Microloans, Education and Growth

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Abstract

This paper constructs a two-period overlapping generations model of human capital investment decisions where a microloan program designed to finance entrepreneurial activities is active. It is shown that, in the presence of human capital externalities, microloans that are small and have immediate repayment can be growth depressing, and welfare decreasing, through their effect on the opportunity cost of schooling. By increasing the opportunity cost of schooling, such microloans divert investment away from human capital: by failing to internalize the social returns to education, households' individually optimal investment decisions in the face of microcredit availability act to depress the growth of the economy and result in sub-optimal welfare outcomes. Conditions under which these negative effects can occur are identified and potential solutions are suggested.

1 Introduction

Microfinance and microloans are among the most celebrated development success stories of the last quarter century. The Microcredit Summit Campaign estimates that in 2007, microcredit had reached almost 155 million recipients, almost 110 million of whom were women and over 106 million were considered to be among the world's poorest (Daley-Harris, 2009). Despite the popularity and spread of microcredit, relatively little is known about the effect of credit receipt on the outcomes of individuals and households. The purpose of this paper is to provide insight into one aspect of microloans that has, as yet, received little attention: that the nature of microloans can cause lower investment in human capital which can have growth and welfare implications for economy. It is demonstrated through the use of an overlapping generations model that even when microloans are introduced in the form of a new capital injection into an economy there are circumstances in which they can lead to welfare loss and negative growth effects. Isolating the aspects of microloans that can lead to lower welfare and growth can assist in the design of loan programs that are less likely to encounter such negative consequences.

It is, perhaps, hard to understand how microloans - especially those that inject outside capital into an essentially closed economy - could actually be welfare reducing. In a static setting, the introduction of microloans represents an expansion of the budget set, which should result in increased utility. We show that the small and quickly maturing nature of these loans can depress long-term investment in human capital.[1] If households have binding time constraints then microloans can raise the current opportunity cost of schooling, causing households to concentrate more on entrepreneurial activities and less on education. This can have a beneficial short-term welfare effect for households but a detrimental long-term effect for the household dynasty. By raising the opportunity cost of schooling and demanding a quick return on investment, microloans might actually serve to suppress human capital accumulation in the communities in which they are introduced. In the presence of social returns to education, the long-term effect of microloans might actually be to impede economic growth rather than help it, leading to decreased welfare. In the end, by acting to suppress growth, microloan programs of this type can result in increased rather than decreased poverty.

The paper also examines aspects of microloans that could contribute to the adverse consequences of the loan program, in particular the size and repayment schedule of the loans, and discusses possible modifications to avoid these consequences.

2 Related Literature

The early economic literature on microfinance focused on group liability as a way to overcome the lack of information and collateral in low-income country credit markets (Stiglitz 1990, Ghatak and Guinnane, 1999; Armendariz de Aghion and Morduch, 2005). Group lending was shown to have the potential to overcome these information and collateral problems. With shared liability, the entire group becomes responsible for repayment and thus group members have an incentive monitor each other. And indeed the evidence suggests that group lending and peer-monitoring have been very effective: repayment rates for microloans average over 90 percent (Grameen Foundation).

Empirical studies of the effects of microloans on the outcomes of the participants are numerous and often conflicting. Pitt and Khandker (1998) find large positive consumption effects from Grameen Bank loans, especially for women. Coleman (1999), however,

[1] See Morduch (1999) for a good overview of the economics of peer lending and characteristics of typical microfinance programs.

finds little to no impact of a microcredit program in Northeast Thailand on recipient welfare, but notes that failure to control for selection would lead to a conclusion of positive impacts. Kaboski and Townsend (2005) using a natural experiment approach find positive consumption impacts of microloans, but not on investment. Karlan and Zinman (2009) use randomization of marginal clients to evaluate the impact of consumer lending in South Africa, and find that the receipt of microcredit improves the welfare of the recipients. In a novel approach to address the selection problem, Schroeder (2010) examines consumption effects from Grameen Bank lending in Bangladesh using an estimation strategy that relies on second-moment restrictions and finds positive and significant consumption effects from microloans.

To address the problem of selection, randomized designs have been used to explore the impact of microfinance product design such as group lending and repayment schedules (e.g. Giné and Karlan, 2006, 2009; Field and Pande, 2008)). Banerjee, et. al. (2009) is a large-scale randomized experiment that examines outcomes from a microcredit intervention. In this study, the authors find that durable consumption rises but non-durable consumption does not. More importantly for the current analysis, they do not find any measurable effects on health or educational investment.

Studies of the specific effects of microloans on educational investment and educational outcomes are few. The aforementioned Banerjee, et. al. (2009) study included a measure of educational investment and found no measurable effect. However, a study of the effect of microloan receipt in Bangladesh by Islam and Choe (2009) found that microloans reduced school enrollment among children of recipient households. However, In a study of two districts in Buenos Aires, Becchetti and Conzo (2010) find positive effects of microloans on schooling. Kuboski and Townsend (2012) find no increase in schooling with microloan receipt in villages in northern Thailand.

The theoretical analysis relies critically on the presence of human capital externalities. Such agglomeration externalities are empirically well founded. Many studies have found significant social returns to education. Hall and Jones (1999) find significant total factor productivity (TFP) and growth effects from average education levels as do de la Fuente and Domenech (2001). And while Acemoglu and Angrist (2000) do not find evidence of social returns from high school education in the US, Moretti (2006) finds sizeable externalities associated with college education in the US. Both of these findings are reinforced by Irazano and Peri (2009) who find positive social returns from high school and college education in the U.S.

The theoretical literature on microfinance has largely been confined to the aforementioned studies of the efficacy of microcredit and peer lending in overcoming information and collateral constraints (e.g., Besley and Coate, 1995; Varian, 1989) and less focused on recipient households or how their choices affect an economy as in the present study. Perhaps the most closely related paper to the current study is Wydick (1999) who constructs a static model of household investment decisions and illustrates how access to microcredit for capital investments can increase the value of the marginal product of the labor of children in the household which raises the opportunity cost of education and thus depresses the level of educational investment. An empirical analysis using Guatemalan data reveals that when families use microcredit to finance capital investments the likelihood a child in the household will be withdrawn from school to work increases. The aforementioned paper by Maldonadoa and González-Vega (2008) also constructs a static model of household investment. They find evidence from Bolivia that schooling gaps for the children families decrease with the length of the family's membership in a microfinance organization but that schooling gaps increase with land holdings.

This paper expands on these static models by constructing a multi-period model with agglomeration effects which allows the examination of the long-run consequences of the introduction of a microcredit program on economic growth and social welfare in a recipient country. The unique contribution of this study is the exploration of the conditions under which the introduction of a microcredit program can lead not only to lower educational investments but also to lower growth and social welfare. The model allows a sharper focus on the particular aspects of typical microfinance arrangements that potentially lead to lower human capital investments and subsequent slower growth of a country.

3 Model and results

To understand the effects of the introduction of a microcredit program into a low-income economy we consider a loan program where the loans are 'small' and where repayment begins immediately. This stylized loan program is broadly consistent with most real-world microloan programs (Armendariz de Aghion and Morduch, 2005). The introduction of the micro-loan program into the economy provides credit to productive agents who, because of financial market incompleteness, would otherwise be denied funding for their projects. This credit is used to fund a technology that increases productivity in market-based production and, in so doing, raises the opportunity cost of education, as time in school is time away from the market activity. This higher opportunity cost of education can lead to a lower levels of aggregate human capital. Absent social returns to education, the increase in financial market efficiency is welfare enhancing, and this result holds even with the potential reduction in aggregate human capital. If social returns to education exist, the welfare implications of micro-loan availability are less clear.

To assess whether and when microloans may reduce aggregate human capital and welfare, we develop a simple overlapping generations model. Young agents must choose effort levels directed toward education or entrepreneurial production as made available via microloans. Old agents have access to microloans, but may also produce via a technology dependent on both individual and aggregate human capital.

3.1 The model

We develop a two-period model with agglomeration effects and no population growth. For simplicity, both young and old own their production technology and consume what they produce. young agents have a unit time endowment which they may divide between goods production and human capital accumulation. Young agents in time t receive utility, $u\left(c_{1t}, c^e_{2t+1}\right)$, from consumption in periods t and $t+1$, where c_{1t} and c_{2t} represent the consumption of the young and old in period t, respectively, and c^e_{2t+1} is the young agent's expectation of consumption when old.[2] Consumption by the young in period t comes from goods produced via a primitive technology, m. This technology is taken to depend on the level M of microloans, which are assumed to enhance labor productivity: thus $m = m(M)$ with $m' > 0$. Because the mapping from M to m is injective we may dispense with the dependence on M and simply track the the marginal productivity of primitive labor, m.

Young agents divide their time between production for own consumption and education to accumulate human capital which can increase productivity in period $t+1$, specifically, $c_{1t} = m_t \cdot n_{1t}$, and $h_t = 1 - n_{1t}$. Here $n \in (0,1)$ is the labor supplied by the agent towards good production, h is the attained level of human capital accumulation.[3] Since microloan repayment begins immediately, $m_t(M_t)$ is properly characterized as the production net of micro loan repayment. Implicit in this is the assumption that microloans are consumption enhancing net of repayment (i.e. we assume away 'bad' loans where the investment fails to yield a return sufficient to meet repayment obligations).

An old agent also has a unit of time which he supplies inelastically to goods production. The agent has access to the same technology as when young, but also to an additional technology, $F(h_t, H_{t+1}, \delta)$. Here F captures the education-enhanced production technology available to the old. Notice that this technology depends on both the individual human capital acquired when young, h_t, and the time $t+1$ level of aggregate human capital H_{t+1}, which is the sum of all individual human capital at time $t+1$. Aggregate human capital is assumed to increase education enhanced production in $t+1$ and therefore agglomeration externalities, or social returns to human capital are introduced.

The technology F is assumed to be "all or nothing" in labor: using F is a full-time job. This modeling feature is incorporated using an indicator function $\delta(n)$ which is equal to unity when $n = 1$ and zero otherwise, together with the assumption that $F(h, H, 0) = 0$. The

[2] As is standard, we focus on point expectations because our model is non-stochastic.

[3] Implicit in our production formulation is that the young agent supply labor inelastically: no value is place on leisure.

representative young agent's problem may thus be written as

$$
\begin{aligned}
\max_{c_{1t},h_t,n_{1t}} \quad & u\left(c_{1t}, c^e_{2t+1}\right) \\
& c_{1t} = m_t n_{1t} \\
& h_t = 1 - n_{1t} \\
& c^e_{2t+1} = F(h_t, H^e_{t+1}, \delta(1 - n^e_{2t+1})) + m^e_{t+1} n^e_{2t+1},
\end{aligned}
$$

where we note that the young agent's decisions condition on their expectations of the level of aggregate human capital when they are old.

Denote by $h_t = h\left(m_t, m_{t+1}, H^e_{t+1}\right)$ the education decision of a representative young agent in time t who faces the exogenous (to the agent) factors m_t and m_{t+1}, and holds expectations H^e_{t+1}. In a rational expectations equilibrium, agents have perfect foresight: $H^e_{t+1} = H_{t+1}$. Since all young agents are identical, we have the following definition:

Definition 1 *Given a path $\{m_t\}_{t\geq 0}$ of loan-induced productivities, a rational expectations equilibrium (REE) is a sequence $\{H_t\}_{t\geq 1}$ of aggregrate human capital levels satisfying*

$$H_{t+1} = h_t = h\left(m_t, m_{t+1}, H_{t+1}\right).$$

Note, in particular, that if m is taken as constant, then, abusing notation slightly, the equilibrium may be represented as a steady-state level of aggregate human capital H^* satisfying $H^* = h\left(m, H^*\right)$. For the remainder of the paper, we assume that m is fixed. This equation may then be used to conduction comparative statics, that is, to assess the impact on H^* of exogenous changes in m.

As emphasized by Samuelson's *correspondence principle*, comparative statics are only meaningful when the corresponding equilibrium enjoys an appropriate stability: after all, if the equilibrium is not stable then any small perturbation – any comparative-static experiment – may lead to non-equilibrium outcomes.

Because young agents condition their education decisions on expected aggregate outcomes the appropriate notion of stability is *expectational stability* or *E-stability*. This notion comes from the literature on adaptive learning: see Evan and Honkapohja (2001) for an in-depth treatment, and Emerson and McGough (2017) for applications to models of human capital accumulation. Intuitively, we back off the assumption that agents have perfect foresight, and instead imagine that they form expectations using past data. As is standard for non-stochastic models in which agents are learning a steady state, we assume that young agents form expectations H^e_{t+1} by taking a weighted average of their parents expectations H^e_t and the new data H_t:

$$H^e_{t+1} = (1-\gamma)\cdot H^e_t + \gamma \cdot H_t, \tag{1}$$

where $\gamma \in (0,1)$ is referred to as the gain. Noting that $H_t = h(m, H^e_t)$, we have that H^* is a fixed point of the dynamic system (1). We have the following definition:

Definition 2 *The REE H^* is E-stable provided that for sufficiently small $\gamma > 0$ it is a Lyapunov stable fixed point of the dynamic system (1), that is, provided that given any open neighborhood U of H^* there is an open neighborhood V of H^* with $V \subset U$ so that if $H_0^e \in V$ then $H_t^e \in U$ and $H_t^e \to H^*$.*

Intuitively, E-stability guarantees that if the dynamic system (1) is initialized near the REE then it stays near the REE and asymptotes to the REE. In particular, small perturbations do not lead to large changes in behavior.

Here and in the sequel, we adopt the generic assumption $h_H(m,H^*) \neq 1$. We have the following result characterizing E-stable equilibria:

Lemma 1 *The equilibrium H^* is E-stable if and only if $h_H(m,H^*) < 1$.*

The proof of this and all results are in the Appendix. Lemma 1 provides a natural condition that is necessary and sufficient for E-stability, and thus necessary and sufficient for the application of comparative static analysis.

3.2 Comparative statics: partial equilibrium analysis

Our intuition is that the availability of microloans raises the opportunity cost of education and subsequently decreases equilibrium aggregate human capital. Whether this decrease obtains depends delicately on income/substitution effects. In this section, we take a partial-equilibrium view by assuming the level of aggregate human capital H is fixed and subsequently focusing on the behavior of the representative young agent. In the next section we adopt the general equilibrium perspective and allow H to be determined endogenously.

We begin by making assumptions on preferences and technology. The utility specification is taken to have the usual properties, i.e. $u_\star > 0$ and $u_{\star\star} < 0$ for $\star \in \{c_1, c_2\}$; and the technology satisfies $F_h, F_H > 0$, $F_{hh}, F_{HH} < 0$ and $F_{hH} \geq 0$. Finally, we make two additional assumptions on the pair (u,F): given $H, m > 0$ the agent will choose $c_{1t}, c_{2t+1} > 0$ and $n_{2t+1} = 0$: the first assumption restricts attention to preferences and technologies that present solutions in the interior of the consumption space – an assumption that is easily satisfied by imposing standard Inada conditions; and the second assumption simply requires that our technology is sufficiently productive that the old do not choose the primitive technology over it. It is in this sense that our microloans are small: they are not assumed to inject enough productive capital into the economy to cause the primitive technology to ex ante dominate the sophisticated technology.

It is convenient now to introduce the preferences over (c_1, h)-bundles implied by the utility function u. Specifically, let $v(c_1, h, H) = u(c_1, F(h, H))$. Capitalizing on the assumptions above, we may now write the representative agent's problem in two equivalent ways:

consumption approach	*education approach*
$\max_{c_1,c_2,h} \; u(c_1,c_2)$ $c_1 = (1-h)m$ $c_2 = F(h,H)$	$\max_{c_1,h} \; v(c_1,h,H)$ $c_1 + m \cdot h = m$

The consumption approach yields the standard and useful first-order condition

$$\mathrm{MRS}_{c_1c_2} \equiv \frac{u_{c_1}}{u_{c_2}} = F_h/m. \tag{2}$$

The education approach emphasizes that $1/m$ is the relative price of first-period consumption.

We say that c_1 and h are *v-substitutes* if they are gross substitutes with respect to preferences given by the utility function v. Writing the human-capital investment decision of the young agent as $h = h(m,H)$, it follows that if c_1 and h are v-substitutes then $h_m < 0$. The following simple proposition provides a class of utility functions u which induce preferences over (c_1,h)-bundles so that c_1 and h are v-substitutes.

Proposition 1 *Suppose $u_{c_1c_2} = 0$. If*

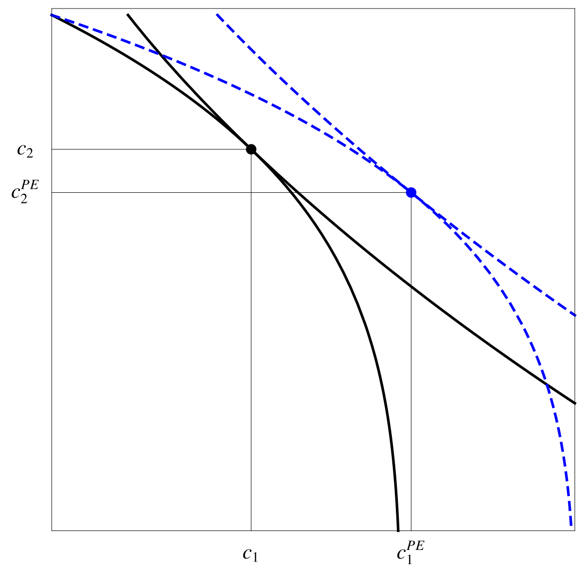
$$-\frac{c_1 \cdot u_{c_1c_1}}{u_{c_1}} < 1 \tag{3}$$

then c_1 and h are v-substitutes.

The expression on the left-hand-side of the inequality (3) is the coefficient of relative risk aversion with respect to period one consumption; and, in this case, it is measuring the willingness of the agent to shift consumption between periods: a lower value of the coefficient indicates a greater willingness to consumption today at the expense of tomorrow. For this reason, if the coefficient is smaller than one then $h_m < 0$: an increase in m, which amounts to a decrease in the relative price of period one consumption, raises the opportunity cost of educational investment, and results in a corresponding decrease in both h and c_2.

For fixed H and m, preferences that result in c_1 and h as v-substitutes may be illustrated graphically by combining the constraints $c_1 = (1-h)m$ and $c_2 = F(h,H)$ to create a production possibilities frontier (PPF), and joining the frontier with the tangential indifference curve corresponding to the optimal consumption bundle. Precisely this graph is provided in Figure 1. The horizontal and vertical axes correspond to c_1 and c_2 respectively, the solid (black) concave curve is the PPF associated to the fixed pair (m,H), and the solid (black) convex curve is the indifference curve containing the chosen bundle (c_1,c_2). The dashed (blue) curves identify the outcome when m is increased, with the corresponding *partial equilibrium* bundle given by $\left(c_1^{PE}, c_2^{PE}\right)$. An increase in m expands the PPF along the horizontal axis, leading to an income and substitution effect; if the substitution effect dominates, as is indicated in the figure, then second-period consumption falls: $c_2^{PE} < c_2$. Since, for fixed H, second-period consumption is increasing in h, it follows that $h_m < 0$.

Figure 1: Partial equilibrium impact of an increase in m.



3.3 Comparative statics: general equilibrium analysis

We now take into account the endogeneity of aggregate human capital by conducting comparative statics on the equilibrium equation $H^* = h(m, H^*)$. Our notion of v-substitutes, together with expectational stability provides our main result:

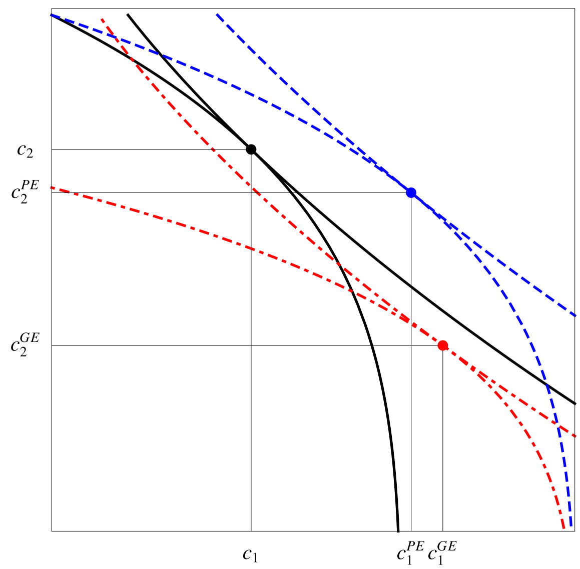
Proposition 2 *If H^* is E-stable and if c_1 and h are v-substitutes then $H_m^* < 0$.*

Proposition 2 confirms our intuition: substitutability, coupled with a rise in the opportunity cost of education, can lead to a decrease in aggregate human capital. Put simply the utility payoff from spending time on the micro-loan activity is larger than the payoff from spending time on human capital accumulation.

The general equilibrium effects of an increase in m can also be illustrated graphically. Figure 2 provides the same partial equilibrium results as Figure 1, but now also includes dot-dashed (red) curves identifying the equilibrium impact of the corresponding change in H^*. Whereas the increase in m expands the PPF along the horizontal axis, the fall in H^* contracts the PPF along the vertical axis, which results in a further decrease in second-period consumption from c_2^{PE} to c_2^{GE} and an increase in first-period consumption from c_1^{PE} to c_1^{GE}.

To provide a more concrete result, we consider parametric classes of utility and produc-

Figure 2: General equilibrium impact of an increase in m.



tion. Specifically, we assume

$$u(c_{1t}, c_{2t+1}) = \frac{1}{1-\sigma}\left(c_{1t}^{1-\sigma} + c_{2t+1}^{1-\sigma} - 2\right), \text{ for } \sigma > 0, \text{ and} \tag{4}$$

$$F(h, H) = Ah^{\alpha}H^{\beta}, \text{ for } A > 0, \alpha, \beta \in (0,1). \tag{5}$$

The following corollary provides the parametric restrictions need to guarantee $H_m^* < 0$.

Corollary 3 *Suppose u and F are given by (4) and (5) respectively. If $\sigma < 1$ and $\alpha + \beta < (1-\sigma)^{-1}$ then $H_m^* < 0$.*

Intuitively, provided that c_1 and c_2 are substitutes, i.e. $\sigma < 1$, and provided that the total elasticity of production with respect to human capital is not too high, i.e. $\alpha + \beta < (1-\sigma)^{-1}$, then a rise in the opportunity cost of education reduces equilibrium human capital. Finally, we note that given $\sigma < 1$, provided that the production function has decreasing or constant returns to scale, i.e. $\alpha + \beta \leq 1$, then the conditions of the corollary are satisfied and $H_m^* < 0$.

3.4 Comparative statics: welfare

Human capital accumulation is widely held as an important determinant of long run economic growth and a key to escaping poverty traps; through this lens, we may broadly interpret Proposition 2 as indicating that, and providing conditions under which, microloans may be welfare reducing. The simple structure of our model allows us to strengthen this point via direct computation. Denote by c_i^* steady-state consumption, and define $W(m) = u(c_1^*, c_2^*)$ and $y(m) = c_1^* + c_2^*$, where we interpret W as welfare and y as output (gdp). Since all agents are identical in the steady-state equilibrium of the model, any social welfare function that weights utility will return the same welfare measure. Additionally, every agent in the steady-state equilibrium will consume the same amount and thus societal production will be in direct proportion to individual consumption. We have the following result:

Proposition 4 *Suppose that H^* is E-stable and c_1 and h are v-substitutes. Then $W_m < 0$ provided that*

$$H_m^* < \left(\frac{H^* - 1}{m}\right)\frac{F_h}{F_H}. \tag{6}$$

Since $H^* \in (0,1)$, we know that the RHS of (4) is negative. Also, Proposition 2 already tells us that if H^* is E-stable and if c_1 and h are v-substitutes then $H_m^* < 0$. Proposition 4 provides an upper bound on H_m^* sufficient to guarantee that an increase in m not only leads to a decrease in aggregate human capital, it also lowers societal welfare.

While the RHS of (6) may seem difficult to interpret, it is not difficult to derive. An increase in m by dm leads to a change in h by dh and a change in H^* by dH^*. The change in h has no first-order effect on welfare (this is the envelope theorem at work); the change in m increases welfare by $(1-H^*)u_{c_1} \cdot dm$ and the change in H^* leads to a change in welfare by $f_H \cdot u_{c_2} \cdot dH$. Since $dH^* = H_m^* \cdot dm$ we have that the total change in welfare is negative provided

$$(1-H^*)u_{c_1} + F_H \cdot H_m^* \cdot u_{c_2} < 0. \tag{7}$$

Dividing each side by u_{c_2} and using the FOC (2) yields (6).

We may also see this loss of welfare graphically. Returning to Figure 2, simply note that the final indifference curve, identified as the dot-dashed (red) curve containing the general equilibrium consumption bundle $\left(c_1^{GE}, c_2^{GE}\right)$, is lower than the original indifference curve, identified as the solid (black) curve containing the original bundle (c_1, c_2).

Proposition 4 provides precise conditions under which increasing access to microloans not only reduces aggregate human capital, but explicitly reduces welfare as well. The potential for welfare reduction given an increase in m is somewhat surprising as, given our modeling technique, increasing m directly increases the productivity of the young while having no exogenous impact on the productivity of the old. These results turn on the presence of the agglomeration effect, as can be easily seen in condition (7): if $F_H = 0$, this condition can not be satisfied. Of course, that the possibility of welfare reduction requires $F_H > 0$ is not surprising: without agglomeration effects, an increase in m simply enlarges the choice set of an individual, and thus can not be welfare reducing.

A similar result regarding GDP may be obtained. For this result we maintain the natural assumption that, in equilibrium, the primitive technology is less productive at the margin than the advanced technology: $F_h + F_H > m$.

Proposition 5 *Suppose that H^* is E-stable and if c_1 and h are v-substitutes. Then $y_m < 0$ provided that*

$$H_m^* < \frac{H^* - 1}{F_h + F_H - m}. \tag{8}$$

To illustrate more quantitatively the implications of propositions 4 and 5, we turn to numerical work. We adopt the specifications for utility and production given by (4) and (5). We select a calibration so that $\sigma < 1$ and $\alpha + \beta < (1-\sigma)^{-1}$; thus, H^* is E-stable and c_1 and h are v-substitutes. Then, given a small baseline level of m_b, which identifies the productivity of the young due to the current level of microloans, we allow m_b to increase, and record the percent increase $\%\Delta m_b$ on the horizontal axes of Figures 3 and 4. As m_b increases, H^* will fall, and as H^* falls, we compute the corresponding percent changes in H^* and y. We also measure the change in welfare by computing the corresponding compensating consumption $\%\Delta cc$, that is, $\%\Delta cc$ is the percent change in steady-state consumption required to compensate for a given change in welfare. Formally, $\%\Delta cc\,(\%\Delta m_b)$ is implicitly defined as

$$u\Big(\left(1 + \%\Delta cc\left(\%\Delta m_b\right)\right) \cdot c_1^*\left(m_b\right), \left(1 + \%\Delta cc\left(\%\Delta m_b\right)\right) \cdot c_2^*\left(m_b\right) \Big) = W\left(\left(1 + \%\Delta m_b\right) m_b\right).$$

For example, if a given change $\%\Delta m_b$ results in $\%\Delta cc = 10\%$ then the steady-state consumption of both young and old agents would need to be increased by 10% to compensate for the associated welfare loss. In particular, note that $\%\Delta cc > 0$ implies a loss of welfare.

Figure 3 provides the numerical analysis in case c_1 and h are highly substitutable: $\sigma = .25$. In this case, as the productivity of the young due to microloans increases and ultimately doubles, output falls by 20%, human capital accumulation is cut in half, and to compensate for the corresponding welfare loss, agents require a 10% increase in steady-state consumption. Figure 4 provides a more moderate example, with $\sigma = .4$. In this case, the initial increase in m does lead to welfare losses, but eventually, the increased productivity of the young, together with their modest desire for consumption smoothing, leads to an increase in welfare. Thus, as the size of the microloan becomes sufficient large, welfare increases.

4 Conclusion and Discussion

Access to credit is scarce for poor families in developing countries. Microcredit institutions that provide credit to these households through peer-lending and other financial innovations provide liquidity that can have many positive attributes: increased consumption, investment in productive assets, insurance against income shocks and so on. But the nature of the

Figure 3: Changes in H^*, welfare and output for increasing m: high substitution ($\%\Delta cc > 0$ implies a loss of welfare).

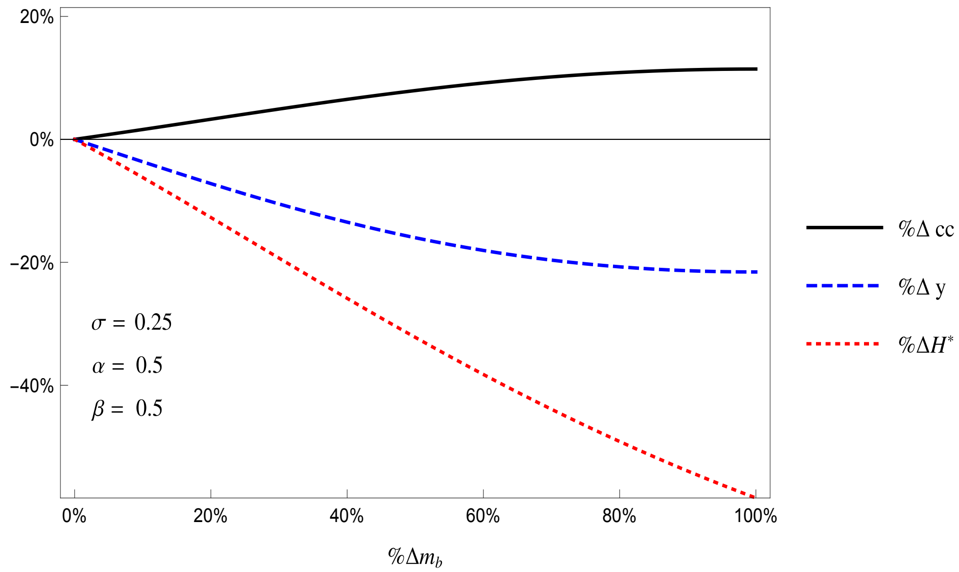
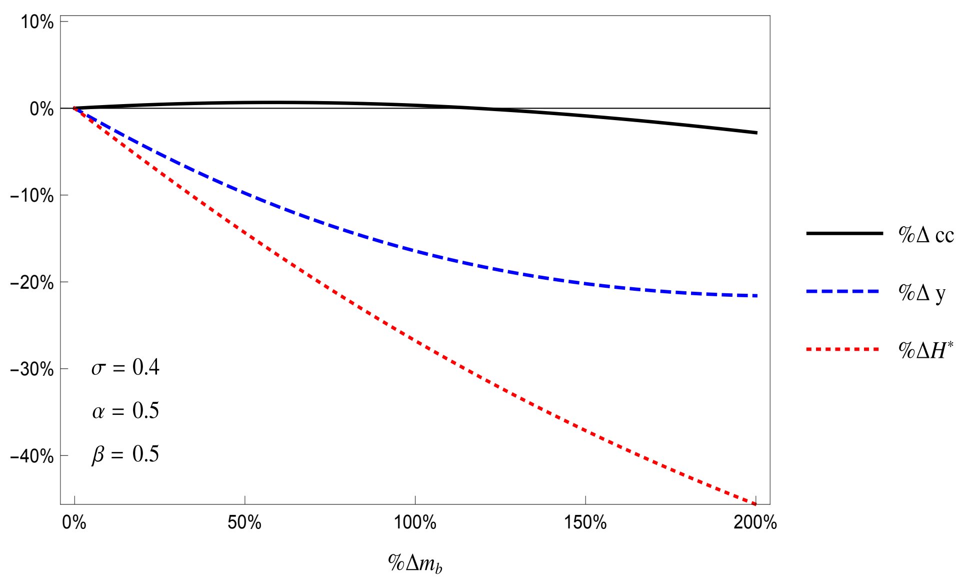


Figure 4: Changes in H^*, welfare and output for increasing m: moderate substitution ($\%\Delta cc > 0$ implies a loss of welfare).



typical microloan - that it is small and repayment begins very soon after the loan is acquired - may have an unfortunate side effect: it can create incentives to make investments in very short-term productive assets at the expense of assets that pay off in the future like human capital. Thus, in some circumstances, microloans may actually increase the opportunity cost of education and reduce educational investment by recipient households. Such choices are individually rational. If education has social returns as well as private returns this can lead to a reduction in growth and welfare for the entire economy. Thus the decision by households that receive microloans to reduce investments in human capital ends up lowering societal productivity.

The sensitivity of the results in the paper to the assumed income and substitution effects may help explain why previous empirical research has not reached consensus. It is quite likely that the same loan program applies in different contexts may have very different results in terms of education and other human capital investments. Blanket policy recommendations are thus inappropriate, but our model suggests two aspects of microloans that may contribute to constrained investment in education: the quick commencement of repayment and the size of the loan.

In the model presented in this paper, the return on investments is net of repayment, so in essence we are forcing immediate (within period) repayment. Relaxing this constraint would allow investments in assets that may have a higher present discounted values, but whose returns do not come until the next period. Student loans in the United States have the feature that repayment begins only when the investment begins to realize returns; when the recipient begins to work post-education. Such a loan program might be very beneficial to developing country economies as well.

It is also shown in the theory that larger loans can overcome the negative human capital aspects of microloans. It should be noted that this is despite the fact that microloans always depress human capital accumulation. Larger loans inject enough new capital into the economy that they overcome the damage done to the economy by the suppression of educational investments. Such new wealth might ease credit constraints of future generations, however, so the long term affect on growth and welfare might be positive. This is worth exploring in a fully dynamic model of microcredit on a similar stylized economy.

5 Appendix

Proof of Lemma 1. The dynamic system (1), together with the agent's behavior $H_t = h(m, H_t^e)$, may be written

$$H_{t+1}^e = (1-\gamma) \cdot H_t^e + \gamma \cdot h(m, H_t^e) \equiv G(m, H_t^e).$$

The steady state H^* is Lyapunov stable provided that $|DG(m, H^*)| < 1$. We may compute

$$\begin{aligned} |DG(m,H^*)| < 1 \quad &\Leftrightarrow \quad -1 < 1 - \gamma + \gamma \cdot h_H(m,H^*) < 1 \\ &\Leftrightarrow \quad \frac{\gamma - 2}{\gamma} < h_H(m,H^*) < 1. \end{aligned}$$

The result follows from the fact that $\frac{\gamma-2}{\gamma} \to -\infty$ as $\gamma \to 0$. ■

Proof of Proposition 1. The FOC associated to the education approach may be written $m \cdot v_{c_1} = v_h$. Using $v_{c_1} = u_{c_1}$ and $v_h = u_{c_2} F_h$, and imposing the budget constraints, we obtain

$$m \cdot u_{c_1}\left((1-h)m, F(h,H)\right) = u_{c_2}\left((1-h)m, F(h,H)\right) F_h(h,H).$$

Compute the total differential with respect to m and h, and using $u_{c_1 c_2} = 0$, yields

$$m \cdot u_{c_1 c_1} \cdot \left((1-h) \cdot dm - m \cdot dh\right) + u_{c_1} \cdot dm = \left(F_h^2 \cdot u_{c_2 c_2} + u_{c_2} \cdot F_{hh}\right) dh.$$

Solving for h_m, we obtain

$$h_m = \frac{u_{c_1 c_1} \cdot (1-h)m + u_{c_1}}{F_h^2 \cdot u_{c_2 c_2} + u_{c_2} \cdot F_{hh} + m^2 \cdot u_{c_1 c_1}}.$$

Since the denominator is always negative, and since $(1-h)m = c_1$, we get $h_m < 0$ provided that $u_{c_1 c_1} \cdot c_1 + u_{c_1} > 0$, and the result follows. ■

Proof of Proposition 2. The equilibrium is characterized by $H^* = h(m, H^*)$. Total differentiation yields

$$H_m^* = \frac{h_m(m, H^*)}{1 - h_H(m, H^*)}.$$

Since H^* is E-stable, we have that $h_H(m, H^*) < 1$, and since c_1 and h are v-substitutes we have that $h_m(m, H^*) < 0$, and so the result follows. ■

Proof of Corollary 3. Letting $G(m,h,H) = F(m,h,H)^{\sigma} m^{1-\sigma} - F_h(m,h,H)(1-h)^{\sigma}$, the FOC can be written $G = 0$, so that $h_m = -G_h^{-1} G_m$ and $h_H = -G_h^{-1} G_H$. We may compute

$$\begin{aligned} G_h &= \sigma F^{\sigma-1} m^{1-\sigma} F_h - F_{hh}(1-h)^{\sigma} + \sigma F_h (1-h)^{\sigma-1} \\ G_m &= (1-\sigma) F^{\sigma} m^{-\sigma} \\ G_H &= \sigma F^{\sigma-1} m^{1-\sigma} F_H - F_{hH}(1-h)^{\sigma}. \end{aligned}$$

It follows that $G_h > 0$ and $G_m > 0 \Leftrightarrow \sigma < 1$. Thus $\sigma < 1$ implies $h_m < 0$.

To complete the proof, we must show that $h_H < 1$. It suffices to show that $G_h + G_H > 0$. Noting, for example, that $F_{hh} = \frac{\alpha(\alpha-1)F}{H^2}$, and using

$$\left(\frac{c_2}{c_1}\right)^{\sigma} = \frac{F_h}{m},$$

we compute

$$
\begin{aligned}
G_h+G_H &= \sigma F^{\sigma-1}m^{1-\sigma}(F_h+F_H)+\sigma F_h(1-H)^{\sigma-1}-(F_{hh}+F_{hH})(1-H)^{\sigma}>0\\
&\Leftrightarrow \sigma\left(\frac{F}{m(1-H)}\right)^{\sigma}\frac{m}{F}(F_h+F_H)+\frac{\sigma F_h}{1-H}>F_{hh}+F_{hH}\\
&\Leftrightarrow \sigma\frac{F_h}{F}(F_h+F_H)+\frac{\sigma F_h}{1-H}>F_{hh}+F_{hH}\\
&\Leftrightarrow \frac{\sigma\alpha}{H}\left(\frac{\alpha+\beta}{H}\right)F+\frac{\sigma\alpha F}{H(1-H)}>\frac{\alpha(\alpha-1)F}{H^2}+\frac{\alpha\beta F}{H^2}\\
&\Leftrightarrow \sigma\alpha(\alpha+\beta)+\frac{\sigma\alpha H}{1-H}>\alpha(\alpha-1)+\alpha\beta\\
&\Leftrightarrow \frac{H}{1-H}>\frac{\alpha-1+\beta-\sigma(\alpha+\beta)}{\sigma}\\
&\Leftrightarrow \frac{H}{1-H}>\frac{(\alpha+\beta)(1-\sigma)-1}{\sigma}=\frac{1-\sigma}{\sigma}\left(\alpha+\beta-\frac{1}{1-\sigma}\right).
\end{aligned}
$$

By the premise of the corollary, $\alpha+\beta-\frac{1}{1-\sigma}<0$. tSince $H\in(0,1)$, the result follows. ■

Proof of Proposition 4. We may write

$$W(m)=u\left((1-H^*)m,F(H^*,H^*)\right),$$

so that

$$W_m=u_{c_1}((1-H^*)-m\cdot H_m^*)+u_{c_2}(F_h+F_H)\cdot H_m^*.$$

Thus

$$
\begin{aligned}
W_m<0 &\Leftrightarrow \frac{u_{c_1}}{u_{c_2}}((1-H^*)-m\cdot H_m^*)+(F_h+F_H)\cdot H_m^*<0\\
&\Leftrightarrow \frac{F_h}{m}((1-H^*)-m\cdot H_m^*)+(F_h+F_H)\cdot H_m^*<0\\
&\Leftrightarrow \frac{F_h}{m}(1-H^*)+F_H\cdot H_m^*<0,
\end{aligned}
$$

where we have used equation (2), and the result follows. ■

Proof of Proposition 5. We may write

$$y(m)=(1-H^*)m+F(H^*,H^*),$$

and then compute

$$y_m=(1-H^*)-m\cdot H_m^*+(F_h+F_H)\cdot H_m^*,$$

and the result follows. ■

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