The Macroeconomics of Microfinance*

Francisco J. Buera[†] Joseph P. Kaboski[‡] Yongseok Shin[§]

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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 impact is substantially different in general equilibrium and in partial equilibrium. In partial equilibrium, aggregate output and capital increase with microfinance but aggregate total factor productivity (TFP) falls. 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. Nevertheless, 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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[†]Federal Reserve Bank of Chicago; francisco.buera@chi.frb.org.

[‡]University of Notre Dame and NBER; jkaboski@nd.edu.

[§]Washington University in St. Louis, Federal Reserve Bank of St. Louis, and NBER; yshin@wustl.edu.

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 (Banerjee et al., 2015b). 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 (Buera et al., 2016).

As opposed to the microevaluations, the macroeconomic effects of economy-wide microfinance have been unexplored. Our paper is an attempt to fill this void by providing a quantitative assessment of the potential impact of economy-wide microfinance availability, with particular attention to general equilibrium (GE) effects. The quantitative framework we develop allows for long-run general equilibrium analyses, which are beyond the scope of microevaluation methods typically designed for short-run partial equilibrium (PE) effects. However, we draw upon recent microevaluations of real-world microfinance programs to discipline and validate our model.

Although the model is consistent with the relatively small impacts measured in the microevaluation studies, it nonetheless predicts that microfinance, when made widely available in an economy, has significant aggregate and distributional impacts that are quantitatively and qualitatively different from the short-run PE effects. When scaled up, microfinance can increase output and investment in the short-run PE. However, over time, the availability of microfinance leads to a reduction in savings and therefore capital. In GE, this leads to higher interest rates, which prevent hordes of low productivity entrepreneurs from entering

[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. The scaling up of microfinance is usually understood as the expansion of programs providing small loans to reach all the poor population, as opposed to increasing the average size of loans.

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

and hence help increase TFP. In net, aggregate output is more or less unaffected by microfinance, as the lower aggregate capital and the higher TFP cancel out. Nevertheless, the welfare effects of microfinance are positive for everyone, and especially so for the poor—who take out small consumption loans—and marginal entrepreneurs—who take out small production loans. The high interest rates in GE redistribute some of the gains of scaled-up microfinance away from borrowers toward the wealthy, in the form of higher returns on wealth.

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, since the wealthy already have enough collateral and hence access to formal financing, 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 and significant 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, 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, 2012a). The Indian case corresponds to a relatively standard for-profit microfinance program with high interest rates and low take-up rates, while the Thai version is a publicly-funded village fund program with lower interest rates and higher take-up rates.[3]

The short-run PE case is the relevant comparison because these empirical studies evaluate small-scale (relative to the aggregate economy) programs that have been around for

[3]Buera et al. (2016) discuss how these two strands of programs tend to have different impacts.

one or two years. When microfinance loans whose size matches the specifics of the two studies are introduced into our model, it captures the estimated magnitude of overall credit expansion, the increase in investment and entrepreneurship, including the entry of marginal entrepreneurs, and the increase in consumption. The model also affirms that impacts are focused on marginal entrepreneurs, consistent with microevidence.

Having validated the model's empirical relevance with available evidence, we use the model to extend the results beyond those measured in micro studies. Namely, we simulate and quantify the long-run effect 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 are important.

Our short-run PE analysis shows that, although the marginal impacts of the interventions typically evaluated may be small, the total impact of the overall level of microfinance for slightly larger loans (e.g., up to one year of annual wages) is not negligible. When compared to an economy with no microfinance, income and capital are 5 percent higher in the short run as microfinance enables more people to invest, but TFP is 2 percent lower, since microfinance encourages the entry of low productivity entrepreneurs and a larger fraction of aggregate capital is allocated to them.

In general equilibrium, by definition, the wage and interest rate respond to the economy-wide availability of microfinance. Even in the short-run, the wage and interest rate both rise with the increased demand for capital enabled by microfinance, and so the aggregate short-run increase in capital and entrepreneurial entry are much smaller than in PE. TFP actually rises modestly.

In the long run, the availability of microfinance leads to lower saving in the economy, and in GE the interest rate rises in response, reducing the demand for capital (a 7 percent decline). With higher factor prices, microfinance has only a small effect on the number of entrepreneurs. TFP rises 2 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 in long-run GE.

From a welfare perspective, everyone benefits from microfinance, but it has heterogeneous impacts that vary by wealth and entrepreneurial productivity, and GE effects are once again important. The largest gains accrue to those who are marginal entrepreneurs, who take out microloans for production, as well as to the poor, who take out microloans for consumption. The others gain indirectly through higher consumption over the transition as they now save less, and through the possibility that they take out microloans in the future. In GE, an additional force is at work. The higher interest rate implies more gains for the wealthy through higher returns on their wealth, and this comes at the expense of those who borrow and pay more in interest.

In relating our model predictions to the findings from microevaluations, we recognize that empirical studies often emphasize aspects of the real-world microfinance programs that are not in our benchmark model. Moreover, the ease of considering counterfactuals or alternative scenarios is a strength of our quantitative framework. We therefore consider several extensions, which include subsidized credit (which leads to much higher take-up rates and short-run increases in consumption but also exacerbates the decline in saving) and 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).

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 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 around the world 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 the end 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. For example, a single program, the National Bank for Agriculture and Rural Development (NABARD) in India grew from 146,000 to 55 million clients over this period.[4] By the same token of incomplete survey participation and coverage, these numbers certainly understate the actual number of institutions and borrowers.

[4] `https://stateofthecampaign.org/2015/12/15/2015-report-number-of-clients-reached/`

Microloans are, almost by definition, small and relatively 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 Microfinance Information Exchange (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 (first column), 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 (second column).[6] In Table 1 we also see that the expansion of microfinance is particularly important among the poorest countries (fourth column), where credit markets are very underdeveloped, as measured by the ratio of total credit to GDP (last column). In countries like Cambodia and Bolivia, we can see that microcredit accounts for about 17 percent of all private credit in the economy.[7]

[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, with the Central African Republic showing the highest delinquency rate at 88 percent.

[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.

[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 into 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.

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. We report the five countries with the highest fraction of borrowers, as well as Benin, the African country with the highest fraction, and India, the country with the largest total number of borrowers. All data are for 2014, the most recent common year across datasets. The data on microfinance levels (number of borrowers, total amount of microcredit, and average loan size) is from MIX Market Database. Population and real income per capita data are Penn World Tables (PWT) 9.0 data. Since the MIX data are reported in current U.S. dollars and the GDP data ("cgdpe") from the PWT are in 2011 U.S. dollars, we bring these PWT data forward to 2014 using the U.S. Personal Consumption Expenditures deflator. Total credit to GDP data are from the Financial Structure and Development Dataset, June 2016, by Beck et al., where total credit is the sum of private credit ("prcrdbofgdp") and private bond market capitalization ("prbond").

1.2 Existing Literature

This paper is the first to quantitatively evaluate the short-run and long-run aggregate 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. (See Buera et al. (2015) for a summary.) 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 or microcredit has typically been viewed as a technological or policy innovation enhancing the repayment probability of uncollateralized loans. Alternative theories of the precise nature 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

[8]The NBER working paper version of this paper is dated March 2012.

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

and Pande, 2008; Gine and Karlan, 2010; Carpena et al., 2010; Attanasio et al., 2011). In this paper, we take an agnostic approach to the nature of this technology and simply model it as an innovation that enables the extension and 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 (2012a) and Breza and Kinnan (2016), who study localized general equilibrium effects of microfinance. Kaboski and Townsend (2012a) studies the Thai Million Baht village fund program, which injected roughly 25,000 USD into villages for lending and finds a 7 percent increase in wages in the typical village in their sample as well as increases in consumption. Breza and Kinnan (2016) examine the opposite change: a drop in microcredit stemming from a government-driven microfinance collapse in Andhra Pradesh that impacted other districts of India through its effect on the balance sheets of lenders. They find that in areas exposed, the majority of microcredit disappeared, and as a result agricultural day wages declined 4 percent and non-agricultural day wages declined 8 percent, while household consumption dropped 5 percent. 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. A special issue of *American Economic Journal: Applied Economics* reports randomized evaluations in Bosnia-Herzegovina, Ethiopia, India, Mexico, Mongolia, and Morocco, and these results are summarized in the overview article, Banerjee et al. (2015c).[10] On average 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 profits, income, or consumption. Buera et al. (2016) summarizes these studies, as well as village fund studies in Thailand (Kaboski and Townsend, 2011, 2012b) and China (Cai et al., 2016), which have lower interest rates and higher take-up than other microfinance interventions. The Thai study finds short-run increases in consumption and income, while the Chinese study an increase in income. Each of the above studies emphasizes the heterogeneous impacts of microfinance. We perform a more critical comparison of these empirical findings with our model predictions in Section 3.3.

2 Model

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

[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.

There are measure N of infinitely-lived individuals, who are heterogeneous in their wealth, a, and the quality of their entrepreneurial idea or productivity, z. Their wealth is determined endogenously by forward-looking saving behavior. 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 death of ideas can be interpreted as changes in market conditions that affect the profitability of individual skills or business opportunities.

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 and their access to capital. Access to capital is determined by their wealth through an endogenous collateral constraint, founded on the imperfect enforceability of capital rental 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.

In our quantitative analysis, we consider various extensions of the benchmark model: a small open economy; subsidized microcredit; labor income risk and "forced" entrepreneurship; microfinance as consumption loans; and a two-sector economy with a large-scale sector that requires a fixed cost for operation at the establishment level. To simplify the exposition of the model, here we only present the benchmark model and defer a detailed discussion of such extensions to Section 5.

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 (z).

2.2 Technology

At the beginning of each period, an individual with entrepreneurial idea or productivity z and wealth a chooses whether to work for a wage 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, 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.

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 of limited commitment 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 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 static problem. The following proposition, proved in Buera et al. (2011), provides a simple characterization of 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*

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

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}. 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 ($\nu < 0$).[11] Thus, in equilibrium the interest rate for microfinance loans will differ from that on assets and conventional loans: $r_{MF} = r + \nu$. We allow individuals to divide up the microfinance limit to be used for consumption and future capital rental. Consumption loans are modeled as intertemporal borrowing that allows assets to be negative in order to finance current

[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.

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

In financing capital, microfinance naturally interacts with the conventional capital market. Note first that 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. We now formulate the problem recursively for a stationary environment.

At the beginning of a period, an individual's state is summarized by his wealth a and productivity z. He then chooses whether to be a worker or an entrepreneur for the period. The value for him at this stage, $v(a, z)$, is the larger of the value of being a worker, $v^W(a, z)$, and the value of being an entrepreneur, $v^E(a, z)$:

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

Note that the value of being a worker, $v^W(a, z)$, depends on his entrepreneurial productivity

z, which may be implemented at a later date. We denote the optimal occupation choice by $o(a,z) \in \{W, E\}$.

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

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

where w 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', z'), and the expectation operator $\mathbb{E}_{z'}$ stands for the integration with respect to the distributions of z'. It has $v(a,z)$ in it, because the worker can change his occupation based on (a', z'). Note that b_{MF} affects the worker's intertemporal constraint, and that 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.

$$v^E(a,z) = \max_{c,a',k_{MF},k_{CL},l} u(c) + \beta \mathbb{E}_{z'}[v_{t+1}(a',z')\,|z] \tag{6}$$

$$\begin{aligned} \text{s.t. } c + a' \leq\ & zf(k_{MF} + k_{CL}, l) - R_{MF}k_{MF} - Rk_{CL} - wl \\ & + (1+r)\,a\mathbf{1}_{a\geq 0}(a) + (1+r_{MF})\,a\mathbf{1}_{a<0}(a) \end{aligned} \tag{7}$$

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

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

$$a' \geq -b_{MF} \tag{10}$$

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

2.6 Stationary Competitive Equilibrium

A stationary competitive equilibrium is composed of an invariant distribution of wealth and entrepreneurial productivity with joint distribution $G(a,z)$ and the marginal distribution of z denoted by $\mu(z)$, individual decision rules on consumption, asset accumulation, occupation, labor input, and capital input, $c(a,z)$, $a'(a,z)$, $o(a,z)$, $l(a,z)$, $k_{MF}(a,z)$, $k_{CL}(a,z)$, 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 $c\left(a,z\right)$, $a'\left(a,z\right)$, $o(a,z)$, $l\left(a,z\right)$, $k_{MF}\left(a,z\right)$, and $k_{CL}\left(a,z\right)$ 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):

$$\int \left[k_{MF}\left(a,z\right) + k_{CL}\left(a,z\right)\right] G\left(da,dz\right) = \int aG\left(da,dz\right) \tag{Capital}$$

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

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

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

$$G\left(a,z\right) = \gamma \int_{\{(\tilde{a},\tilde{z})|\tilde{z}\leq z, a'(\tilde{a},\tilde{z})\leq a\}} G\left(d\tilde{a},d\tilde{z}\right) + \left(1-\gamma\right)\mu\left(z\right) \int_{\{(\tilde{a},\tilde{z})|a'(\tilde{a},\tilde{z})\leq a\}} G\left(d\tilde{a},d\tilde{z}\right);$$

where we define aggregate consumption $C \equiv \int c\left(a,z\right) G\left(da,dz\right)$, aggregate capital $K \equiv \int \left[k_{MF}\left(a,z\right) + k_{CL}\left(a,z\right)\right] G\left(da,dz\right)$, total microfinanced capital $K_{MF} \equiv \int k_{MF}\left(a,z\right) G\left(da,dz\right)$, and total (microfinanced) consumption loan $B_{MF} \equiv \int_{a<0} aG\left(da,dz\right)$.

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 $\{G_t(a,z)\}_{t=0}^{\infty}$, 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, 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 productivity determine their occupational choices and also saving behavior in the absence of 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 8 parameters: 2 technological parameters, α and θ; the depreciation rate δ; 2 parameters describing the process for entrepreneurial talent, γ and η, where $\mu(z) = 1 - z^{-\eta}$; 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 assign δ, σ, and the relationship $\alpha/(1/\eta + \alpha + \theta)$ to standard values in the literature. We set the one-year depreciation rate δ to 0.06 and σ to 1.5. It is easy to show that $\alpha/(1/\eta+\alpha+\theta)$ is the aggregate capital income share with perfect credit markets, which we set to 0.3.[12]

We have 5 remaining "degrees of freedom" (six parameters but recall the capital share pinning down the above relationship among 3 technology parameters). We calibrate them to match 5 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 share of earnings generated by the top 1 percent of earners; the annual exit rate of establishments; and the annual real interest rate.

We calibrate these parameters to India, a large developing country for which good data exist, specifically nationally representatitve data on firms and households from the Annual Survey of Industries, the National Sample Survey, 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

[12]We are being conservative in choosing a relatively low capital share. The larger the share of capital, the bigger the role of capital misallocation and hence the effect of microfinance. We are also accommodating the fact that some of the payments to capital in the data are actually payments to entrepreneurial input.

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	$\eta = 2.63$
Top 1-percent earnings share	0.27	0.27	$\alpha + \theta = 0.54$
Establishment exit rate	0.05	0.05	$\gamma = 0.93$
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, $\eta = 2.63$, to match the employment share of the largest 10 percent of establishments in the 1997 Indian Economic Census, 0.58. We can then infer $\alpha + \theta = 0.535$ 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 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 Annual Survey of Industry and NSS combined.[13] The model requires a discount factor of $\beta = 0.85$ 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, given the other targets, the external finance to GDP ratio of 0.34 implies $\phi = 0.148$.

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 their respective no-microfinance levels.

Figure 1 illustrates the occupational (left panel) and saving choices (right panel) of individuals as a function of their entrepreneurial productivity and wealth. 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

[13]Given available data, we use a slightly longer time period corresponding to avoid cyclical fluctuations. 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. Entrepreneurs exit only if their new idea is below the equilibrium cutoff level. This difference is higher in India than that reported for the U.S. by Buera et al. (2011) because financial frictions are more severe in India.

with high and low spreads ν. The two cases correspond to for-profit and subsidized publicly-funded microfinance programs, which are described in detail in the following section.

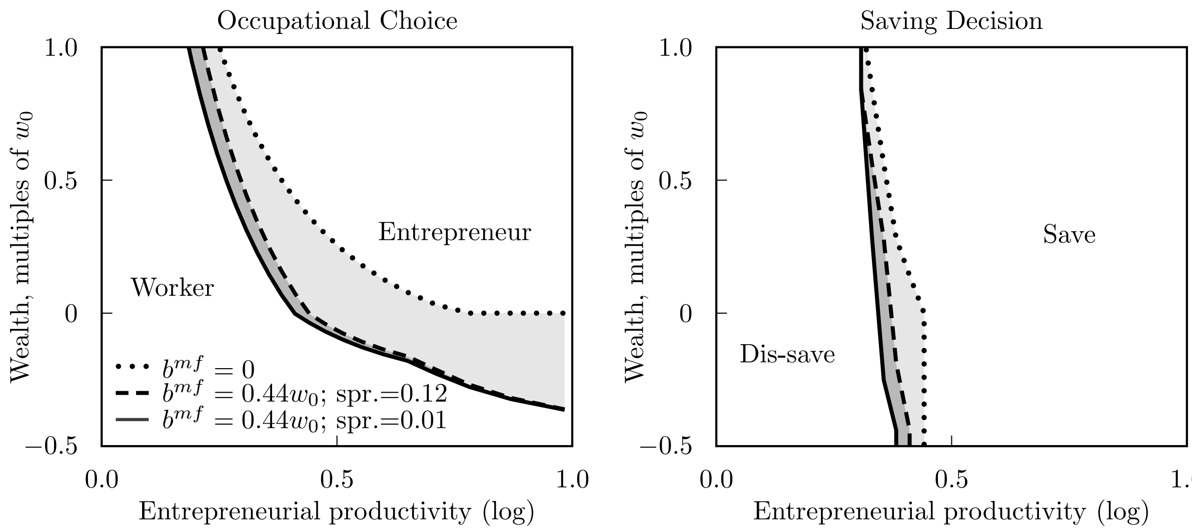

Fig. 1: Occupation Choice and Saving Decision. The left panel illustrates the worker-entrepreneur occupational choice. The right panel illustrates the set of individuals that choose to save in order to eventually become an unconstrained entrepreneur and those that choose to dis-save. Each line demarcates 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 dotted line is for the initial stationary equilibrium without microfinance. Holding prices equal (i.e., partial equilibrium), when microfinance with $b^{MF} = 0.44w_0$ is introduced with a 12 percentage point interest rate spread on microcredit, the occupation choice and saving decision are now represented by the dashed line. The light gray area shows those who switch their occupation choice (left panel) and saving decision (right panel) because of microfinance. The solid line is for a 1 percentage point spread but with the same b^{MF}. The darker gray area is those who switch their occupation choice (left panel) and saving decision (right panel) because of the lower spread on microcredit.

In the left panel, the three 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 three different cases. The dotted line is for the initial stationary equilibrium without microfinance, while the dashed and solid lines represent the cases with $b_{MF} = 0.44w_0$ for high (ν=0.12) and low (ν=0.01) spreads, respectively. 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 reflect occupational choices distorted by financial frictions: individuals who are less talented but wealthy become entrepreneurs, while some poorer but more able individuals remain workers. What is of interest are the shaded areas between the dotted and solid lines, which represents those who switch their occupation from worker 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. Between the dashed and solid lines, The poor are credit-rationed and may hold high returns to capital, so they respond little to the credit spread relative to the wealthy who are more responsive.

Although not shown in this figure, the dashed and 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 dotted line is for the initial equilibrium without microfinance and the dashed and solid lines are for $b_{MF} = 0.44w_0$ in PE with spreads of 0.12 and 0.01, respectively. Individuals with entrepreneurial productivity and wealth to the left of this threshold are in a "poverty trap" and dis-save:[14] 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, 2012a). The scale of these programs is small relative to the macroeconomy of either country, and hence a PE analysis is appropriate.[15] In addition, the microevaluations were conducted within a year

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

[15] 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

or two of the launching of the programs, and hence we compare them with the short-run predictions of the model.[16]

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.[17]

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 funds.[18] 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, an 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 0.03 as a fraction of annual household expenditures. These loans constituted one-third of total credit in the median village. The point estimate of a 15-percent increase in new businesses (or a 1-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.[19] The injected credit had no measurable impact on the aggregate investment, but it significantly increased the probability of making discrete investments by 35 percent—from 0.11 to 0.15.[20] The credit led to a significant increase in per-capita consumption of 15 percent, with essentially no

studies. Nevertheless, markets for rural villages are somewhat segmented, and for the smallest villages the intervention was relatively large. Significant GE effects were indeed detected is such villages (Kaboski and Townsend, 2012a).

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

[17]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).

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

[19]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.

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

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.

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 percent 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 $b_{MF} = 0.44w_0$ 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 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.)

The model predictions are in line with the microevaluation. The simulated amount of total microcredit is larger than in the data when normalized by total expenditures (0.09 vs. 0.03), but smaller when normalized by total credit (0.23 vs. 0.33). The model predicts a mild increase in entrepreneurship (1 percentage point vs. 2 in the data). It also shows a larger short-run increase in investment than in the data (37 percent vs. 35 percent, the latter a probability) but a smaller rise in consumption (6 percent vs. 15 percent in the data).

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 amounts to 6 percent of total credit after the intervention. In that sense, the intervention was small relative to the Thai intervention.

Nevertheless, the loans had a positive effect on entrepreneurship: 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 are positive but statistically insignificant. However, the loans did produce a significant increase in durable goods consumption of 16 percent, and a significant increase in durable goods used

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	0.03	0.09
Total microcredit relative to total credit	0.33	0.23
Entrepreneurship	+1 p.p.	+2 p.p.
Investment	+35%†	+37%
Consumption	+15%	+6%

Table 3: Short-Run PE Model Prediction vs. Microevaluation in Thailand. The microcredit limit in the model ($b_{MF} = 0.44w_0$) is chosen to match the average microloan size relative to per-worker GDP in Thailand. The credit spread of 1 percentage point 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 partial equilibrium nature of the microevaluation. The investment increase in the data (†) is the increase in the probability of making lumpy investments.

for businesses of 128 percent. 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 $b_{MF} = 0.11w_0$ to $b_{MF} = 0.17w_0$. 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 roughly in line with the microevaluation. The relatively small intervention leads understandably to smaller impacts, even a bit smaller in the model. Specifically, the simulation predicts a smaller increase in microcredit relative to total expenditures (0.9 vs. 1.8 percentage points), entrepreneurship (0.1 vs. 1 percentage point), investment (4.5 vs. 16 percent in durable goods and 128 percent in durable goods used for business), and consumption (0.5 vs. 1 percent).

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

India	Microeval.	Model
Micro loan credit spread	12%	12%
Total microcredit relative to total credit (targeted)	$0.04 \to 0.06$	$0.04 \to 0.06$
Total microcredit relative to total expenditures	+1.8 p.p.	+0.9 p.p.
Entrepreneurship	+1 p.p.	+0.1 p.p.
Investment	+16–128%	+4.5%
Consumption	+1%	+0.5%

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 $0.11w_0$ to $0.17w_0$, 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 percentage point spread is the difference between the lending rates of microfinance institutions and commercial banks in the data. In the microevaluation, the effect on entrepreneurship, investment or consumption is not statistically significant at the 5-percent level.

are lower—see Buera et al. (2016). 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.[21]

We demonstrate the heterogeneous impacts on credit, income, and consumption in our model in Figure 2, across individuals with different entrepreneurial productivity. Using the $b_{MF} = 0.44w_0$ of the Thai study, we consider a high interest rate spread (12 percentage points, dashed lines) and a lower spread (1 percentage point, solid lines). For a given z level, we integrate over the conditional wealth distribution, including even those who do not use microfinance. The positive impacts on income and consumption are naturally larger with the low spread, especially since microcredit usage is higher, but both cases show heterogeneous impacts across the z distribution. For both credit usage (average microloans) and income, the impacts are concentrated among marginal productivity individuals, around the 75th percentile. Some of these marginal borrowers exhibit substantially smaller or even 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 concentration of the impact on marginal entrepreneurs manifests itself in another way as well: Our model predicts that new entrants under microfinance have 0.1 fewer workers on average (not shown in the figure). This is similar to the finding of Banerjee et al. that

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

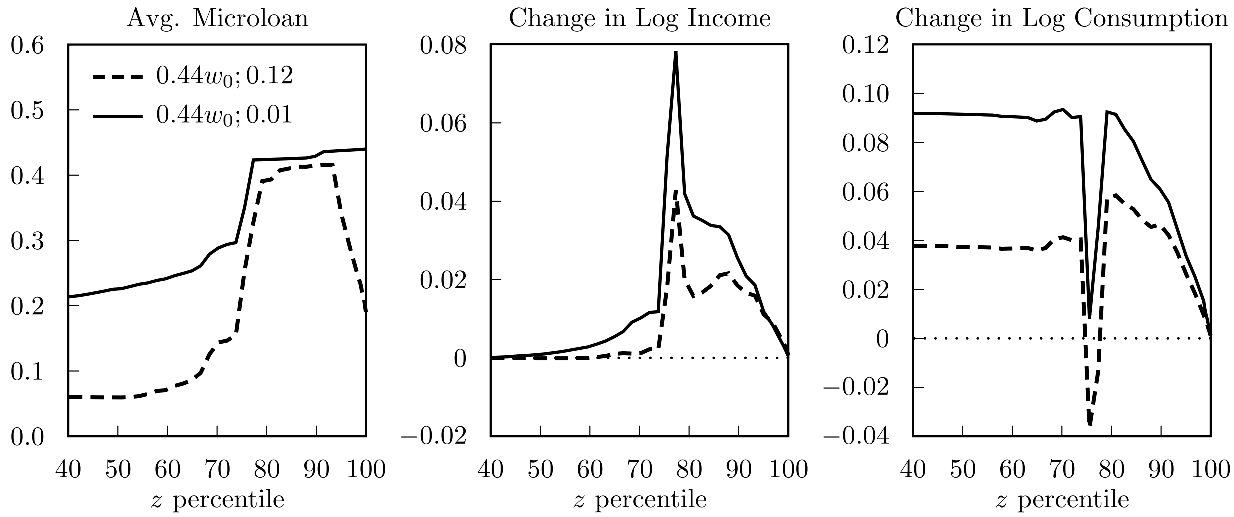

Fig. 2: Short-Run PE Effect of Microfinance by Entrepreneurial Productivity. The horizontal axes are the percentiles of z. The left panel shows the average microcredit loan relative to the initial wage for given z's (integrated over wealth, including those not using microfinance). The dashed line is for the case with a 12 p.p. spread, and the solid line for a 1 p.p. spread. The center panel shows the change in income (in log), and the right panel shows the change in consumption (in log).

new entrants under microfinance employ 0.2 fewer workers on average. (The magnitude seems small, but that is because only a small fraction of new entrants do use microfinance.) 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 magnitude 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 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 alternative 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 ($\nu = 0.12$) on microloans, and consider the lower interest rate spread in Section 5.1. This choice partly 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.

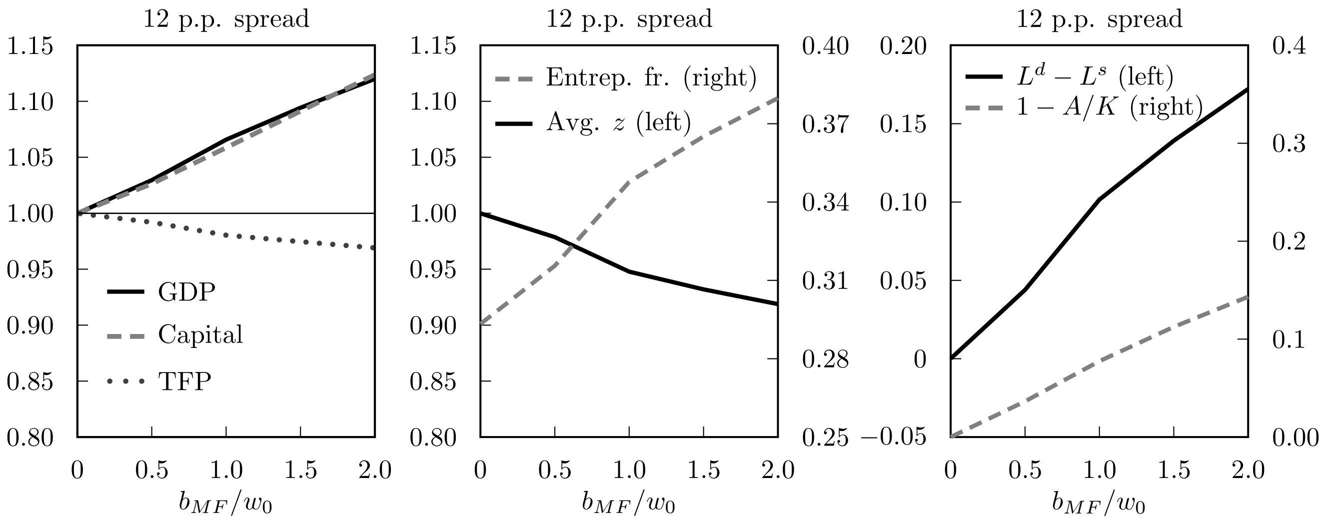

Fig. 3: Short-Run Effect of Microfinance in Partial Equilibrium. With a 12 p.p. spread on microloans and varying b_{MF} as multiples of the no-microfinance wage (horizontal axis). Output (GDP concept), capital, TFP, and average z of active entreprenerus are normalized by their respective values in the 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 (right scale). The solid line in the right panel is the excess demand of workers in the labor market (or workers from outside the economy), relative to the population size of the economy.

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. 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 13 percent. In contrast, total factor productivity (TFP) decreases by as much as 4 percent.

The center panel explains some of this decrease 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. 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 8 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 lowers 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 account for by the increase in the fraction of capital allocated to relatively unproductive entrepreneurs, those marginal entrepreneurs who disproportionately benefit from microfinance. In the appendix, we derive and plot the decomposition of the aggregate TFP: the number of entrepreneurs, the average productivity of entrepreneurs, and the allocation of capital among entrepreneurs.

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.[22]

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 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 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 13 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

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

fall in capital reflects a small decrease in asset holdings, as the aggregate saving declines in response to the availability of microfinance.

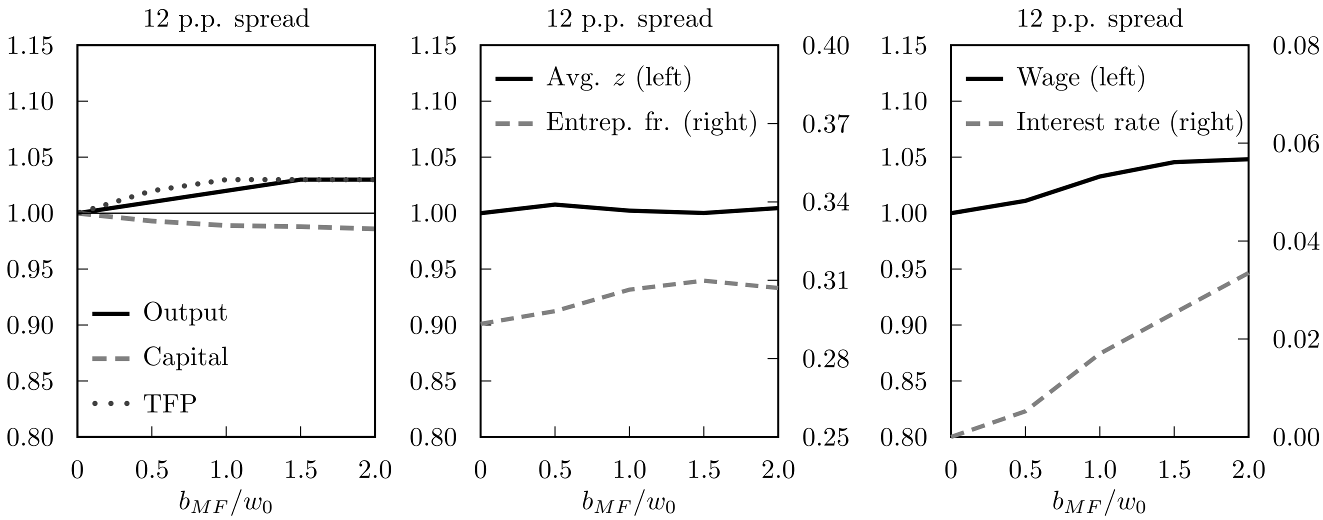

Fig. 4: Short-Run Effect of Microfinance in General Equilibrium. With a 12 p.p. spread on microloans and varying b_{MF} (horizontal axis). Output, capital, TFP, average z of active entreprenerus, and wage are normalized by their respective values in the initial stationary equilibrium without microfinance.

The right two 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, as shown in the right panel. For large values of b_{MF}, interest rates rise by more than 3 percentage points, and wages by nearly 6 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 increases by less than 2 percentage points for larger values of b_{MF}, compared to 8 percentage points in PE. Moreover, the average productivity of those who enter remains stable. With the average productivity of entrepreneurs remaining constant, the increase in TFP is driven almost equally by the larger number of entrepreneurs and the better allocation of capital across them on the intensive margin—see the decomposition figure in the appendix.

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 assets (and hence capital) fall over time. Figure 5 presents the long-run results. 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 somewhat (solid line, left panel), partly because the interest rate on saving increases (dashed line, right panel), which aids the asset accumulation and self-financing of poor but productive entrepreneurs. The increase in interest rate is even larger in the long run, up to almost 5 percentage points, as capital becomes scarcer in the long run.

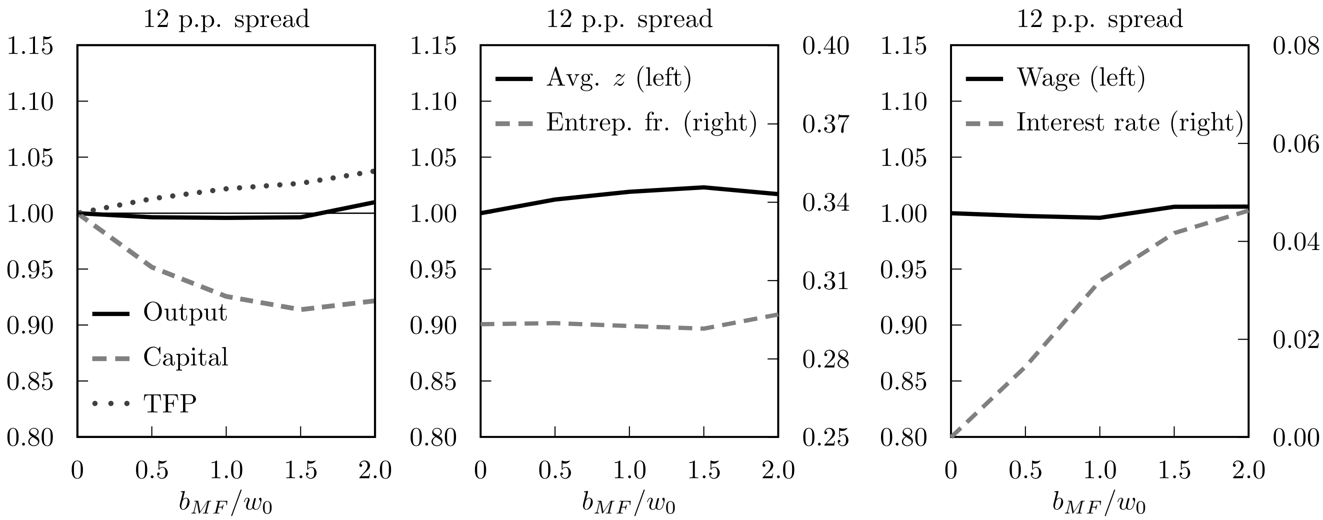

Fig. 5: Long-Run Effect of Microfinance in General Equilibrium. With a 12 p.p. spread on microloans and varying b_{MF} (horizontal axis). Output, capital, TFP, average z of active entrepreneurs, and wage are normalized by their respective values in the initial stationary equilibrium without microfinance.

In sum, in general equilibrium, 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.

Of course, if output remains constant but savings is lower in the steady state, there is clearly a consumption increase that comes from microfinance, even in GE. Moreover, there are transitional dynamics of still greater consumption along the transition path where output is still higher but saving rates have fallen. Together, these lead to welfare gains.

These 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 productivity distribution (right panel). We present these gains for the case of $b_{MF} = 0.44w_0$, 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 solid lines GE. The transitional dynamics are properly accounted for.

The figure shows that everyone gains from microfinance. In PE, the gains are largest for the poorest (dashed line, left panel) and those with marginal productivity (i.e., between the 75th and 95th percentiles; dashed line, right panel). The poor gain because their current

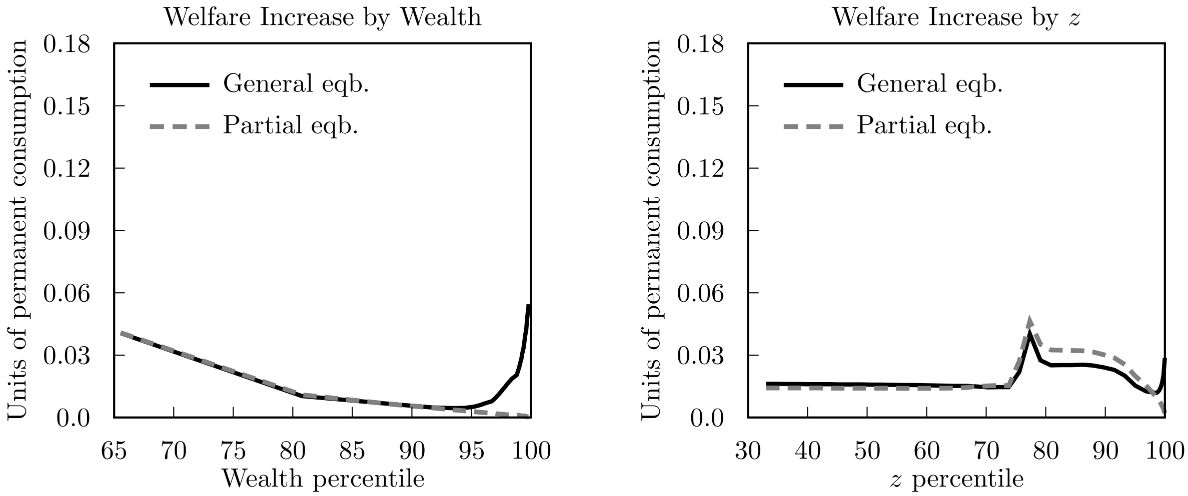

Fig. 6: Welfare Gains with Microfinance, by Wealth and Individual Productivity. The horizontal axis in the left (right) panel is the wealth (productivity) percentiles in the initial equilibrium without microfinance. The vertical axis is the welfare gains from microfinance in units of permanent consumption. For each wealth (productivity) level, the conditional entrepreneurial productivity (wealth) distribution is integrated out. We consider microcredit with $b_{MF} = 0.44w_0$ and 12 p.p. spread. In both panels, the solid lines are for general equilibria and the dashed lines for partial equilibria, properly accounting for the transition dynamics.

consumption constraint is relaxed by the consumption loan dimension of microfinance. The marginally productive gain more relatively because they face a tighter constraint than the higher productivity entrepreneurs, and hence their occupation and production decisions are relaxed by more: The rental constraint $\bar{k}$ increases with z. In GE, the marginally productive do not gain as much (solid line, right panel), because the higher factor prices discourage them from becoming entrepreneurs, especially during the transition. However, the wealthy benefit even more in GE (solid line, left panel), since higher interest rates means higher returns on wealth. For the most productive entrepreneurs, their production decision is not really affected by microfinance, but since they are on average wealthy, higher interest rates on their wealth benefit them. This explains the divergence between the solid and dashed lines in the top percentiles of z (right panel).

In sum, we find substantial welfare gains, especially for the poor and the marginally productive entrepreneurs. In addition, the GE interest rate effect benefits the very wealthy significantly, with higher returns on their wealth.

5 Extensions

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 so on.

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.

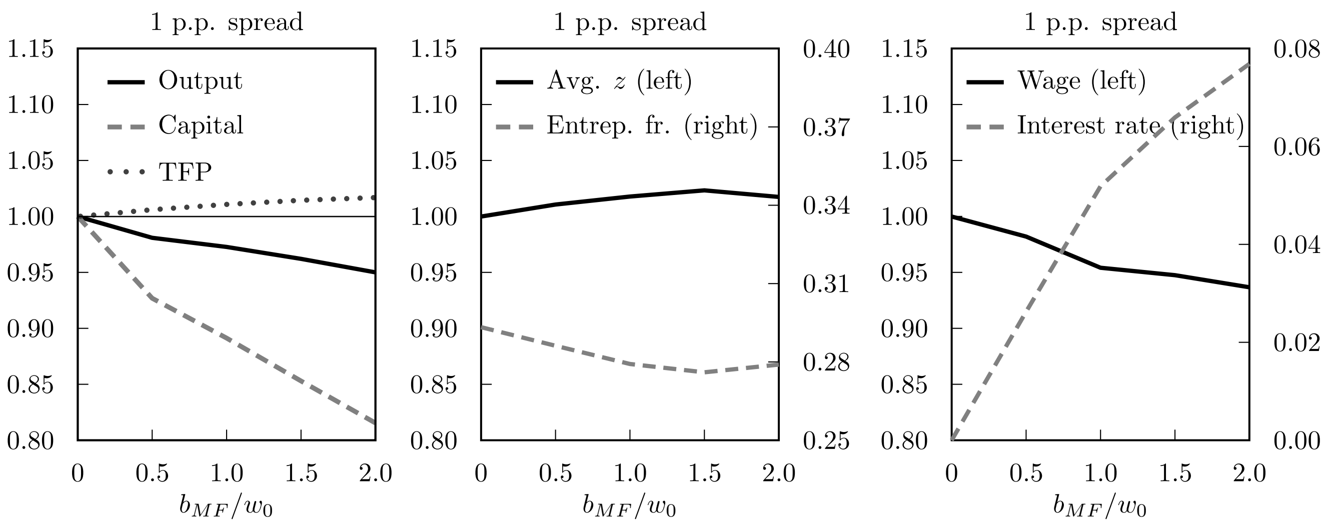

Fig. 7: Long-Run GE Implications of Low Interest Rate Microfinance. This figure is the 1 p.p. spread counterpart to Figure 5. Output, capital, TFP, average z of active entrepreneurs, and wage are normalized by their respective values in the initial stationary equilibrium without microfinance.

The long-run aggregate results in GE are presented in Figure 7. The patterns are similar to the results with the higher interest microfinance (Figure 5) in many ways, 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 18 percent lower (dashed line, left panel), and interest rates rising as much as nearly 8 percentage points (dashed line, right panel). The corresponding figures with 12 p.p. spread are 8 for capital and less than 5 for interest rate. The higher equilibrium interest rates limit entry into entrepreneurship, which actually falls (dashed line, center panel). Although average productivity of entrepreneurs still increases, the net effect results in smaller TFP gains, less than half the gains with the higher spread benchmark. The steep drop in capital and smaller gains to TFP together lead to a substantial *decline* in total output (solid line, left panel) and wages (solid line, right panel), of up to 5 and 7 percent, respectively. The entrepreneurship drops despite the lower wages because of the fall in assets that 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 margin of entrepreneurship bind more in the steady state with microfinance than in the one without.

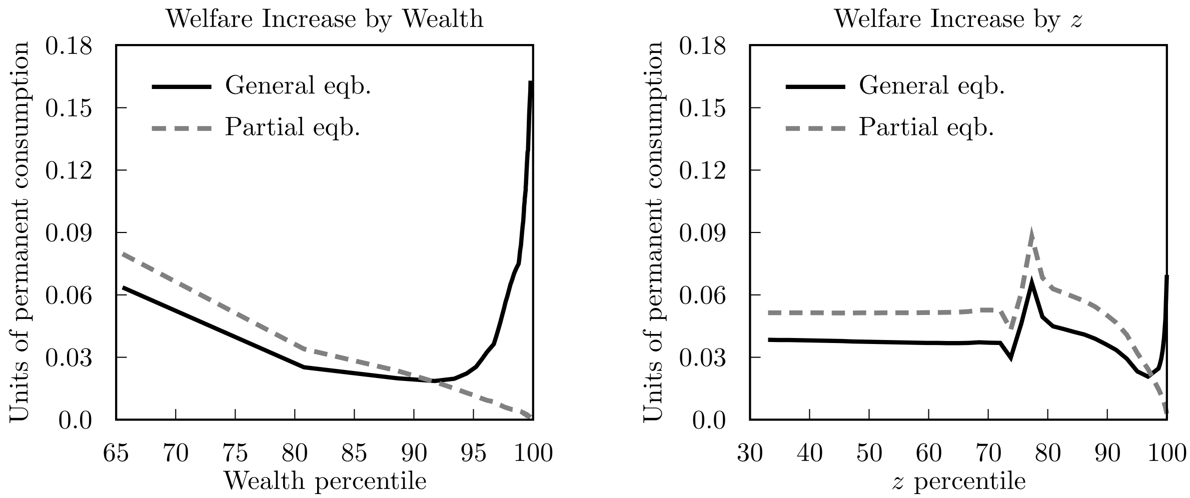

Fig. 8: Welfare Gains with Microfinance, by Wealth and Individual Productivity. The horizontal axis in the left (right) panel is the wealth (productivity) percentiles in the initial equilibrium without microfinance. The vertical axis is the welfare gains from microfinance in units of permanent consumption. For each wealth (productivity) level, the conditional entrepreneurial productivity (wealth) distribution is integrated out. We consider microcredit with $b_{MF} = 0.44w_0$ and 1 p.p. spread (in contrast to 12 p.p. in Figure 6). In both panels, the solid lines are for general equilibria and the dashed lines for partial equilibria, properly accounting for the transition dynamics.

The distribution of welfare gains in this economy are shown in Figure 8, again for the case of $b_{MF} = 0.44w_0$. Qualitatively, the distribution of welfare gains is similar to that from the higher interest rate microfinance (Figure 6), but there are quantitative differences. First, the overall gains are larger, which is predictable, since the microfinance technology improves as the intermediation costs require ν for producing microfinance as lower in this case. Second, going from PE to GE, the welfare gains tilt away more from the poor to rich (left panel) than the 12 p.p. case: An even larger interest rate increase with the lower spread represents a higher return on wealth and also more strongly reduces consumption loan demands.

5.2 Small Open Economy

We have focused on the full general equilibrium, where the change in interest rates has important 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.

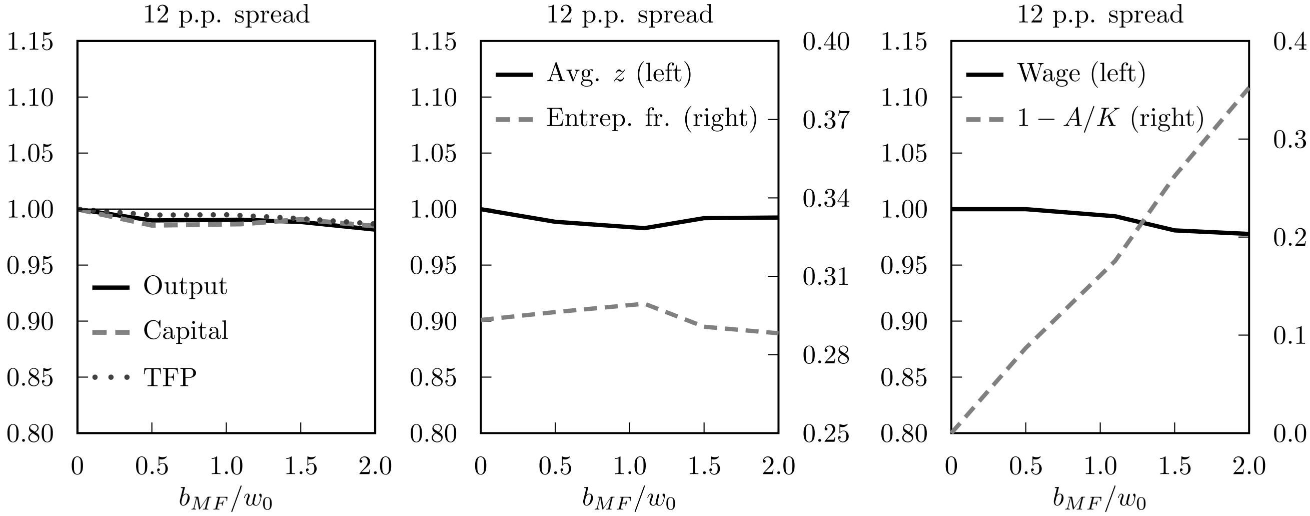

Fig. 9: Long-Run Effect of Microfinance for a Small Open Economy. With a 12 p.p. spread on microloans and varying b_{MF} (horizontal axis). Output, capital, TFP, average z of active entreprenerus, and wage are normalized by their respective values in the initial equilibrium without microfinance. For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

Figure 9 shows the results. The long-run impacts of microfinance on aggregate outcomes are small but negative, up to 2 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 increased capital in the short-run PE case (Figure 3). In the long run, however, assets fall as in GE, and assets affect the demand for capital via the collateral constraint on capital rental. Thus, even when the interest rate is fixed aggregate capital falls. Wages fall slightly, as do the number of entrepreneurs and the average entrepreneurial productivity. These explain the mild drop in TFP. In any case, the conclusion that microfinance does not have strong aggregate effects on output is robust to the small open economy assumption.

5.3 Other Extensions

We offer a brief summary of other extensions we have worked out, but we refer readers to our earlier working paper (Buera et al., 2012) for detail. These extensions are part of a model in which microfinance can only be used for production and not as consumption loan.

First, when microfinance is unavailable to finance consumption, it has similar aggregate impacts, but these impacts materialize through different GE channels. In the long-run GE case, as in our benchmark, microfinance increases TFP and decreases capital, leaving output roughly unchanged. However, the important GE channel is the increase in wages, which comes from the increase in the number of entrepreneurs and the demand for workers. Given this increase in wage, microfinance in GE redistributes from wealthy (entrepreneurs who hire many workers) toward the poor (marginal entrepreneurs and workers). In terms of welfare, microfinance still positively affects the majority of the population who are not entrepreneurs, but through higher wages rather than consumption loans.

Second, we explore even more heavily subsidized microfinance, which relates to the narratives of microfinance as quasi "grants" coming from international sources or donors.[23] 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 loan. Specifically, we assume that no rent is paid and only 90 percent of the undepreciated capital is returned—in our benchmark formulation, $\nu = -(r + \delta + 0.1)$.

The immediate implication is that microfinance has more direct and forceful redistributive effects favoring its users. For a small open economy, the long-run equilibrium with heavily subsidized microfinance exhibits many more entrepreneurs and correspondingly higher wages. This in effect is a redistribution of income from high-savers (high productivity entrepreneurs) to low-savers (marginal entrepreneurs and workers), which results in much lower aggregate saving rates. In the long run, via the collateral constraint, the lower aggregate wealth leads to lower aggregate capital than in the unsubsidized microfinance case. In summary, relaxing the full repayment requirement of microfinance loans leaves the general lessons from the benchmark analysis intact, although the redistributive effects are further strengthened by the explicit subsidy or grant portion 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.

Third, developing countries tend to have much higher rates of self-employment and entrepreneurship than advanced economies, and it is possible that many such people are entrepreneurs out of necessity rather than by choice. In this context, we consider a stochastic shock that hits labor market opportunities and idiosyncratically forces individuals into entrepreneurship, regardless of their productivity or wealth. The model generates a large mass of poor, low-productivity entrepreneurs, who earn less than the market wage. When microfinance is introduced, these forced entrepreneurs now reduce their saving rates drastically, because the access to uncollateralized financing makes it unnecessary to accumulate wealth

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

as collateral for production.[24] Thus, we have large drops in saving among poor borrowers that are used for current consumption. The steep drop in saving leads to steep drops in capital over time. In that sense, this model looks very similar to the model with consumption loans and low interest rate spreads discussed in Section 5.1.

Finally, we consider a model with a large-scale sector and a small-scale sector. 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 and small-scale sectors.

To examine this, we follow Buera et al. (2011) and introduce a second sector that requires a per-period fixed cost for production. 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. The presence of the fixed cost in the large-scale sector implies that the minimum profitable scale of operation in that sector is larger. With financial frictions, individuals will need much more collateral 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, microfinance predominantly finances entry into the small-scale sector, increasing the relative price of investment goods produced by the large-scale sector and thereby lowering capital accumulation further. However, when the microloan size is large enough to finance entry into the large-scale sector, it has the effect of lowering the relative price of the investment goods. With large enough "microfinance" loans, microfinance can lead to higher levels of aggregate capital and output in the long run (GE).

6 Concluding Remarks

Microfinance programs are growing around the world and in some countries approaching levels where general equilibrium effects should be reckoned with. 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 extrapolated from short-run partial equilibrium evalu-

[24]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.

ations. We find small, and sometimes negative, aggregate impacts on output in general equilibrium, but overall positive welfare gains. The welfare gains especially favor the poor (through consumption loans) and the marginal entrepreneurs (through small scale production loans), but the higher interest rates in 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 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.

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Appendix: 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, $l(a,z) = \left(z\theta k(a,z)^{\alpha}/w\right)^{1/(1-\theta)}$, 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:

$$Y = \frac{\left[\int_{\{(a,z):o(a,z)=E\}} z^{\frac{1}{1-\theta}} \varkappa(a,z)^{\frac{\alpha}{1-\theta}} G(da,dz)\right]^{1-\theta}}{N^{1-\alpha-\theta}} \left(\frac{L}{N}\right)^{\theta} K^{\alpha} N^{1-\alpha}. \tag{11}$$

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:

$$\varkappa^{kf}(z) = \frac{z^{\frac{1}{1-\alpha-\theta}}}{\int_{\{(a,z):o(a,z)=E\}} z^{\frac{1}{1-\alpha-\theta}} G(da,dz)}, \tag{12}$$

and the aggregate output under this efficient allocation of capital, Y^{kf}, is obtained by substituting (12) into (11). 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.

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

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.

Using this decomposition, Figure A1 presents an accounting of the role of the extensive (z-efficiency) and intensive (k-efficiency) margins in explaining TFP for the counterfactuals illustrated in Figures 3, 4, 5 and 7.

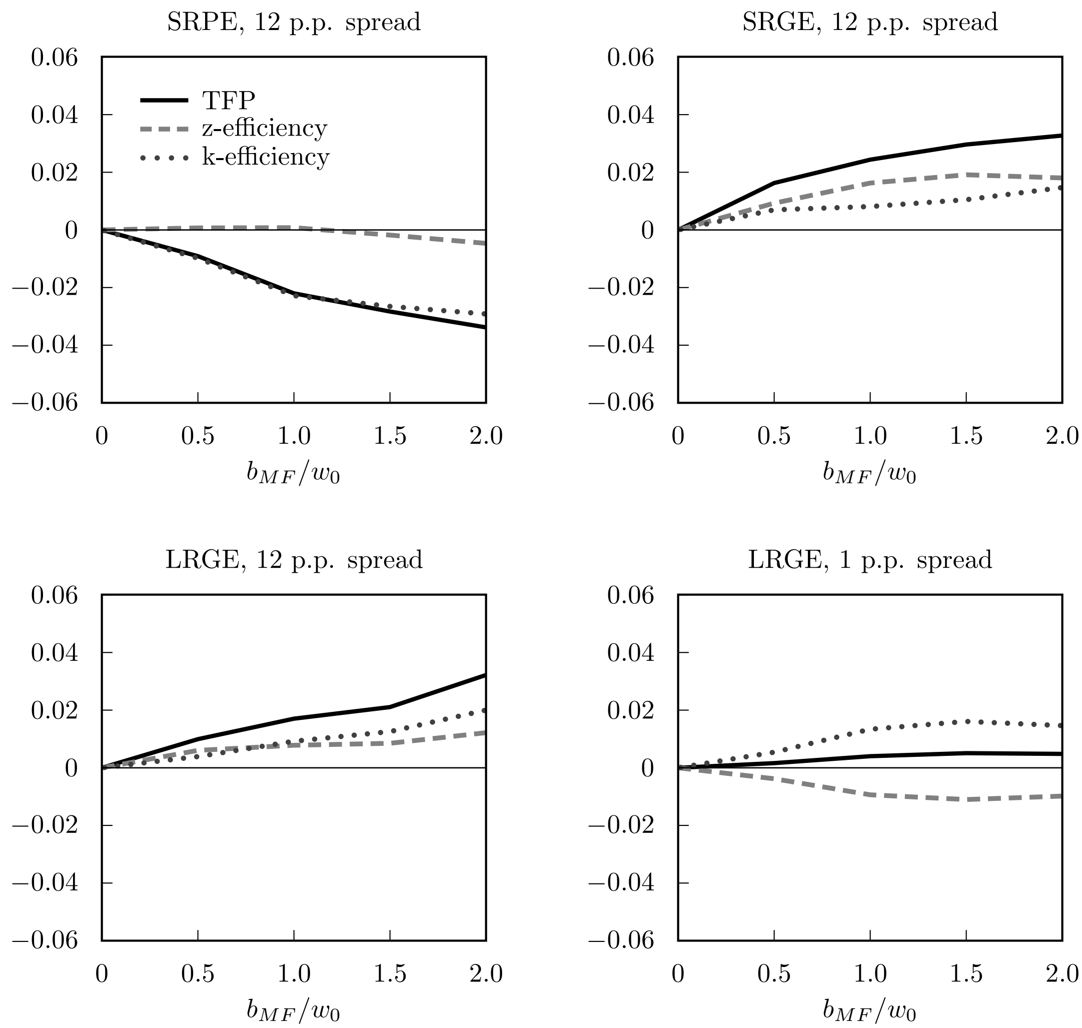

Fig. A1: Explaining TFP. This figure decomposes the effect of microfinance on TFP for different cases discussed in the paper (different panels) and varying b_{MF} (horizontal axis). In each panel, the solid line is the log deviation of TFP from the economy without microfinance. The dashed line is the contribution of the allocation of entrepreneurs at the extensive margin (z-efficiency). The dotted line is the effect of the allocation of capital across active entrepreneurs (k-efficiency). The top left panel is the short-run partial equilibrium effects of microfinance, with a 12 p.p. spread on microloans. The top right panel is the short-run general equilibrium effects, with a 12 p.p. spread. The bottom left panel is the long-run general equilibrium effects with a 12 p.p. spread. The bottom right panel also corresponds to LRGE, but with a 1 p.p. spread.