest rate spread on microloans.

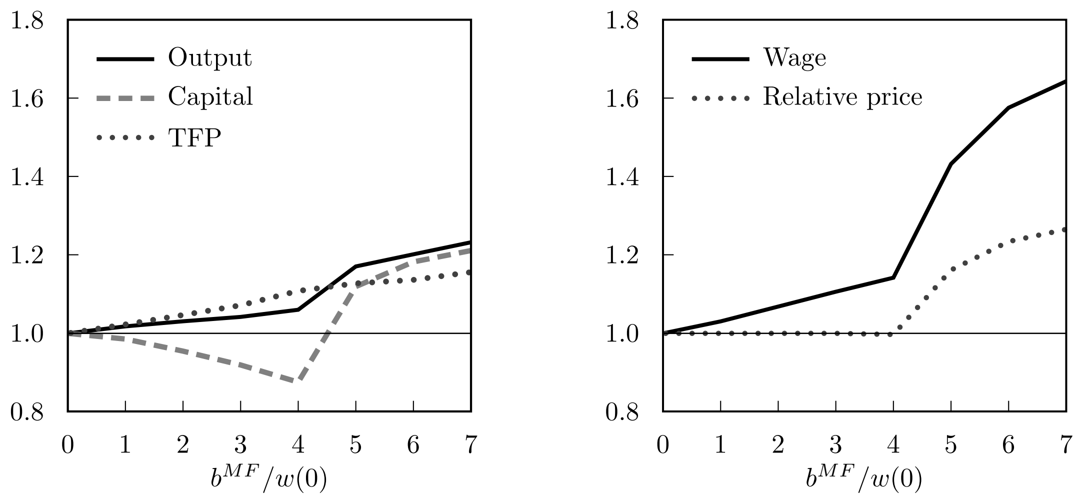

Fig. A2: Long-Run GE Impact of Microfinance in Two-Sector Model

Figure A2 shows the general equilibrium implications of microfinance in this two-sector model in the long run for various sizes of the microfinance limit. The relative price is equal to the price of the small-scale sector output, as we have the large-scale sector output as numeraire. Output and TFP are constructed using constant relative prices. In the figure, all variables are normalized by their respective values in the no-microfinance stationary equilibrium.

The effects of microfinance are strikingly non-linear and even non-monotone for some variables. For moderate levels of microfinance, the model behaves similarly to the one-sector model with microfinance. (Recall that in the benchmark exercise b_{MF}/w_0 ran from 0 to 2 only.) Unlike in the benchmark, microfinance is only for production, not for consumption, and this assumption results in a smaller decrease in capital stock and more positive effect on TFP in the long run for a given b_{MF} than in the benchmark case where microloans can be used for consumption. It is at higher levels of guaranteed credit, those more than 4 times the no-microfinance equilibrium wage, that the two-sector model shows striking differences from the one-sector model of microfinance. Here, microfinance dramatically increases wages and output because it raises TFP *and* capital accumulation (dashed line, left panel) even in general equilibrium. The threshold for this change lies where the amount of guaranteed credit is sufficient to induce individuals with the highest productivity in the large-scale sector to become entrepreneurs even if they have no wealth. In this region, the general equilibrium effect through the relative price drives the results. Aggregate capital increases because the increase in the relative price of small-scale output is equivalent to a decrease in the relative price of capital: Each unit of forgone consumption now yields more physical capital. However, with such large loan sizes, it is not clear whether one can call it *micro*finance.

When we assume smaller substitutability between the goods produced by the large-scale and the small-scale sectors, microfinance with small loan limits pushes down more significantly the relative price of the small-scale sector good. This is because financial frictions in the small-scale sector without fixed costs are more easily alleviated by microfinance, generating more entry into this sector.[35] The lower relative price of the small-scale output affects capital accumulation more negatively, because investment goods are now relatively more expensive. The same nonlinear/non-monotonic effects of microfinance emerge however, once the microfinance loan limit rises above a similar threshold.

[35]This is consistent with the empirical evidence of de Mel et al. (2008, 2009) and Fafchamps et al. (2010), who find that grants to low-wealth female entrepreneurs, likely forced into entrepreneurship because of limited labor market opportunities, yield substantially smaller increases in capital.