The Macroeconomics of Microfinance

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November 21, 2011

Abstract

This paper provides a quantitative evaluation of the aggregate and distributional impacts of economy-wide microfinance or credit programs targeted toward small-scale businesses. In our analysis, we find that the redistributive impacts of microfinance are stronger in general equilibrium than in partial equilibrium, but the aggregate impacts on output, capital, and consumption are smaller. The aggregate total factor productivity (TFP) decreases with microfinance in partial equilibrium, but increases in general equilibrium. Making the typical microfinance program more widely available has only a small impact on per-capita income, since the increase in TFP is offset by lower capital accumulation that stems from the redistribution of income from high-saving individuals to low-saving ones. However, the vast majority of the population are positively impacted by microfinance, but only through the equilibrium increase in wages.

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Over the past several decades microfinance—i.e., credit targeted toward small-scale entrepreneurial activities of 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 2006, access grew by up to 29 per cent a year, reaching a scale at which macroeconomic considerations become relevant. The Microcredit Summit Campaign as of 2007 reports 3,552 initiatives serving roughly 107 million borrowers, which including borrowers and their households affect 533 million people, roughly the size of Latin America. For various countries, microfinance loans represent a significant fraction of GDP.[2] Despite the growth and magnitude of such interventions and their importance in academic and policy circles, quantitative analyses of these programs are almost exclusively limited to microevaluations.[3] The macroeconomic effects of economy-wide microfinance have been largely unexplored.[4]

This paper is an attempt to fill that void by providing a quantitative assessment of the potential impacts of economy-wide microfinance availability. Our focus is a single important aspect of scaling up microfinance: general equilibrium (GE) effects. We find that typical microfinance, when made widely available in an economy, can have significant aggregate and distributional impacts, and that the GE effects on interest rates and, especially, wages are quantitatively important. Microfinance is a pro-poor redistributive policy, benefitting the poor, and especially marginal entrepreneurs, and potentially hurting the most able and rich entrepreneurs. In partial equilibrium (PE), it induces a high rate of entry among marginally productive entrepreneurs, increasing the capital, labor demand, and output, but lowering average productivity. In general equilibrium, the increase in the wage that results from marginal entrepreneurs selecting out of the labor supply amplifies the redistributional aspect of microfinance. It also leads to strikingly different impacts on output, capital, and total factor productivity (TFP). In redistributing income away from individuals with high saving rates (high-ability entrepreneurs) to those with low saving rates (marginal entrepreneurs and

[1] The United Nations, in declaring 2005 as the "International Year of Microcredit," called on a commitment to scaling up microfinance at regional and national levels in order to help achieve their Millenium 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 expanding the size of loans provided.

[2] Examples are Bangladesh (3%), Bolivia (9%), Kenya (3%), and Nicaragua (10%), as calculated using loan data from the Microfinance Information Exchange and domestic prices GDP numbers from the Penn World Tables.

[3] The microevaluations of the economic impacts of microcredit on households include Pitt and Khandker (1998), Banerjee et al. (2009), Kaboski and Townsend (2011a), and Karlan and Zinman (2010a,b).

[4] We note two important exceptions. Ahlin and Jiang (2008), using the stylized model of Banerjee and Newman (1993), derive the theoretical conditions under which microfinance can lead to aggregate development. Kaboski and Townsend (2011b) use reduced-form methods to estimate the general equilibrium effects of village banks on wages and interest rates within the village.

workers), microfinance lowers aggregate savings and capital accumulation. Higher wages and interest rates also lead low-productivity but rich entrepreneurs to exit. Hence, in general equilibrium, TFP actually increases with microfinance in contrast to the PE results. In net, the lower capital accumulation but higher TFP lead the positive overall impacts on consumption and output, but these aggregate effects are substantially smaller than in partial equilibrium.

To develop the analysis, we start from a model of entrepreneurship and heterogeneous producers in which financial frictions have already been shown to have sizable impacts on TFP, capital accumulation, and wages (Buera et al., 2011). Individuals choose in each period whether to become an entrepreneur or supply labor for a wage. They have different levels of entrepreneurial productivity and wealth. The former evolves stochastically, generating the need to reallocate capital and labor from previously-productive entrepreneurs to currently-productive ones. Financial frictions—which we model in the form of endogenous collateral constraints founded on imperfect enforceability of contracts—hinder this reallocation process.

Into this environment, we introduce microfinance. While being agnostic about the underlying innovation behind microfinance, we view it as a financial intermediation technology that guarantees people access to (and full repayment of) productive capital up to a limit regardless of their collateral or entrepreneurial talent. Since we model economy-wide microfinance, everyone has access to it in principle. However, since the wealthy already have access to financing beyond the microfinance limit, only the poor entrepreneurs have their choice set expanded by microfinance, and the marginal entrepreneurs—who choose not to save to self-finance their business in the absence of microcredit—are significantly impacted in a most direct way.

We discipline and validate our analysis on two fronts. We first require that our model matches data from developed and developing countries on the distribution and dynamics of establishments, and the ratio of external finance to GDP. We then compare the short-run partial equilibrium implications of our calibrated model with measured impacts from recent microevaluations of interventions in urban India (Banerjee et al., 2009) and rural Thailand (Kaboski and Townsend, 2011a,b). We find that our model captures the overall level of credit and the increase in investment and entrepreneurship, including the entry of marginal entrepreneurs. Although the model does not address consumption loans, and hence underpredicts the increase in consumption, it nevertheless captures the heterogeneous impact on consumption reported in the above empirical studies. Thus, the mechanisms we model are important in empirical studies, and their orders of magnitude are comparable.

We then use the model to quantify the relationship between the size of microfinance—that is, the guaranteed borrowing limit—and key macroeconomic measures of development in steady states: output, TFP, capital, wage and interest rates, and its distributional consequences. We begin with the impacts on long-run outcomes in partial equilibrium (PE), and then contrast these with the corresponding impacts in general equilibrium.

In the long-run PE case, wages and interest rates are held fixed, and we do not clear markets. Output and consumption increase monotonically with the size of the intervention, each increasing by about 45 percent for guaranteed credit limit of two times the annual wage, which is the typical size of microfinance loans. The increase in output is driven by an increase in capital, augmented by savings accumulation over time, and labor inputs; TFP actually declines somewhat, reflecting the entry of marginal entrepreneurs.

In GE, the results are quite different. In order to clear labor markets, wages rise monotonically with the level of microfinance, by 7 percent for guaranteed borrowing that is twice the annual wage. This increase is in line with the wage increase empirically observed in Kaboski and Townsend (2011b). Higher wages lead to higher TFP, since higher wages induce exit of low-productivity-but-high-wealth entrepreneurs. TFP rises by 5 percent, and almost all of the TFP gain comes from a more efficient distribution of capital (intensive margin). Nonetheless, the higher wage redistributes wealth from higher-ability entrepreneurs with higher saving rates to lower-productivity individuals with lower saving rates. Thus, aggregate saving rates fall, and likewise capital falls monotonically, by roughly 9 percent. With a capital share of 0.33, this offsets a large part of the increase in TFP, so output increases by less than 2 percent. Given lower savings rates, however, the impacts are slightly larger in terms of consumption (3 percent).

While the aggregate impacts of microfinance on output and consumption are much smaller in general equilibrium than they would be in partial equilibrium, microfinance is even more strongly pro-poor in general equilibrium because of the higher wage. The welfare gains for those with essentially zero wealth (the vast majority of the population) are roughly twice as large under general equilibrium, equivalent to 8 percent of their permanent consumption for guaranteed credit of twice annual wages. Similarly, the welfare gains of low ability agents—those with no intention of becoming entrepreneurs—are equivalent to about 6 percent of permanent consumption, or more than three times the gains in partial equilibrium. However, the GE effects make the highest ability and highest wealth entrepreneurs of the economy actually worse off from economy-wide microfinance, because their entrepreneurial profit falls with the higher factor prices. To sum up, a large part of the distributional impact of microfinance follows from GE effects.

We analyze three variations of the model that add additional insights, and highlight important alternative modeling assumptions. The first extension models a small open economy in which microfinance borrowers do not compete with other borrowers for aggregate capital.

This model broadly reproduces the patterns in the benchmark model both quantitatively and qualitatively, including the sharp decline in capital. Although the supply of capital is infinitely elastic, the demand for overall capital decreases; the increased demand for capital from the availability of uncollateralized loans is more than offset by the decreased demand due to lower accumulation of collateral by talented entrepreneurs. The second extension introduces an idiosyncratic shock to labor supply that effectively forces individuals, even those with little capital and/or ability, into entrepreneurship. This captures the idea of undercapitalized, low-ability entrepreneurs with few labor market alternatives. In this model, for levels of microfinance up to three times annual wages, the resulting rise in interest rates induces marginal entrepreneurs to become workers, and wages and output actually fall. The third extension follows Buera et al. (2011) by introducing a large-scale sector that requires a large fixed cost for production. This adds a third general equilibrium effect (the relative price between the large- and small-scale sectors) and microfinance plays an important role in how resources (capital, labor, and entrepreneurial talent) are allocated between the two sectors. When guaranteed credit is sufficient to directly finance entrepreneurship in the large-scale sector, the available credit can dramatically increase output, TFP, and even capital.

The rest of the paper is organizes as follows. Section 1 provides empirical motivation by summarizing important microfinance programs, reviewing the literature, and showing microevidence for the saving patterns underlying our capital accumulation effect. In Section 2, we develop the model, including the microfinance intervention. Section 3 describes the calibration, benchmark partial equilibrium results, and a detailed comparison of our results with empirical microevaluations. We contrast these with general equilibrium results in Section 4, and then provide extensions. Section 5 concludes.

1 Empirical Motivation

This section documents the importance and main characteristics of microfinance and other government-sponsored credit programs targeted toward small-scale entrepreneurs across the world. We also review the existing studies on microfinance, and summarize the empirical literature on differences in savings rates among entrepreneurs and non-entrepreneurs to motivate an important feature of our model economy.

1.1 Credit Programs

Microfinance programs and other credit programs targeted toward small-scale entrepreneurs are both prevalent and growing. The Microcredit Summit Campaign Report (2011) documents 3,552 institutions with reported loans to over 155 million clients throughout the world as of 2007. For comparison, the numbers in 1997 were 618 institutions and 13 million clients. The six-fold increase in the number of institutions and 12-fold increase in the number of borrowers over 10 years certainly overstates average growth—because of an increase in survey participation—but the actual growth is still dramatic. For example, a single program, the National Bank for Agriculture and Rural Development (NABARD) in India grew from 146,000 to 49 million clients over this period. By the same token of incomplete survey participation and coverage, these numbers certainly understate the actual number of institutions and borrowers.

Microloans are, almost by definition, small, and typically relatively short-term (e.g. one year or less), and have high repayment rates. A broad vision of the structure of microlending can be gleaned from the Microfinance Information Exchange (MIX) Dataset, which provide comparable data of 1127 microfinance institutions in 102 countries, totalling $65 billion in outstanding loans and serving over 90 million borrowers in 2009. The average loan balance per borrower is $655 dollars in 2009, but because these are in poor countries, they are equivalent on average to a fifth of per-capita gross national income. Moreover, since per-capita income overstates median personal income, and microfinance is often targeted toward the poorer segments of the economy, the average loan is likely a substantially larger fraction of the income *of borrowers*. The variation across institutions is also large, with a standard deviation of 84 per cent, and the highest ratio of average loan balance to per-capita income is 4. A important achievement of microfinance is its success in providing uncollateralized loans with relatively low default rates. In 2009, only 5 per cent of loans were more than 90 days delinquent.[5]

Country	Borrowers per-capita	MF Loans /GDP	Average Loan Balance	Per-capita Income	Total Credit / GDP
Bangladesh	0.13	0.028	112	547	0.37
Mongolia	0.13	0.129	1393	1410	0.62
Peru	0.11	0.041	1590	4658	0.21
Bolivia	0.09	0.107	1926	1776	0.31
Vietnam	0.09	0.044	510	1024	1.06
Kenya	0.04	0.036	744	803	0.20
India	0.02	0.003	146	1154	0.53
Mean	0.02	0.004	655	3192	0.50
Std. Dev.	0.03	0.020	3192	3071	0.30

Table 1: Microfinance Facts, MIX Data

[5]This number overstates historical default rates, as it partially reflects the impact of the world recession. For instance, the figure for 2008 is 3 per cent. There is also significant heterogeneity in delinquency rates across countries. In the MIX data, 10 per cent of the countries report less than 1 per cent of loans delinquent, while slightly over 10 per cent of the countries report more than 10 per cent of loans in this category, with the Central African Republic being the country with the highest delinquency rate at 24 per cent.

For some countries the expansion of microfinance is reaching very significant levels, with up to 13 per cent of the population being active borrowers, and the value of loans outstanding reaching close to 13 per cent of GDP. This is illustrated in Table 1, where we report the size of microcredits for the top five countries in term of the number of borrowers per-capita, as well as Kenya which is the country with the largest penetration in Africa, and India, the country with the largest absolute number of microfinance clients. In Table 1 we can also appreciate that the expansion of microfinance is particularly important among the poorest countries, for which credit markets are very underdeveloped.

NGOs and private for-profit institutions play a large role in global microfinance. In the MIX data, NGOs constitute 37 per cent of the institutions and reach 30 per cent of the borrowers. Private banks constitute 7 percent of the institutions, but, because they are larger, they reach another 27 percent of the borrowers in the data, and account for 63 per cent of the total value of loans.[6] Government initiatives in microfinance and other credit programs targeted toward small-scale entrepreneurs are still important, and many of these are not accounted for in the MIX Dataset. We review public programs in two countries, India and Thailand. There have been recent microevaluations in these two countries, one evaluating a public intervention (Thailand) and the other private (India).

In India, the banking and credit sector is dominated by state-owned banks. NABARD is the government rural development bank which operates through state co-operative banks, state agricultural and rural development banks, regional rural banks, and even commercial banks. A major program of NABARD is the promotion of small-scale Self Help Groups (SHG) for savings and internal lendings. In 2009, 4.2 million credit-linked SHGs had roughly \$5.1 billion in outstanding loans, of which almost \$2.7 billion was new loans. We calculate an average loan size of \$1,200, or roughly 140 per cent of per-capita income. In addition, another roughly \$80 million went to microfinance institutions. These loans were then distributed to members of the SHGs. Once we incorporate NABARD's information to the Indian figures in Table 1, the number of borrowers per-capita in India increase to 6 per cent, and the value of loans outstanding are close to 1 per cent of GDP.

In addition, Banerjee and Duflo (2008) describe regulations governing all (private and public) banks that stipulate that 40 per cent of credit must go toward priority sectors—agriculture, agricultural processing, transportation, and small-scale industry. Large firms (plants and machinery in excess of Rs. 10 million in 2000) were excluded from the priority

[6]Non-bank Financial Institutions, which provide some services similar to those of banks, but are subject to different regulations, are another important type of MFI. They account for 36 per cent of the MFIs, 38 per cent of the borrowers, and 21 per cent of the loans. Most of these are for-profit entities. Overall, for-profit institutions account for 41 per cent of the MFIs, serve 56 per cent of the borrowers, and lend 73 per cent of the loans.

sector. They show that these regulations are indeed binding.

Thailand is another country that has had a large, government-sponsored expansion of credit to village banks for microlending. In 2001, the Thai Million Baht Village Fund program (MBVF) was inaugurated, which offered one million baht (roughly $25,000 at the time) to each of the nearly 80,000 villages in Thailand, as a seed grant for starting a village lending and saving fund. The $1.5 billion was tantamount to about 1.5 per cent of Thai GDP at the time. Loans were typically made without collateral, up to roughly $1,250, but most loans were annual loans of about $500, about 40 per cent of per-capita income at the time. Kaboski and Townsend (2011a) show that borrowing limits varied by village size, and they estimate that the program allowed households to borrow up to 91 per cent of annual household income in the smallest villages. The experience of funds also varied, but typically showed high repayment rates (97 per cent) over several years. These funds were evaluated, and successful funds were offered to leverage their capital through loans of up to an additional one million baht from the Government Savings Bank and the Bank of Agriculture and Agricultural Cooperatives, becoming true village banks.

In addition, Thailand has two public banks, the Bank of Agriculture and Agricultural Cooperatives, and the Government Savings Bank, a more urban bank. In practice, these institutions target credit toward lower income borrowers, and all financial institutions are required to hold a minimum amount of assets in these public banks, providing an implicit subsidy. The former was an early pioneer in joint liability lending, while the latter claims to be one of the largest microfinance institutions in the world.

1.2 Existing Literature

A theoretical literature has emphasized the aggregate and distributional impacts of financial intermediation in models of occupational choice and financial frictions (Banerjee and Newman, 1993; Aghion and Bolton, 1997; Lloyd-Ellis and Bernhardt, 2000; Erosa and Hidalgo Cabrillana, 2008). In these studies, improved financial intermediation induces entry into entrepreneurship, increased productivity and investment, and a general equilibrium effect that increases the wage. In these studies, the distribution of wealth (Banerjee and Newman, 1993) and often the joint distribution of wealth and productivity (Lloyd-Ellis and Bernhardt, 2000; Erosa and Hidalgo Cabrillana, 2008) are critical. A related quantitative literature has found impacts of increases in financial intermediation in these models on productivity and income to be sizable (Giné and Townsend, 2004; Amaral and Quintin, 2009; Jeong and Townsend, 2007, 2008), but Buera et al. (2011) and Buera and Shin (2010) show that modeling endogenous saving responses over a long horizon and general equilibrium effects on interest rates are important to quantitative assessment. This paper is the first to evaluate the quantitative impact of microfinance as a targeted form of financial intermediation. We follow this literature by evaluating microfinance within a model that incorporates occupational choice, endogenous wages and interest rates, and rich savings decisions.[7]

Microfinance or microcredit has been viewed as a technological or policy innovation enabling high repayment of uncollateralized loans. Alternative theories of the precise nature of this technology have been proposed, including joint liability lending (e.g., Besley and Coate (1995)), high frequency repayment (e.g., Jain and Mansuri (2003)), and dynamic incentives (e.g., Armendariz and Morduch (2005)). Unfortunately, empirical tests of the importance of these alternative mechanisms have not produced a smoking gun in terms of the nature of technology leading to high repayment (e.g., Ahlin and Townsend (2007); Field and Pande (2008); Gine and Karlan (2010)). We therefore take an agnostic approach to the nature of this technology and simply model it as an innovation that allows for a minimum uncollateralized loan.

There is a recently growing empirical literature evaluating microfinance. The closest related study is Kaboski and Townsend (2011b), who study a larger intervention that involved the injection of funds amounting to up to 40 percent of village income. The intervention led to positive impacts on village-level wages, interpreted as localized general equilibrium effects. Kaboski and Townsend find increases in income and business income but not actual business starts. Their companion paper Kaboski and Townsend (2011a) finds increases in investment, but their model stresses that microfinance availability induces investment only for those close to the investment margin, and therefore large samples are required to pick up impacts on investment.[8] The largest impacts of the program were on consumption, however. Kaboski and Townsend (2011a) note that the the impacts on consumption are heterogeneous, varying across investors/non-investors and borrowers/non-borrowers.

The rest of this literature has focused on estimating partial equilibrium impacts of relatively-small interventions. While each study is in some sense unique, they generally find positive impacts on business activity, while some also find impacts on consumption/expenditures as well. The earliest study by Pitt and Khandker (1998) found positive impacts on expenditures and hours worked, especially among women for whom most work is self-employment. In a randomized intervention, Karlan and Zinman (2010b) do not find direct effects on business starts, but they do find impacts on business profits. citetBane09,

[7] Ahlin and Jiang (2008) study the aggregate impact of microfinance within the context of a Banerjee and Newman (1993) model. The analysis is theoretical rather than quantitative. They show that in a model with exogenous saving decisions and interest rates, general equilibrium effects on wages can impact the ability of people to finance large-scale projects and can determine whether microfinance increases or decreases aggregate output in the steady state.

[8] Related, citetBueh10 , a recent study examining the same intervention, finds significant positive impacts on entrepreneurship using data that lacks a baseline but has a much larger sample.

another randomized intervention with a much larger sample, do find positive impacts onbusiness starts rather than just labor supply, business income/profits, or investment.[9] Neither Karlan and Zinman nor Banerjee et al find impacts on aggregate consumption/expenditures, but Banerjee et al. confirm heterogeneous impacts on consumption, even among those who do not own businesses, driven presumably by changing in savings behavior rather than general equilibrium effects.

In summary, the impacts are *prima facie* qualitatively in line with the aforementioned theories. We perform a more critical comparison of these results with our theory in Section 3.3.

1.3 Savings Heterogeneity

A central feature of our mechanism is the differential endogenous saving rates between entrepreneurs and workers, and between high- and low-ability people. In this section we present empirical support for these patterns.

Quadrini (1999), Gentry and Hubbard (2000), and Buera (2009) provide evidence of savings behavior among entrepreneurs and non-entrepreneurs in the US that is qualitatively consistent with the mechanism that we emphasize. Specifically, using data from two rounds of the Survey of Consumer Finance, and defining savings as the change in net worth, Gentry and Hubbard find that the median saving rates for entrants and continuing entrepreneurs were 36 percent and 17 per cent, respectively. In comparison, the median saving rate for non-entrepreneurs was just 4 per cent, while that for exiting entrepreneurs was *minus* 48 per cent. The pattern is robust to regression analyzes that include demographic controls. Quadrini analyzes data from the Panel Study of Income Dynamics and finds that the propensity for entrepreneurship is significantly related to higher rates of wealth accumulation, even after controlling for income. Buera confirms that business owners save on average 26 per cent more than non-business owners, but also shows that, just prior to starting a business, future business owners save on average 7 per cent more than non-business owners. Finally, Buera shows that after entry young entrepreneurs have higher saving rates than mature entrepreneurs.

In the context of a developing country, Pawasutipaisit and Townsend (2010) use monthly longitudinal survey data to construct corporate accounts for households in rural and semi-urban Thailand. They have several findings of relevance to our study. First, returns on assets are highly persistent, and they are therefore interpreted as a measure of productivity. Second, increases in net savings are positively associated with the return on assets (correlation of 0.53)

[9] Kaboski and Townsend (2005) find evidence of increased occupational mobility, but the exogenous source of variation in microfinance availability is driven by training and savings related policies.

and also the saving rate (correlation of 0.21), both of which are significant at the one-percent level. These significant positive relationships are robust to the addition of control variables, fixed effects, instrumenting for productivity, and using TFP estimates as an alternative measure of productivity.

Although the Thai study is a very different environment from the US research, all of the studies provide evidence that entrepreneurial ability matters for savings behavior. In the United States, entrepreneurial decisions are a reasonable proxy for entrepreneurial ability because financial markets are relatively developed, so entry depends less on wealth and more on ability (Hurst and Lusardi, 2004). However, in Thailand, where financial frictions are stronger, entrepreneurial decision are more constrained by wealth and thus less related to productivity (Paulson and Townsend, 2004).

2 Model

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

There are measure N of infinitely-lived individuals, who are heterogeneous in their wealth and the quality of their entrepreneurial idea or talent, z. Individuals' wealth is determined endogenously by forward-looking saving behavior. The entrepreneurial idea is drawn from an invariant distribution $\mu(z)$. 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 quality of the previous idea; that is, γ controls the persistence of the entrepreneurial idea or talent process. The γ shock 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: whether to work for a wage or to operate a business (entrepreneurship). Their occupation choices are based on their comparative advantage as an entrepreneur (z) and their access to capital. Access to capital is limited by their wealth through an endogenous collateral constraint, because of imperfect enforceability of capital rental contracts. We model microfinance as an innovation that guarantees the repayment of a minimum uncollateralized loan regardless of entrepreneurs' wealth or talent.

One entrepreneur can operate only one production unit (establishment) in a given period. Entrepreneurial ideas are inalienable, and there is no market for managers or entrepreneurial talent. The way we model an establishment draws upon the span of control of Lucas (1978).

2.1 Preferences

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

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

where β is the discount factor, and σ is the coefficient of relative risk aversion. The expectation is over the realizations of entrepreneurial ideas (z), which depend on the stochastic death of ideas $(1-\gamma)$ and on draws from $\mu(z)$.

2.2 Technology

At the beginning of each period, an individual with entrepreneurial idea z and wealth a chooses whether to work for a wage w or operate a business. An entrepreneur with talent 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.

Given factor prices w and R (rental rate of capital), the profit of an entrepreneur is:

$$\pi(k,l;R,w) = zk^{\alpha}l^{\theta} - Rk - wl.$$

For later use, we define the optimal level of capital and labor inputs when production is not subject to financial constraints:

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

2.3 Credit (Capital Rental) 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. 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 ($a \geq 0$). The zero-profit condition of the intermediaries implies $R = r + \delta$, where r is the deposit and lending rate and δ is the depreciation rate.

Capital rental by entrepreneurs are limited by imperfect enforceability of contracts. In particular, we assume that, after production has taken place, entrepreneurs may renege on the contracts. In such cases, the entrepreneurs can keep the 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.

Note that ϕ indexes the strength of an economy's legal institutions enforcing contractual obligations. This one-dimensional parameter 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 no credit ($\phi = 0$) and those with perfect credit markets ($\phi = 1$).

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 inputs 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 talent 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 their contracts can be represented by a function $\bar{k}(a,z;\phi)$, which is increasing in a, z, 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 is sufficient to characterize enforceable allocations because we assume that defaulting entrepreneurs regain full 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 talent of an entrepreneur 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 and repayment of additional capital input. While the *total* capital limit will depend on the individuals' assets, this additional capital is independent of wealth and talent. To be more specific, we incorporate microfinance by relaxing individuals' capital rental limit into the following constraint:

$$k \leq \max\{\bar{k}(a, z; \phi), a + b^{MF}\}$$

where b^{MF} denotes the intra-period borrowing limit of (i.e., the additional capital provided by) the microfinance innovation. Note that an entrepreneur chooses either to rent from the financial intermediary subject to the endogenous rental limit $\bar{k}(a, z; \phi)$ or to use microfinancing to top up his self-financed capital $a + b^{MF}$.

Our modeling of microfinance can be interpreted as a technological innovation that enables financial intermediaries to receive full repayment on small uncollateralized loans.[10] Alternatively, microfinance can be thought of as a government policy that guarantees loans for small firms, such as that of the US Small Business Administration. Either way, we are abstracting from the cost associated with operating microfinance institutions or the cost of, and implicit subsidy to defaulters. In this context, our results should be interpreted as an upper bound on the gains from microfinance.

2.5 Recursive Representation of Individuals' Problem

Individuals maximize (1) by choosing sequences of consumption, financial wealth, occupations, and capital/labor inputs if they choose to be entrepreneurs, subject to a sequence of period budget constraints and rental limits.

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

$$v(a, z) = \max\left\{v^W(a, z), v^E(a, z)\right\}. \tag{3}$$

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

[10]The exact nature of this innovation is being debated, and is thought to take the form of dynamic incentives, joint liability, and/or community sanctions.

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

$$v^{W}(a,z) = \max_{c,a' \geq 0} u(c) + \beta \{\gamma v(a',z) + (1-\gamma)\mathbb{E}_{z'}[v(a',z')]\} \tag{4}$$
$$\text{s.t. } c + a' \leq w + (1+r)a,$$

where w is his labor income. The continuation value is a function of the end-of-period state (a',z'), where $z'=z$ with probability γ and $z' \sim \mu(z')$ with probability $1-\gamma$. In the next period, he will face an occupational choice again, and the function $v(a,z)$ appears in the continuation value.

Alternatively, individuals can choose to become an entrepreneur. The value function of being an entrepreneur is as follows.

$$v^{E}(a,z) = \max_{c,a',k,l \geq 0} u(c) + \beta \{\gamma v(a',z) + (1-\gamma)\mathbb{E}_{z'}[v(a',z')]\} \tag{5}$$
$$\text{s.t. } c + a' \leq zf(k,l) - Rk - wl + (1+r)a$$
$$k \leq \max\left\{\bar{k}(a,z;\phi), a + b^{MF}\right\}$$

Note that an entrepreneur's income is given by period profit $zf(k,l) - Rk - wl$ plus the return to his initial wealth, and that his choices of capital inputs are constrained by the larger of $\bar{k}(a,z;\phi)$ and b^{MF}.

2.6 Stationary Competitive Equilibrium

A stationary competitive equilibrium is composed of: an invariant distribution of wealth and entrepreneurial ideas $G(a,z)$, with the marginal distribution of z denoted with $\mu(z)$; policy functions $c(a,z)$, $a'(a,z)$, $o(a,z)$, $l(a,z)$, $k(a,z)$; rental limits $\bar{k}(a,z;\phi)$; and prices w, R, r such that:

1. Given $\bar{k}(a,z;\phi)$, w, R, and r, the individual policy functions $c(a,z)$, $a'(a,z)$, $o(a,z)$, $l(a,z)$, $k(a,z)$ solve (3), (4) and (5);

2. Financial intermediaries make zero profit: $R = r + \delta$;

3. Rental limits $\bar{k}(a,z;\phi)$ are the most generous limits satisfying condition (2), with $\bar{k}(a,z;\phi) \leq k^{u}(z)$;

4. Capital rental, labor, and goods markets clear:

$$\frac{K}{N} \equiv \int k(a,z)\,G(da,dz) = \int aG(da,dz) \tag{Capital rental}$$

$$\int l(a,z)\,G(da,dz) = \int_{\{o(a,z)=W\}} G(da,dz) \qquad \text{(Labor)}$$

$$\int c(a,z)\,G(da,dz) + \delta\frac{K}{N} = \int_{\{o(a,z)=E\}} \left[zk(a,z)^{\alpha}\,l(a,z)^{\theta}\right] G(da,dz) \qquad \text{(Goods)}$$

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

$$G(a,z) = \gamma \int_{\{(\tilde{a},\tilde{z})|\tilde{z}\le z, a'(\tilde{a},\tilde{z})\le a\}} G(d\tilde{a},d\tilde{z}) + (1-\gamma)\,\mu(z) \int_{\{(\tilde{a},\tilde{z})|a'(\tilde{a},\tilde{z})\le a\}} G(d\tilde{a},d\tilde{z})\,.$$

A competitive equilibrium consisting of sequences of wealth distributions $\{G_t(a,z)\}_{t=0}^{\infty}$, policy functions, rental limits, and prices $\{w_t, r_t\}_{t=0}^{\infty}$, is defined in an analogous fashion.

3 Quantitative Analysis

To quantify the aggregate and distributional impact of microfinance, we calibrate our model in two stages. First, using the US data on standard macroeconomic aggregates, we calibrate a set of technological and preference parameters that are assumed to be the same across countries. In the second stage, using data from India, we choose ϕ, the parameter governing the enforcement of contracts, to match the external finance to GDP ratio, and jointly calibrate the parameter governing the establishment distribution. We then conduct experiments to assess the effect of microfinance by varying b^{MF}, the maximum loans guaranteed under microfinance.

3.1 Calibration

We first calibrate preference and technology parameters so that the perfect-credit economy matches key aspects of the US, a relatively undistorted economy. Our target moments pertain to standard macroeconomic aggregates, and establishment size distribution and dynamics, among others.

We need to specify values for seven parameters: two technological parameters, α, θ, and the depreciation rate δ; two parameters describing the process for entrepreneurial talent, γ and η; the subjective discount factor β, and the coefficient of relative risk aversion σ. Of these seven parameters, η will be re-calibrated below to match the Indian data.

One preference parameter, σ, and two technological parameters, $\alpha/(1/\eta + \alpha + \theta)$ and δ, can be set to standard values in the literature. We let $\sigma = 1.5$. The one-year depreciation rate is set at $\delta = 0.06$, and we choose $\alpha/(1/\eta + \alpha + \theta)$ to match the aggregate capital income share of 0.30.[11]

Target Moments	US Data	Model	Parameter
Top 10-percentile employment share	0.69	0.69	$\eta = 4.84$
Top 5-percentile earnings share	0.30	0.30	$\alpha + \theta = 0.79$
Establishment exit rate	0.10	0.10	$\gamma = 0.89$
Interest rate	0.04	0.04	$\beta = 0.92$
Target Moments	Indian Data	Model	Parameter
Top 10-percentile employment share	0.58	0.58	$\eta = 5.56$
External finance to GDP ratio	0.34	0.34	$\phi = 0.08$

Table 2: Calibration

We are thus left with the four parameters that are more specific to our study. We calibrate them to match as many relevant moments in the US data as shown in Table 2: the employment share of the top decile of establishments; the share of earnings generated by the top five per cent of earners; the annual exit rate of establishments; and the annual real interest rate. Given the returns to scale, $\alpha + \theta$, we choose the tail parameter of the entrepreneurial talent distribution, $\eta = 4.84$, to match the employment share of the largest ten percent of establishments, 0.69. We can then infer $\alpha + \theta = 0.79$ from the earnings share of the top five percent of earners. Top earners are mostly entrepreneurs (both in the US data and in the model), and $\alpha + \theta$ controls the fraction of output going to the entrepreneurial input. The parameter $\gamma = 0.89$ leads to an annual establishment exit rate of ten per cent in the model. This is consistent with the exit rate of establishments reported in the US Census Business Dynamics Statistics.[12] Finally, the model requires a discount factor of $\beta = 0.92$ to match the annual interest rate of four per cent

We use the above parameter values calibrated to the US data for our analysis of microfinance, with two important exceptions. First, microfinance is implemented in countries with underdeveloped financial markets. Second, the establishment size distribution in less developed countries are vastly different from that of the US. Using detailed data available for India, we re-calibrate ϕ and η. The ratio of external finance to GDP in India is 0.34, which happens to be equal to the average ratio across non-OECD countries over the 1990s as reported by Beck et al. (2000). This period is chosen because it immediately precedes the explosive proliferation of large-scale microfinance programs. From Indian census data, we compute the employment share of the largest 10-percent of establishments to be 0.58. A

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

[12] Note that $1 - \gamma$ is larger than 0.1, 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 in either sector.

joint calibration leads to $\phi = 0.08$ and $\eta = 5.56$.

3.2 Short-run PE Results

We quantify the effects of microfinance for a wide range of b^{MF}. We begin by discussing the results of the short-run partial equilibrium analysis. This builds understanding of the model, and it also facilitates our next step, a comparison of the model's implications with microevaluations of microfinance initiatives in India and Thailand. We show that the model matches key qualitative features found in microevaluations of microfinance initiatives, and the quantitative magnitudes in the model are of comparable order of magnitude.

We begin in the steady state without microfinance, $b^{MF} = 0$. The short-run PE impact we now discuss refer to impacts one period after the introduction of the microfinance technology, when labor and capital market clearing conditions are relaxed and the wage and interest rate are kept constant at their levels in the $b^{MF} = 0$ equilibrium.

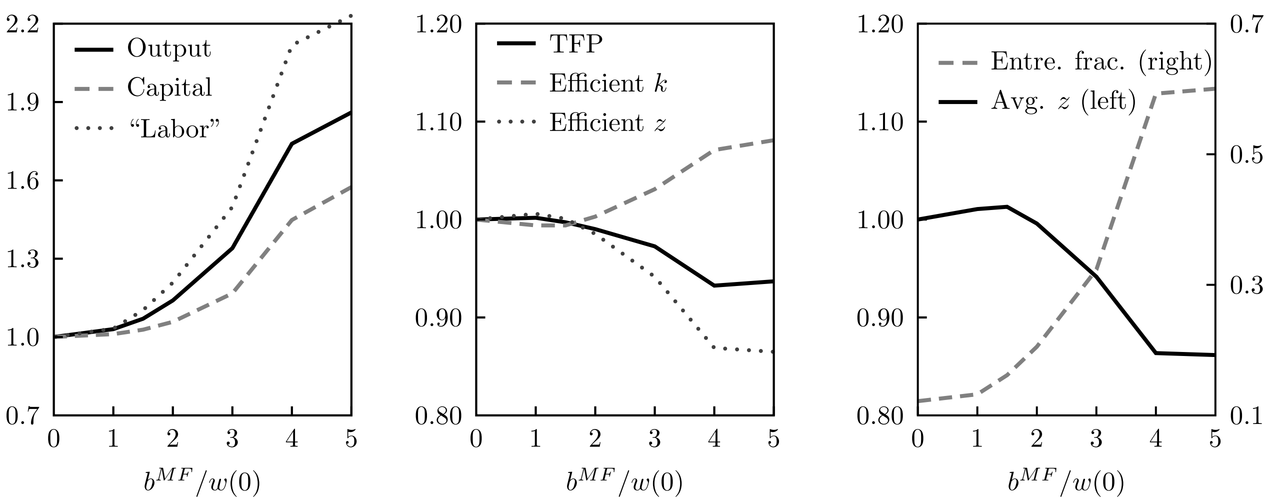

Fig. 1: Short-Run Aggregate Implications in Partial Equilibrium

In the left panel of Figure 1, we show aggregate output, capital, and the total labor input, which includes the labor input of the entrepreneurs plus that of the workers that are employed by these entrepreneurs, for several experiments corresponding to various levels of b^{MF}. On the horizontal axis, b^{MF} relative to the equilibrium wage in the $b^{MF} = 0$ economy (i.e., b^{MF} over $w(b^{MF} = 0)$) is shown, which ranges from 0 to 5. All three aggregate quantities are normalized by their respective levels in the $b^{MF} = 0$ economy. The pattern is clear, all three increase monotonically, with output increasing up to almost 85 percent, the total labor input – including workers and entrepreneurs – increasing up to over 120 percent, and capital increasing up to almost 65 percent. Nevertheless, the overall efficiency of production declines, as is attested by the over 6% drop in TFP shown by the solid line in the center panel of Figure 1.

In the center panel of Figure 1, we also decompose this productivity decline, which reflects changes in the allocation of production resources (capital and entrepreneurial talent). The dashed line represents the effect of better capital allocation among existing entrepreneurs (intensive margin), while the dotted line shows the effect through selection into entrepreneurship (extensive margin). The formulas for this TFP decomposition are derived and explained in the appendix. In this short-run PE exercise, the impact on TFP is the result of a sharp deterioration in the quality of entrepreneurs, which more than offsets the improvement in the allocation of capital across entrepreneurs.

The right-hand side panel sheds further light on the increase in the total labor input and the decline in TFP by plotting the rate of entrepreneurship and the average ability of entrepreneurs.[13] The availability of microfinance increases the number of entrepreneurs, marginally for low levels of guaranteed borrowing but dramatically for higher levels. The increase in the number of entrepreneurs, and the workers demanded by these entrepreneurs, account for most of the increase in the total labor input shown in the left panel.[14] The available capital allows some talented-but-poor agents to enter, but also induces marginal ability people to become entrepreneurs. At low levels of guaranteed capital (i.e., $b^{MF} < 1.5w$), the former plays a significant role, but at higher levels, the latter dominates and average ability falls dramatically, explaining the drop in TFP.

In summary, in partial equilibrium, microfinance has a significant positive impact on capital and the total labor input, leading to a significant increase in per-capita income. The overall efficiency of production is worsen, as micro finance eventually leads to the entry of marginal, less productive, entrepreneurs. As we will show, these conclusions are drastically altered in general equilibrium.

3.3 Comparison with Microevaluations

We now compare the above short-run partial equilibrium predictions of our model with two recent microevaluations, the urban Indian Spandana study by Banerjee et al. (2009) and the rural Thai Million Baht village fund program evaluation by Kaboski and Townsend (2011a,b). These two microevalations are chosen since they closely examine the patterns most relevant to our model, entrepreneurship, investment, and consumption.

While the model and empirical studies do not map together perfectly, the purpose is to gauge whether our model captures key aspects and mechanisms in the empirical work, in

[13] The average entrepreneurial talent is normalized by its value in the stationary equilibrium with $b^{MF} = 0$.

[14] The labor input of the entrepreneurs' labor input increases by only 9% as b^{MF} increases from 0 to 5. The new entrepreneurs employ on average $1.2 - 1.4$ workers, and therefore, their own labor input accounts for roughly 40% of the increase in the total labor input, while the labor input of the workers they employ accounts for 55%.

order to assess the potential validity of the model for making GE predictions.

We compare along three dimensions: the amount of microfinance borrowing, the impact on investment activities (entrepreneurship and investment), and the impact on consumption, and find that the model performs reasonably well along each front, although the model overpredicts impacts on investment and underpredicts impacts on consumption. It is important to keep in mind that we do not model consumption loans which are an important use of microcredit in both empirical studies. Hence, our intervention is somewhat larger in terms of credit for entrepreneurial activities but clearly smaller in terms of credit for consumption.

The Indian study involved a randomized expansion of branches across different slum neighborhoods in Hyderabad, India. The follow up survey was roughly 18 months after loans were disbursed. Loan amounts ranged from 10 to 20,000 Rupees, or roughly up to 1 to 2 times annual per capita expenditures in the baseline survey (12,000 R).[15] The randomization led to an increase of roughly 1300 R of microfinance per capita, or just over 0.1, when normalized by annual expenditures. This increase was a 50 percent increase over the baseline level of microfinance, of about 2400 R, and the after intervention level of microfinance constituted about 42 percent of total credit. The loans increased new business starts by 1.6 percentage points on a baseline of 5.4 percent. The impacts on the revenues, assets, and profits of existing business owners are positive but all statistically insignificant. However, the loans did produce a significant increase in durable consumption of 16 percent, and a significant increase in durables used for businesses of 128 percent.

Table 3: Comparison Summary

	Model	India	Thailand
Max Loan/Exp per Cap	1	1-2	1
Credit/Exp per Cap	0.1	0.1	0.1
Microfinance/Total Credit	29%	44%	33%
Entrepreneurship	+4 pp	+2 pp	+1 pp
Investment	+46%	+16/128%	+30% (prob).
Consumption	+1%	+16%	+15%

The Thai study involved the study of a government transfer of one million baht of seed money to rural villages for founding village funds. Since villages differed in their size, this constituted more than 25 percent of total annual income in the smallest village but less than 0.2 percent in the largest village, which caused variation in lending.[16] It is important to keep the size of the intervention in mind because it did indeed lead to general equilibrium

[15]The empirical per capita numbers in this section are actually "per adult equivalent".

[16]The impact results here are taken from Kaboski and Townsend (2011b), with the exception of new business starts and business profits, which are from Kaboski and Townsend (2011a). For the purpose of better comparison, we have specifically calculated the other numbers for this paper using the same data.

impacts in some villages. Loan sizes were about 20,000 baht, roughly equal to annual expenditures per capita (22,000 Baht) in the survey area. Since impacts are measured as coefficients on continuous variables, we put impacts in terms of the median village. The credit injection constituted 2300 baht per capita, or again roughly 0.1 as a fraction of annual per capita expenditure, and the intervention constituted about 33 percent of total credit in the median village. The point estimates of a 15 percent increase in new businesses is statistically insignificant, but credit did lead to a significant increase in business profits as a fraction of income of 2.6 percentage points, which amounts to an increase of 56 percent. The credit had no measurable impact on the aggregate level of investment, but did significantly increase the probability of investment by about 33 percent. [17] Credit led to a significant increase in per capita consumption of about 15 percent, with essentially no impact on durable consumption, and led to an 11 percentage point increase in income at the end of the second year.

For the model, we choose $b^{MF} = 1.5w$, which yields a maximum loan size relative to consumption of 1, comparable to the two empirical interventions. Our short run, one period (i.e., one year) results match up well with the the horizon of the empirical studies. For easier comparison, Table 3 summarizes the aggregate impact across the two studies and the model. The resulting microfinance credit relative to consumption is 0.10, quite comparable to the studies. This constitutes a smaller fraction of total credit (i.e., external finance), 29 percent, but in the model this is total external finance, including very large firms. Additional large formal external finance clearly exist in India and Thailand, but are not part of the survey of local neighborhoods and villages, respectively. The impact on entrepreneurship is larger in the model, increasing entrants by 4 percentage points, than in the studies. In percentage terms, this increase is even larger, since entrepreneurship rates are substantially larger in the empirical studies. We also find large increases in investment of 46 percent. On the other hand, we find a small – 1 percent– increase in consumption, consistent with the statistical insignificance in the India, but substantially less than the point estimate increase of 16 percent, and the statistically significant increase of 15 percent in Thailand. Again, one likely reason is that our model lacks pure consumption loans. Also, for the Thai study, the general equilibrium wage increase may be driving the increase in consumption.

Both the Kaboski-Townsend and Banerjee et al. studies emphasize that impacts are heterogeneous, namely that marginal investors are more likely to increase investment and decrease consumption, while others are more likely to increase consumption. Our model is consistent with the increase in investment, and corresponding decline in consumption, among

[17] The point estimate of the effect on aggregate investment is actually a negative 4 percent, but this is in no way significant (the standard error is four times the coefficient).

marginal entrepreneurs. [18]

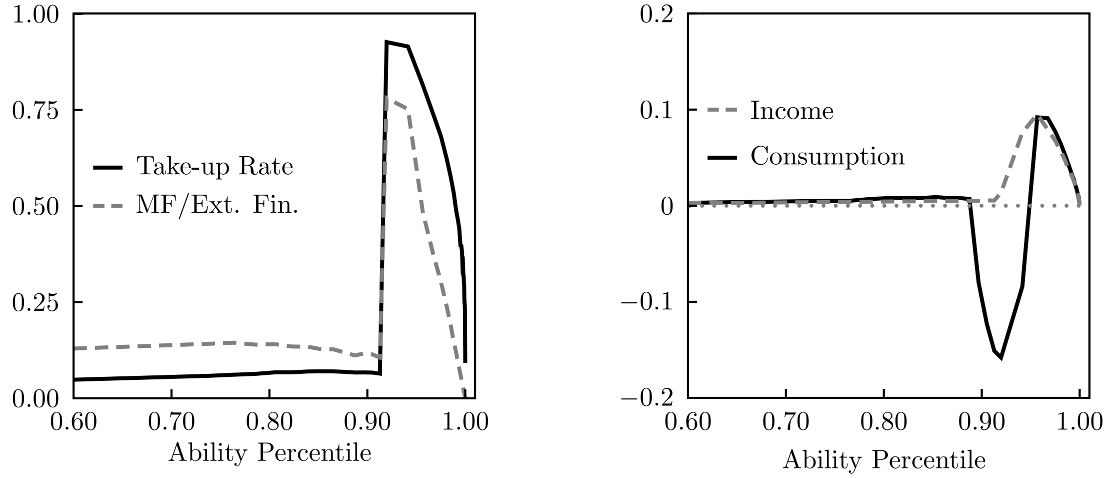

Fig. 2: Additional Micro-Implications, $b^{MF} = 1.5w$

The model's heterogeneous impacts on borrowing and consumption are shown in Figure 6. The left panel plots the take up rate of microfinance loans and microfinance as a fraction of total external finance. We emphasize that take-up rates are low overall, and though highest for those with marginal entrepreneurial ability, they average 11 percent. Low take-up rates are consistent with the findings of Banerjee et al, who find that treatment increased the fraction of households borrowing by just 13 percentage points. The right-hand side shows the heterogeneous impact on consumption, which actually decreasing for the marginal ability entrepreneurs. The decrease in consumption corresponds with an increase in savings, consistent with both the Indian and Thai studies findings that investors (or those likely to invest on average) decrease current consumption.

In summary, while the model lacks consumption loans, an important element of microfinance credit, it does capture important aggregate and heterogeneous aspects of entrepreneurship, investment/savings, and consumption decisions that are prevalent in the data. We turn now to evaluate the impact of these decisions on long run and then general equilibrium outcomes.

4 Microfinance in General Equilibrium

This section evaluates the impacts of microfinance in general equilibrium. We first evaluate the long run implications of microfinance, contrasting the impacts in general equilibrium with those in partial equilibrium. We then discuss how general equilibrium considerations

[18] Banerjee et al. also find that with microfinance new entrepreneurs are concentrated in small-scale, lowest fixed cost industries like food industries, which is consistent with the prediction of our two-sector model developed in Section 4.3.3.

affect the welfare implications of introducing a microfinance technology. Finally, we present three extensions to evaluate the sensitivity of our results to important modeling assumptions.

4.1 Partial vs. General Equilibrium

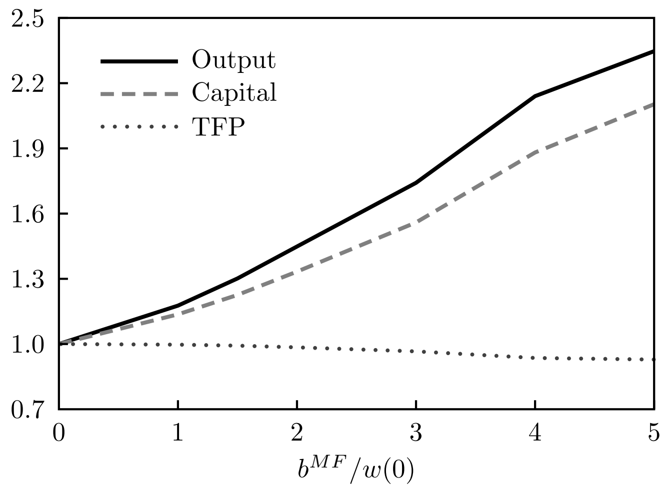

Fig. 3: Steady State Aggregate Implications in Partial Equilibrium

Figure 3 shows the long run, steady state implications of microfinance in partial equilibrium. Relative to the short run results in Figure 3, the impacts here are significantly larger. The steady state effects on output and capital (and the total labor input) are around 30 percent larger than the effects after one period. These differences reflect the importance of asset accumulation dynamics. In PE, increased income and increased entrepreneurship leads to higher levels of savings among entrepreneurs and those saving to become entrepreneurs. This increased savings acts as collateral, and therefore enables still higher use of capital. Thus, aggregate capital increases further. Savings accumulation also induces even greater entry of entrepreneurs over time. These are typically the more marginal entrepreneurs, however, and so this has an added, but small, effect on TFP.

We contrast these results with the results in general equilibrium. In the partial equilibrium simulations, microfinance leads to excess demands in capital and labor markets, which can be inferred from the fact that the equilibrium interest rate and wage are higher than in the initial equilibrium without microfinance, $b^{MF} = 0$. In general equilibrium, aggregate savings and investment decisions now must coincide. More importantly, labor markets must clear.

Figure 4 shows the importance of GE for the aggregate impacts of microfinance in our benchmark economy. In the left panel, we observe the impacts on capital, TFP, and output. There are three clear differences from the PE analysis in Figure 3. First, capital falls

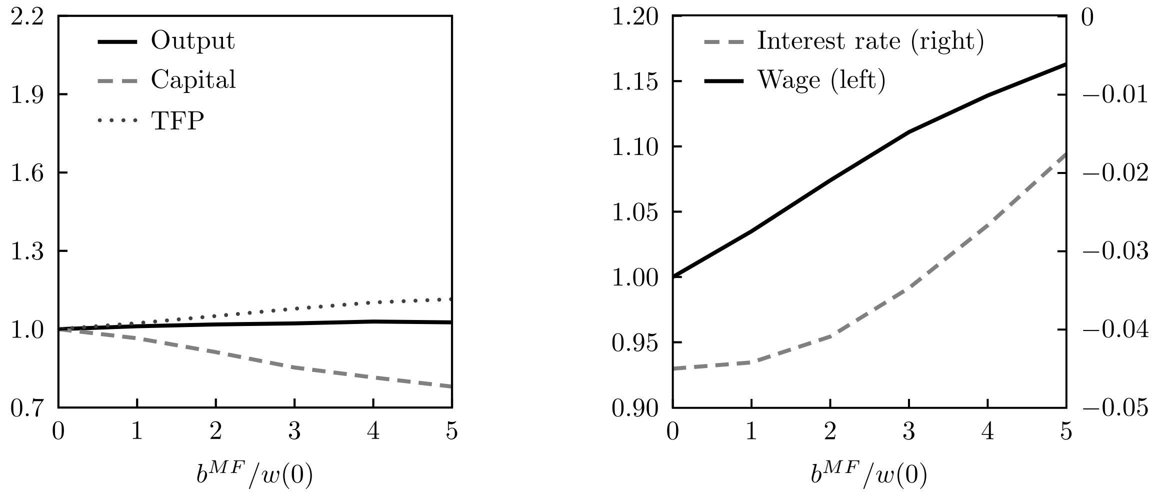

Fig. 4: Impact of Microfinance in General Equilibrium

precipitously with microfinance in GE, by almost 10 percent for $b^{MF} = 2w$. Second, TFP gains are now positive, 5 percent for $b^{MF} = 2w$, and up to 11 percent when $b^{MF} = 5w$. Finally, given TFP gains but lower levels of capital, the net effects on output are relatively small, less than 2 percent for $b^{MF} = 2w$, and only reaching 2.6 percent when $b^{MF} = 5w$.

In the right panel of Figure 4, we see that equilibrium wages (solid line) and interest rates (dashed line) rise with b^{MF}. The higher interest rate is due in part from the direct effect of microfinance increasing demand for capital, but mainly it is due to the reduction in the overall capital stock. The increase in the wage is due to both a reduction in available workers as more agents become entrepreneurs, but it is also due to the increased demand for workers because of the increased TFP. The magnitude of the wage increase, 3-7 percent, for b^{MF} of 1-2 is quantitatively in line with the 7 percent wage increase empirically estimated by Kaboski and Townsend (2011b) in the Thai intervention.

We now provide detailed explanations for the effect of GE on TFP and then its effect on capital accumulation.

Effect on TFP In the right panel of Figure 5 we decompose the increase in TFP (solid) in term of the intensive (dashed, efficient k) and extensive (dotted, efficient z) margins. In GE, the cost of capital rises as does the opportunity cost of becoming an entrepreneur. Hence, although the rate of entrepreneurship increases in GE, the increase is substantially smaller than in PE. In GE, the fraction of entrepreneurs increases 4 percentage points for $b^{MF} = 2w$ relative to 15 percentage points in PE. However, the higher wage also causes the exit of untalented-but-rich entrepreneurs, so that although microfinance still induces some not-so-talented entrepreneurs to enter in GE, the average ability of entrepreneurs actually increases (3 percent for $b^{MF} = 2w$), although it eventually declines. Still, in GE, the majority of

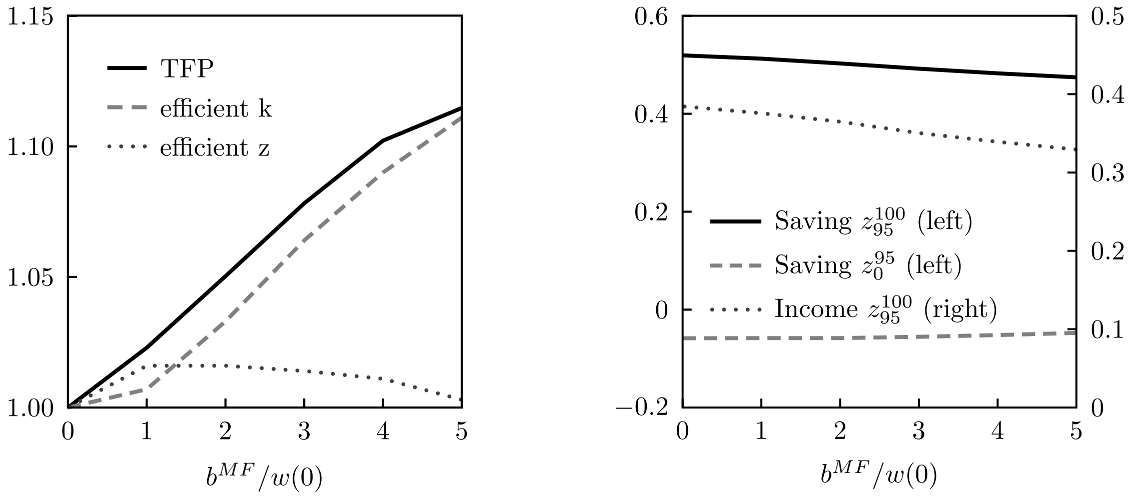

Fig. 5: Decomposition of the Impact of Microfinance in General Equilibrium

TFP gains actually come the intensive margin, the more efficient allocation of capital among existing entrepreneurs, especially for larger levels of b^{MF}, as undercapitalized entrepreneurs get to invest more. This is in sharp contrast to the PE result, where the extensive margin dominated, and actually causes overall TFP to decline.

Effect on Capital Accumulation The substantial negative impact of microfinance on aggregate capital accumulation in Figure 4 (dashed line) is due to redistributive effects of microfinance in general equilibrium.

In the model, individuals with high levels of entrepreneurial talent have high saving rates. There are two reasons. First, given the financial constraints, they derive collateral services from their wealth (i.e., more wealth allows them to produce closer to the efficient scale). Second, given the stochastic nature of the entrepreneurial talent, they save for the periods/states in which they will not be as talented and will not generate as much income. In the right panel of Figure 5, the average saving rate of those belonging to the top 5 percentiles (denoted with z_{95}^{100}) of the talent distribution is shown with a solid line (left scale). This is much higher than the average saving rate of the rest (i.e., those in the bottom 95 percentiles, denoted with z_{0}^{95}), which is in fact negative (dashed line).

Those in the latter group mostly choose to be workers, and do not have a self-financing motive. In addition, our model specification is such that one's earnings are bounded from below by the market wage. Therefore, workers do not have any reason to save from the permanent-income perspective: Their earnings will either remain the same or go up in the future. This latter group also includes not-so-talented entrepreneurs. These "marginal" entrepreneurs clearly have higher saving rates than the workers, because they at least have some self-financing motive for their businesses as well as some permanent-income saving motive since their income may fall in the future. However, compared to those in the top 5 percentiles, their efficient scale is much smaller, and their future earnings are not expected to fall by as much. Therefore, their motive for saving is not as strong, and their saving rate is far lower than that of the top talent group.

Recall that generous microfinance promotes the entry of such marginal entrepreneurs. As shown in the right panel of Figure 5, the income share of the bottom 95-percentile talent group increases with b^{MF} (and the income share of the top-talent group declines as shown by the dotted line), because the marginal entrepreneurs now earn more than what they would have earned as a worker, and the aggregate labor income share is constant at θ in the model.[19]

Overall, the fact is that the income share of those with lower saving rates increases with b^{MF}. The aggregate saving rate is the income-weighted average of individual saving rates, and hence microfinance reduces aggregate saving and the steady-state capital stock.[20]

4.2 Distribution of Welfare Gains

The analysis so far emphasizes that microfinance has heterogeneous impacts, and that the full extent of its effects need to be traced through rich general-equilibrium interactions. This point is most clearly seen when studying the distribution of the welfare consequences of microfinance.

In Figure 6 we present the welfare impact of microfinance across individuals of different entrepreneurial ability (left panel) and wealth (right panel). We report the direct welfare impact (partial equilibrium, dashed line) as well as the impact once general equilibrium interactions are accounted for (solid line). In particular, we show the fraction of consumption that individuals of different ability and wealth are willing to pay in order to have access to microfinance programs that guarantee an investment of 1.5 times the initial yearly wage, i.e., $b^{MF} = 1.5w(b^{MF} = 0)$. These calculations take into account the transitional dynamics following the introduction of microfinance.

Two important messages arise from this figure. First, in the left panel, the large spike

[19] The entry of marginal entrepreneurs, as a compositional effect, also explains why the saving rate of the bottom 95-percentile talent group increases (dashed line): The marginal entrepreneurs have higher saving rates than workers, and there are now more entrepreneurs and fewer workers in this group (denoted with z_0^{95}).

[20] Also note that the saving rate of the top talent group is also decreasing in b^{MF}. There are two reasons for this. First, more entry drives up market wage and capital rental rate, and lowers the efficient scale of production. Therefore, less collateral is needed. Second, with the marginal entrepreneurs operating, the future earnings of the top-talent group is now expected to fall by less. That is, without microfinance, you either maintain your talent or become a worker in the next period. With generous b^{MF}, you could in the next period maintain your talent, become a worker, or become a marginal entrepreneur who earns more than a worker. Therefore, the permanent-income saving motive is weaker with high b^{MF}.

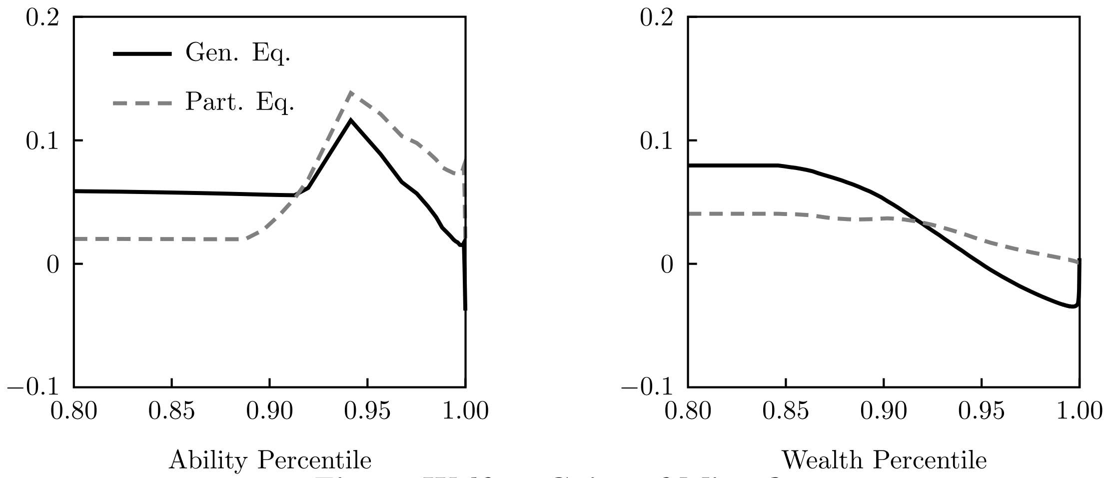

Fig. 6: Welfare Gains of Microfinance

among relatively highly talented individuals shows who gains the most from microfinance: marginal entrepreneurs. Microfinance does not directly affect those who choose to be workers, and at the same time it is too small to directly affect the business of the most talented entrepreneurs. For marginal entrepreneurs, however, their scale of operation is small enough that the microfinance has a meaningful direct impact. Second, in the right panel, consistent with the conventional narratives, microfinance have a larger positive impact on the poor, i.e., individuals with low wealth, although the wealth gradient is small. Likewise, for the wealthiest individuals, microfinance is unimportant in comparison with their wealth, and they gain relatively less than the poor.

Another important lesson from the left panel of Figure 6 is that general equilibrium considerations are key to fully understand the distributional effect of microfinance. For instance, a partial-equilibrium analysis would lead to the conclusion that the least talented individuals would be only slightly affected, and that the most talented would be among those most benefiting from this technology. Instead, when the increase in the equilibrium wage is accounted for, the inference is different. Individuals with low entrepreneurial talent, who choose to be workers, experience a significant welfare gain in the order of nearly ten percent of permanent consumption. On the other hand, the most talented could be made worse-off by microfinance, because their profits are reduced by the higher wage. This conclusion is more clearly seen in the right panel of Figure 6, where the wealth gradient is substantially larger in general equilibrium. Indeed, the higher factor prices lead to a negative welfare gains for the richest 5 percent of the households.[21]

[21] While not clearly seen in this figure, the very top wealth individuals actually gain with the introduction of microfinance, as for them the rental income, which increases with the interest rate, is a substantial part of their income. These individuals represent a very insignificant fraction of the population.

4.3 Extensions

We evaluate three extensions to the baseline general equilibrium model. The first is a small open economy, where wage effects operate, but the interest rate is held constant at the initial interest rate. The second extension introduces an idiosyncratic shock to labor supply that effectively forces individuals, even those with little capital and/or ability, into entrepreneurship. This captures the idea of undercapitalized low-ability entrepreneurs with few labor market alternatives, who make up a large fraction of the self-employed in less developed economies. The third extension follows Buera et al. (2011) by introducing a large-scale sector that requires a large fixed cost of production. This ushers in a third general equilibrium effect (the relative price between the large- and small-scale sectors), and microfinance plays an important role in how resources (capital, labor, and entrepreneurial talent) are allocated between the two sectors.

4.3.1 Small Open Economy

The small open economy (SOE) we consider differs from the benchmark equilibrium in that we fixed the interest rate at its initial value of -4.5 percent. Relative to our partial equilibrium analysis, the SOE differs in that the wage is a market-clearing wage. This exercise is meant to capture a situation where capital is brought to this economy from outside, e..g., from an international NGO.

Perhaps surprising, while the direct effect of the innovation is to increase capital demand, the resulting higher wage suppresses capital demand, even in the case where capital is supplied from "abroad" to keep the interest rate fixed. Aggregate capital decreases, although less than in the closed economy, by a significant amount: At levels of microfinance of two or three times the normalizing wage, this decline constitutes three to six percent of the capital stock, and reaches 11 percent for $b^{MF} = 5w$ ($b^{MF} = 0$). Intuitively, the capital stock declines because the distribution of income from productive to unproductive individuals leads entrepreneurs to accumulate less collateral, and therefore, they are not able to demand as much capital as in the economy with out microfinance.

The impact of microfinance on TFP in this model is smaller than in the benchmark general-equilibrium model. At $b^{MF} = 5w$ ($b^{MF} = 0$), the wage and TFP gains of microfinance are 21 and 7 percent, respectively, relative to 17 and 12 percent in the benchmark model. The smaller impact on TFP is the flipped side of the smaller impact on capital accumulation, as now fewer untalented-but-rich individuals are discourage from entrepreneurship by a rise in the rental price of capital.

Overall, the impact on per-capita income is very similar to the benchmark model. At $b^{MF} = 5w$ ($b^{MF} = 0$), per-capita income increases by 3 percent.

4.3.2 Market Labor Shock

Self-employment rates are typically high in developing countries, and these self-employments partly reflect a lack of access to market labor. To capture this, we add a stochastic labor endowment to the model. Specifically, individuals now receive a vector $\mathbf{z} \equiv \{z, \ell\}$, where z remains the productivity as an entrepreneurs, and ℓ is now the productivity in market labor. With probability χ, $\ell = 1$, and the individual choice set parallels the baseline model, but with probability $1 - \chi$, $\ell = 0$, and the individual is effectively forced into entrepreneurship. We assume that the ℓ-shock is independent of the z-shock, and that the two are equally persistent. We calibrate $\chi = 0.22$ so that the self-employment rate in the model matches the 35 percent non-rural self-employment rate in the 2004–05 National Sample Survey of India. Effectively, this leads to a large mass of poor, low ability entrepreneurs.

The results differ from the baseline along a few dimensions. First, the microfinance innovation leads to substantially higher levels of external finance to GDP, given the demand from the numerous poor entrepreneurs who are forced into self-employment.[22] In other words, the take-up rate of microfinance is higher than in the benchmark case without market labor shock.

Second, more important, for low levels of b^{MF}, output and wage actually fall with microfinance. For example, at $b^{MF} = w(b^{MF} = 0)$, TFP effects are negligible but the steady state capital stock declines by 7.5 percent, so that wage declines by 3 percent and output by 2 percent. With microfinance, interest rate goes up because of the increased demand for capital especially by those in forced entrepreneurship. This induces the marginal entrepreneurs to become workers, thereby increasing the supply in the labor market and driving down the wage. At the same time, income is redistributed from the marginal entrepreneurs to the poor, less able entrepreneurs who are forced into self-employment, and the aggregate capital stock goes down.[23] With large enough microfinance (e.g., b^{MF} three times the normalizing wage), marginal entrepreneurs and most talented entrepreneurs also directly benefit from microfinance, and output and wage are higher than in the no-microfinance case. The magnitude of the increase is still smaller than in our benchmark case without market labor shock, however.

In terms of welfare, the lowest ability "forced" entrepreneurs now gain the most from microfinance. Those who choose to be workers gain less or even lose out in terms of wages, but are still better off in utility terms, since they will also benefit from microfinance when

[22] As b^{MF} goes from zero to five times the normalizing wage, the external finance to GDP ratio increases from 0.56 to 1.08. In the benchmark, the ratio increases from 0.34 to 0.72.

[23] This is consistent with the empirical evidence of de Mel et al. (2008, 2009); Fafchamps et al. (2010), who find that grants to low wealth female entrepreneurs, those they interpret as likely forced into entrepreneurship because of a lack of labor market frictions, yielded substantially smaller increases in profits and capital.

hit with the market labor shock in the future.

4.3.3 Large-Scale Sector

Large-scale establishments dominate certain sectors such as manufacturing, investment goods in particular, and less developed countries tend to have lower relative productivity and higher relative prices in these sectors (Buera et al., 2011). In a multi-sector model, microfinance, although it is not explicitly sector-specific, may thus affect a third pricing margin, the relative price between large- and small-scale sectors. Following Buera et al., we capture this by introducing a second sector with a technology that requires a fixed cost κ to run each period. Individuals now receive a stochastic vector $\mathbf{z} \equiv \{z, z_L\}$, where z_L, the productivity in the large-scale sector, is distributed identically but independently of z. Individuals now choose between being a worker and operating a technology in either sector. Quantitatively, we follow Buera et al. in calibrating $\kappa = 5.5$ to match the observed difference in average scale between manufacturing and services, and assuming that all capital is produced in the large-scale sector.

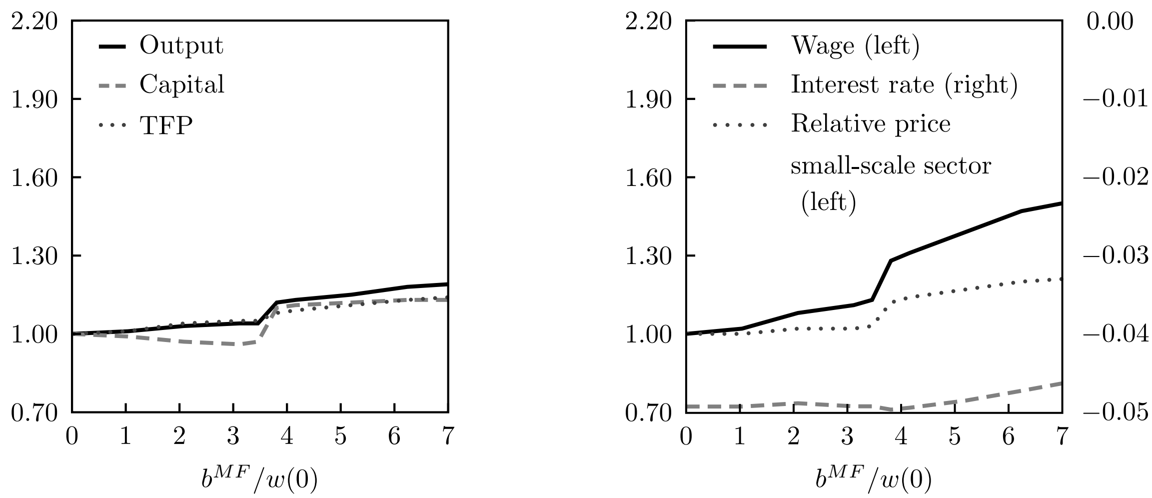

Fig. 7: Aggregate Impacts in Two-Sector Model

Figure 7 shows the aggregate implications of microfinance in this two-sector model. For moderate levels of microfinance, the model behaves very similarly to the one sector model, although the relative price of the small-scale sector falls somewhat, as financial frictions in this sector are more easily alleviated by microfinance. It is at higher levels of guaranteed credit, those above four times wages — higher than typical microfinance but within the range of loans available from the U.S. small business administration — where the two sector model shows striking differences. Here, guaranteed credit dramatically increase wages and output because it *increases* capital accumulation. The threshold for this change occurs, when the amount of guaranteed credit is sufficient to induce agents with the highest ability in the large-scale sector to become entrepreneurs even if they have no wealth. Here, the general equilibrium effect on the relative price drives the results. Although interest rates decline, capital increases because the increase in the relative price of small-scale output is equivalent to a decrease in the relative price of capital. Thus, each units of savings/investment yields substantially more physical capital.

5 Concluding Remarks

Microfinance lending is growing around the world, and indeed in some countries, the levels of microfinance are already at or approaching levels where general equilibrium effects may be important. We have shown that such general equilibrium considerations are quantitatively important for the evaluation of the impacts of economy-wide microfinance. The increase in wages in GE has a strong redistributive component. This leads to smaller levels of capital stocks than PE analysis would predict. However, it also reinforces the redistributive aspect of microfinance to low ability, low wealth individuals.

We believe our results may be more widely applicable to large microfinance interventions, even if local. In many developing countries, local markets are effectively segmented (see, for example, Townsend (1995)), due to high transportation/trade costs or poor information. In such markets, which are small and segmented, even relatively moderately sized interventions may exhibit the important GE effects that we have emphasized.

A TFP Decomposition

In this Appendix we derive the decomposition of TFP used in Figure 1. Using the optimal choice of labor input, $l(a,z) = (z_i \theta p_i k(a,z)^{\alpha}/w)^{1/(1-\theta)}$, we can write aggregate output in sector i as:

$$Y_i = (\theta p_i/w)^{\frac{\theta}{1-\theta}} \int_{(a,z):o(a,z)=i} z_i^{\frac{1}{1-\theta}} k(a,z)^{\frac{\alpha}{1-\theta}} dG(a,z)$$

Denoting the total labor input in section i by $L_i (= \int_{(a,z):o(a,z)=i} l(a,z)\, dG(a,z))$, the broad labor input in sector i by N_i, i.e., labor plus the un-weighted entrepreneurial input, $N_i = L_i + E_i$, $E_i = \int_{(a,z):o(a,z)=i} dG(a,z)$, the total capita input in sector i by K_i, and the share of capital employed by an individual entrepreneurs by $\varkappa_i(a,z) = k(a,z)/K_i$, we can rewrite aggregate output as,

$$Y_i = \frac{\left[\int_{(a,z):o(a,z)=i} z_i^{\frac{1}{1-\theta}} \varkappa_i(a,z)^{\frac{\alpha}{1-\theta}} dG(a,z)\right]^{1-\theta}}{N_i^{1-\alpha-\theta}} \left(\frac{L_i}{N_i}\right)^{\theta} K_i^{\alpha} N_i^{1-\alpha}.$$

We define TFP as output net of the capital and the braod labor inputs, raise to their respected income elasticities, α and $1-\alpha$,

$$TFP_i = \frac{\left[\int_{(a,z):o(a,z)=i} z_i^{\frac{1}{1-\theta}} \varkappa_i(a,z)^{\frac{\alpha}{1-\theta}} dG(a,z)\right]^{1-\theta}}{N_i^{1-\alpha-\theta}} \left(\frac{L_i}{N_i}\right)^{\theta}.$$

We view this to be the measurement of sectoral TFP that is closest to that used in development accounting exercises, under the presumption that the entrepreneurial input is not weighted by individual's productivities, z_i.

In addition, we define the k-efficient TFP, TFP_i^{k-eff}, as the value of the TFP in the case that capital is efficiently allocated among existing entrepreneur,

$$TFP_i^{k-eff} = \left[\frac{\int_{(a,z):o(a,z)=i} z_i^{\frac{1}{1-\alpha-\theta}} dG(a,z)}{E_i}\right]^{1-\alpha-\theta} \left(\frac{E_i}{N_i}\right)^{1-\alpha-\theta} \left(\frac{L_i}{N_i}\right)^{\theta}.$$

Notice that this measure is only a function of a geometric weighted average of entrepreneurial talent in sector i, and the fraction of entrepreneurs and workers.

Using the measure of k-efficient TFP we can decompose the change in TFP into that associated with changes in the allocation of capital across entrepreneurs (k-efficiency) and changes in the allocation of entrepreneurs (z-efficiency):

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

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