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Assessing the potential impact of Microfinance with agent-based modeling ☆

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ABSTRACT

Recent empirical results have cast doubt on the value of Microfinance as a tool for reducing poverty. But, the difficulty lies in evaluating the impact of Microfinance in a world where the Microfinance institutions, their borrowers, and government policies are constantly changing. There is a need for a comprehensive and transparent framework to develop the theoretical grounds for believing in (or against) the efficacy of Microfinance, which can at the same time be used as a testing ground for policymakers. This paper presents a first attempt to develop an agent-based modeling (ABM) framework for pre-policy-implementation testing of the effects of Microfinance. Under the ABM paradigm, a set of behaviors for individual agents in the economy is used to construct a simulation whereby random interaction allows agents to change their state over time. Simulation of the model in different scenarios supported all our intuitions about Microfinance; in particular, there was positive impact of Microfinance on the wealth level of the poor. It was found that increase of available funds, easy access for producers and lower interest rates increase the effectiveness of Microfinance.
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1. Introduction

Since its inception in the villages of Bangladesh in the 1970s, the modern Microfinance revolution is emerging in many countries of the world as a tool for poverty reduction (Robinson, 2001). The award of the Nobel Peace prize to Dr Yunus and the acceptance of Microfinance as one of the primary tools to attack poverty seem to have galvanized its opponents. Severe doubts have been cast upon the effectiveness of Microfinance (Roodman and Morduch, 2009).

> "Thirty years into the movement, it might seem strange that researchers are still asking whether microfinance reduces poverty. In fact, by the standards used to judge whether drugs are safe and effective in the bloodstreams of people, the safety and effectiveness of microfinance injected into the fabric of villages and barrios remains unproven." (Roodman, 2009)

The causality between Microfinance and poverty reduction is yet to be well established and the use of different methodologies, variables and assumptions by different researches are giving contradictory results (Roodman and Morduch, 2009; Pitt and Khandker, 1998; Khandker, 2005). There are considerable difficulties in evaluating the impact of Microfinance in a world where the Microfinance institutions, their borrowers, and government policy are constantly changing. In this environment, policymakers are particularly challenged, since they must usually act before full information arrives, and before econometric results can unambiguously assess the data. This can lead to poorly targeted policies, such as inappropriate or ineffective Microfinance regulation, and can also create a poor environment for assessing the impact, positive or negative, of Microfinance in practice. There is a need for a transparent framework, which focuses upon essentials, to develop the theoretical grounds for or against the efficacy of Microfinance, which can at the same time be used as a testing ground for policymakers. While institutional arrangements matter a lot for the effectiveness of individual microfinance programs, it may be useful to focus upon the primary ideas. Microfinance is, in essence, *micro*-finance; if finance works, so should microfinance.

The agent-based modeling (ABM) framework provides decentralized, dynamic environments with populations of evolving, heterogeneous, boundedly rational agents who interact with one another, typically locally (Duffy, 2006). This paper describes an agent-based modeling framework for pre-policy-implementation testing of the effects of Microfinance in a simplified environment. Under the ABM paradigm, a set of behaviors for individual agents in the economy is used to construct a simulation whereby random interaction allows agents to change their state over time. Here the underlying economic interactions between agents are tightly built upon supporting empirical data of e.g. profit-making for small enterprises, default rates on loans, etc. Aggregate outcome of varied activities performed by

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heterogeneous agents can be analyzed in this approach which gives an effective framework for policy analysis.

2. The model

The key objective of the model was to evaluate the impact of Microfinance on the income level of the poor and the repayment ratio of microcredit over time. It was carried out by a simulation in an agent-based modeling environment in NetLogo. It emulates the behavior of different agents in a simplified environment and shows the outcome as a result of the interactions among agents. Agent-based modeling is an efficient way to get a lucid picture of the impacts of Microfinance, because it can model the structures and procedures of Microfinance from the perspectives of different agents in a real economy, and thus can give the aggregate result of the interactions among different agents. Several parameters of the model are chosen to reflect the orders of magnitude found in a recent study of Urban Microfinance in Bangladesh (Rashid and Bashar, 2010). A direct survey of some twenty different urban microfinance activities showed rates of profit for initial loans to be in excess of 100%. Such high figures led to the presumption that an ABM model which incorporates such interest and profit rate differentials should be able to reproduce the process of wealth creation.

This model considered 5 types of agents related with Microfinance: the poor in the population, the other people in the population, a Microfinance institution (referred here as "MFI"), local money lenders, and suppliers of raw materials. Each agent group is heterogeneous, because they are under different situations and pursue different objects from the interactions. By resorting to agent-based modeling, the model can reflect the various aspects of the real world, make updates, and get the final results after the Microfinance procedure starts. Here at the beginning the poor people get microcredit from MFIs to start a microenterprise according to their productivity level. To do that, they should prepare for start up business such as buying raw materials, renting a building and so on. After producing the product, they need to trade it in the market and repay the microcredit. These procedures require rules to direct the motion of the system and procedures to update and keep track of the agent's situation; this involves many variables such as wealth level, amount of loan, volume of production and trade of the products over time. An agent-based approach replicates these activities in a virtual environment and shows the aggregate outcomes in different time periods.

3. Model setup and agent characteristics

The model creates an environment where different agents live and interact with each other. This environment is a virtual economy space where economic transactions such as borrowing, repaying, manufacturing, and trading happen as time goes on. This space mimics economic activities in the actual world and helps us to capture the outputs of economic transactions. In the NetLogo program this space is represented by a black square, which is composed of a grid of patches (Fig. 1). The agents can move in this spatial environment and interact with each other.

The model starts with a given number of people living in the space. A portion of the whole population (to be stipulated by the user of the model) is assumed to be 'poor' agents in this model who have relatively low wealth level. Since the purpose of this model is to predict the impact of microcredit on the wealth level of the poor, these poor are our main focus throughout the entire procedures. The rest of the population are the non-poor, those individuals with more wealth than the poor. They are included in the model to reflect the economic interactions with the poor. Initially individual agents in the population are randomly distributed throughout the space. Each poor individual has a number of characteristics such as wealth, sex, and productivity, which define their participation in the model. More specifically, each individual, whether male or female, has a wealth level drawn from the normal distribution $N(50, 15)$. [Also he/she has a sex index which is either male or female]. It was assumed in this model, in keeping with the usual facts of LDC's, that the overall productivity of a male is higher than that of a female, since men are usually more educated than women in LDC's. There are also a variety of social and cultural constraints that enable males to earn somewhat higher returns than females of equal productivity. That is, the productivity level for a man is drawn from the normal distribution $N(4, 1.5)$, while that for a woman is from $N(3, 1)$. While the average productivity of a male is higher than that of a female, the variance of

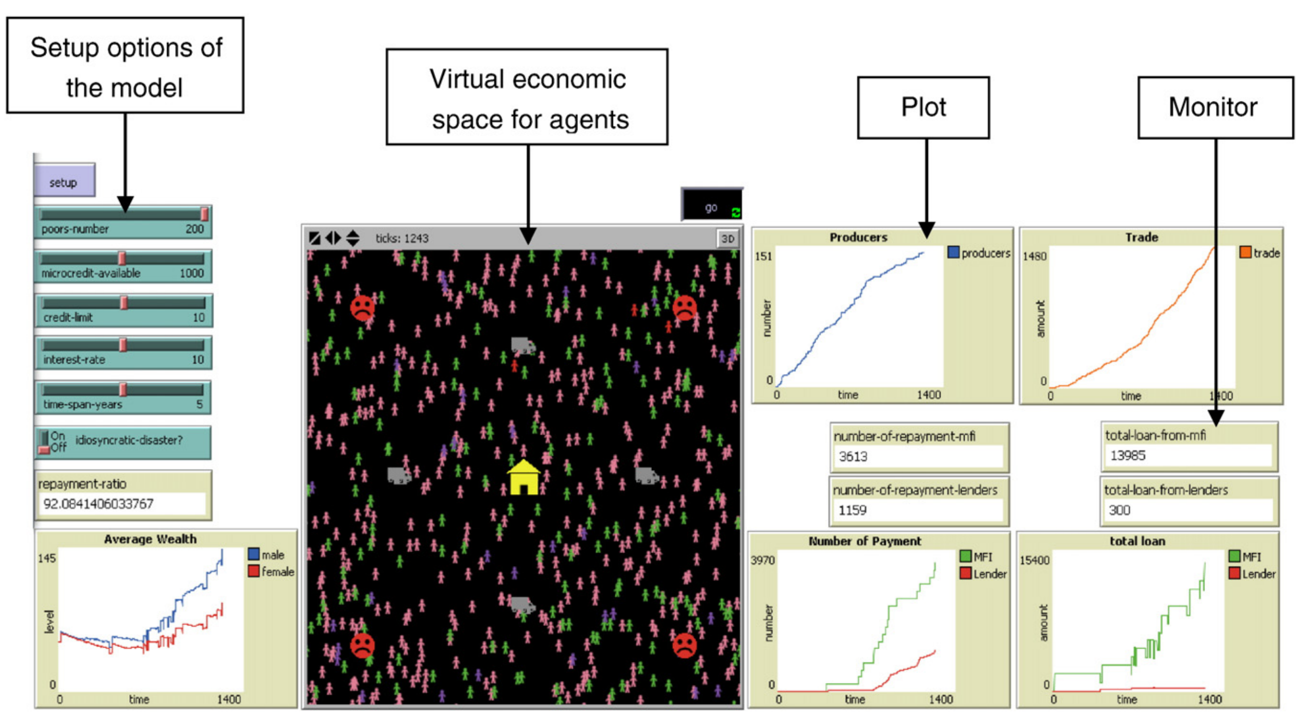

Fig. 1. Interface of the model in NetLogo.

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