

Microfinance Overview: From Simple Loans to Complex Systems

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ABSTRACT— *Financial services for the poor have existed since early ages and have been evolving from simple transactions to the nowadays microfinance sophisticated products and complex markets. However, despite the steady progress of microfinance, many issues still need to be addressed, and the microfinance, as a part of the economic scheme, has proven its requirement for new approaches and studies which would embrace the development of its structures. In this context, the present work gives, at first, an overview of the evolution of microfinance, its trends and main issues. Then, an approach of microfinance as a complex system is presented with regards to the state of the art of the complexity theory. Finally, this paper discusses the relevance of agent-based modeling in microfinance and provides a number of existing microfinance agent-based models.*

Keywords— Microfinance, complex systems, agent-based modeling, computational economics.

1. INTRODUCTION

Microfinance and microcredit are often confused and used interchangeably, but it is important to highlight the difference between them. Sinha [1] states that microcredit refers to small loans and involves providing credit to the poor, while microfinance is appropriate where the loans are supplemented by other financial services such as savings, insurances, pensions and payment services [2]. Indeed, the spirit of microfinance is based on the fact that the unbanked poor need an array of financial services other than just credits and loans [3]. Microfinance, in general, and microcredit in particular, have known a great development in the three last decades and have captured the interest of both researchers and practitioners.

What begins with simple loans to women in Bangladesh has matured in a developed industry, resulting even in IPOs and hybrid business models [4]. A great number of academic studies tried to apprehend relevant issues in microfinance and sought to assess quantitatively the impact of microfinance in microfinance. However, the nature of the actual microfinance market cannot be apprehended by the classical mathematical and quantitative tools. Indeed, the microfinance system is characterized by a dynamic environment of evolving heterogeneous and bounded rational agents who interact with each other and with their environment i.e., the borrowers, the microfinance institutions and the governments are always changing and evolving. Systems with those properties are called complex systems. Moreover, microfinance market can be considered as a complex adaptive system since the agents have the freedom to adapt and learn [5]. One tool to address the complexity of economic complex systems is agent-based modeling (ABM) and for economic systems it is defined as agent-based computational economics (ACE) [6].

The main objective of our work is to discuss the evolution of microfinance under the complexity paradigm and present a tool that allows addressing this complexity. The paper is structured as follows. Section 2 describes the rapid rise of the microfinance model since the Roman Era, its recent developments since the Grameen Bank and discusses the theoretical foundations of microfinance. Section 3 then summarizes the key issues that are considered relevant in microfinance. Section 4 explores the microfinance from a complex systems point of view while Section 5 presents relevant applications of agent-based modeling in microfinance. A brief conclusion summarizes the argument.

2. HISTORY AND FOUNDATIONS OF MICROFINANCE

2.1. Roman and Medieval Era

The first money lending operations go back to the Principate Era. The main lenders were rich private individual with an excess of Capital. Thus, the poor suffered from the excessive amount of interest charged by the lenders, which is called usury. At this time, it was clear that usury was the exploitation of the poor since when unable to repay a debt, the borrower is being bend to slavery [7]. Usury is condemned by many philosophers and by book religions through ages. Aristotle [8] states that:

"The most hated sort (of wealth getting), and with the greatest reason, is usury, which makes a gain out of money itself, and not from the natural object of it. For money was intended to be used in exchange, but not to increase at interest."

Judaism allows interest to be charged to strangers by not between Jews [9]. Islam laws prohibits interest the collection and payment of interest, since the usury in Islam is strongly linked to interests on loans [10]. As well, Christian Church in the Medieval Europe banned all forms of interest-taking on the basis of the Biblical rulings.

As a reform against money lending and poor exploitation, many products were developed like profit and loss sharing and joint venture contracts in Islamic economics. Furthermore, institutions have been created like the Montes Pietatis in the fifteenth century. Promoted by the Franciscans in Italy and England, and mostly based on charity capital, the institution offered loans at moderate interest rates, upon the security of objects left in pawn. Oppositely to money lending, Montes Pietatis privileged the borrower benefit and not the lender profit. Montes Pietatis was not only a pawnbroker but also a microcredit institution [11].

Lending to the poor has known a great development since the revolution of the Montes Pietatis. In 1720s, the Irish writer Jonathan Swift developed many mains idea of contemporary microcredit [12]. He demanded no material collateral but only the vouchsafe of the borrowers' peers. This led to the creation of the first loan fund in Ireland. In the 1840s, during the Great Famine, the Irish microcredit institutions served the fifth of the population of Ireland [13].

Another country concerned with the famine, was Germany. Friedrich Wilhelm Raiffeisen, a German mayor observed that charity did not provide a solution for the terrible poverty caused by the famine. He thought that mutual solidarity may be the solution; he then brought poor farmers together into a cooperative structure. He created savings and credit cooperatives that allowed to their members to borrow at very advantageous rates: Cooperative Banking was born [13]. This experience influenced the Priyayi Bank of Purwokerto, an Indonesian micro-banking institution created in 1895 that had been reorganized into the Cooperative Banking "Bank Rakyat Indonesia" in 1897 by the Dutch administration.

2.2. Contemporary Microfinance

The 20th century has known a contemporary microcredit revolution. In 1961, Joseph Blatchford founded a grassroots community development organization called ACCION. The objective was to help people living in poverty by developing their talents and efforts. But the main experience in the modern microcredit is the Grameen Bank in Bangladesh. Initiated by Mohammad Yunus in 1974, the Grameen Bank is considered as the pioneer of contemporary microfinance. Mohammad Yunus received the Nobel Prize in 2006 for his work in microcredit and its role in poverty alleviation. Moreover, the United Nations declared 2005 as "*The International Year of Microcredit*" and highlighted microfinance as an instrument of the socioeconomic development.

Today, what once started as simple microloans has evolved into developed and varied financial products and strategies. This evolution is called the "*Financial Inclusion Agenda*". The financial inclusion consists in making the access to loans easy for the poor. From a social justice point of view, this financial inclusion agenda is sometime perceived as a negative evolution, since it reflects the change of the initial objective of microfinance which is poverty alleviation. Microcredit in the traditional form isn't really the answer: It is not enough to lend money to the poor; there must be empowerment and assistance through the borrowers' projects.

2.3. Theoretical Foundations

After spotting an early enthusiasm for research on microfinance in the international academic community, we wanted to identify the most studied topics within the field. The articles published in microfinance are basically structured around three inter research topics:

- Theme 1: The foundations of Microfinance
- Theme 2: Impact of microfinance in Poverty alleviation
- Theme 3: Best practices and modern issues

The table below summarizes the main issues emerging from these research themes:

Table 1: Main research topics in Microfinance

Foundations of microfinance	[14];[15];[16];[17]; [18];[19];[20]
Impact of Microfinance of Poverty alleviation	[21];[22];[23];[24];[25];[26]
Best practices and modern issues	[27];[28];[29];[30];[31]

Nowadays, the interest for research in microfinance has arisen. There are several international centers and research institutes working on microfinance, namely: Dauphine Microfinance[32]; Microfinance Center for Central and Eastern Europe and the New Independent States[33]; Russian Microfinance Center[34]; Center for Microfinance (CMF)[35]; Microfinance Gateway (CGAP)[36]; Research in Microfinance (e-MFP)[37]; Center for European Research in Microfinance (CERMi)[38]; Center for Microfinance Nepal[39]; Institute of Development Studies (IDS)[40]; Center for Microfinance-Zurich[41].

A number of journals focus specifically on microfinance and economic development, of which we cite: World Development [42]; The journal of Development Studies [43]; Enterprise Development and Microfinance [44], Journal of International Development [45].

3. MICROFINANCE TRENDS AND ISSUES

3.1. Impact of microfinance

Despite the steady development of microfinance and its success that culminated in the Nobel Prize for Mohammad Yunus and the Grameen Bank in Bangladesh in 2006, many critics about the real impact of microfinance on poverty alleviation. Banerjee and al. [46] found in their evaluation that microfinance has no impact on poverty reduction, health or gender gap. In addition, microloans are not beneficial for the borrower living below the poverty line but for those above it [15]. This can be explained by the fact that more income suggests more risk taking, such as investing in new technologies, and the levels of income flows and risk taking are usually correlated. In result the clientele below the poverty line is caught in subsistence activities and have no specialized skills and so must compete with all the other self-employed poor people in entry-level trades.

High rates of interest are one of the most controversial subjects in microfinance and cause more harm than good, since the poor have to earn a return on investment greater than the interest they have to pay; otherwise, they become poorer not wealthier. Also, the funding from the government doesn't always encourage the small enterprises. It is possible for an economy to invest in both micro and larger enterprises. But governments need to prioritize development approaches that have a higher payoff [47]. Finally, the poverty alleviation cannot be restricted to financial access and income growth. It must be endorsed to services such as public safety, basic education, public health and infrastructure since they increase the productivity and employability of the poor, and thus their income and well being [30].

3.2. Sustainability and outreach

Microfinance services come with high transaction and information costs. Those costs are usually covered by donors' subsidies which mean that microfinance institutions (MFI) are not sustainable. The issue of the sustainability of MFI was first raised in the 90s [16].

Two schools debate about this. The poverty lending approach –welfarist- and the financial systems approach – institutional-. The financial systems approach preaches the importance of financially sustainable microfinance programs whereas the poverty lending emphasizes on the fact that the primary goal of the MFI is using credit to help overcome poverty. Hence, aiming at financial sustainability ultimately goes against the goal of serving large groups of poor borrowers. In fine, there is a trade-off between outreach and sustainability [48][49].

After a long appraisal of the impact of Microfinance and its auspicious development, in recent years the microfinance model has been criticized and its impact questioned [50]. Khawari [51] states that the empirical impact of microfinance is yet to be proven since most of the empirical studies are conducted by the microfinance institutions (MFI) themselves. Moreover, the microcredit crises in different countries (Morocco, Nicaragua, India...) raised more than a question about the real role of microfinance in combating poverty [52]. Thus, the need for new approaches and models to apprehend microfinance issues is more than imminent.

4. MICROFINANCE AS A COMPLEX SYSTEM

4.1. Complex systems: Definitions

A system is typically defined to be complex if it exhibits the following two properties [53]:

- The system is composed of interacting units;
- The system exhibits emergent properties, that is, properties arising from the interactions of the units that are not properties of the individual units themselves.

If, in addition, the complex system includes reactive units i.e., units capable of exhibiting systematically different attributes in reaction to changed environmental conditions, the system is designed as a Complex Adaptive System (CAS) [6].

The study of complex adaptive systems was undertaken intensely at the Santa Fe Institute throughout the early to mid 1990s resulting in the release of many books and papers. There are others important recent research that continue to search into applications of complex systems, namely: Sawyer[54]; Miller[55]; Boccaro[56]; Nicolis[57]; Al-Suwailem[58]. Many research centers and institutes work on complex systems, in addition to a number of journals that focus on the subject [59][60].

4.2. Complexity in Economics

The science of complexity claims that there are common properties of complex systems which are the object of study in many different fields such as the cell, the brain, language, the capitalist market economy. The focus therefore has moved from the macro to the micro level. Macroeconomic variables can be reconstructed by summing up individual magnitudes (bottom-up procedure). Complex structures consisting of heterogeneous interacting agents generate complex dynamics also of the macro variables.

Complex economic structures are usually associated with adaptive agents. According to Delli-Gatti[61], the pre-analytic vision of a complex market economy, in fact, is centered upon agents endowed with limited information and computational capability (bounded rationality) so that they adopt rules of thumb (instead of optimization procedures) and are naturally led to interact with other agents to access information, learn and imitate. In this sense, complexity goes hand in hand with evolutionary dynamics and direct interaction among agents.

4.3. Why Microfinance is a complex adaptive system?

Microfinance is by definition micro-finance. Financial markets and economic systems have already been proven as complex adaptive systems [62]. In this section we will try to identify each property of complex systems previously defined in the microfinance system.

4.3.1. Interaction

In microfinance system, different agents interact. The main agents interacting in the microfinance system are: the clients, the MFI institutions, the local lenders, the market, the suppliers and the regulator. The levels of interactions and the information symmetry depend on the particularities of each market.

4.3.2. Emergence

Emergence is an essential notion in complex systems. A phenomenon is called emergent when the whole has properties of functionalities that its parts don't have [63]. The emergence in Microfinance systems usually results from the bounded rationality of the agents, but also from the information asymmetry in the market.

4.3.3. Reactivity

In the economic system and in the microfinance system in particular, the agent must always evolve in order to survive. Arthur [64] describes the economy as a "constantly developing set of institutions, arrangements, and technological innovations".

5. AGENT BASED MODELING AND SIMULATION IN MICROFINANCE

5.1. Agent based modeling

Agent-based modeling is the computational study of social agents as evolving systems of autonomous interacting agents [65]. The key feature of agent-based modeling is that it involves a bottom-up approach to understand a system's behavior. It starts at the level of the units, characterizes the behavior of each and how they are interrelated [66]. The aggregation of these individual behaviors simulated in software produces macro-level outcomes that can be referred to as emergent or bottom-up [67].

Ferber [68] notes that the multi-agent simulation allows the study of complex systems. It represents the complexity of a phenomenon through the interaction of a set of simple entities called agents. Each agent can:

- Communicate with other agents in order to exchange information;
- Perceive and act in some or all the part of its environment. It is idiosyncratic in the sense that it has its own rules and logic of perception and action;
- Apply its knowledge, skills and other resources to fulfill its individual personal objectives.

Agent-based simulation is used in a wide range of fields: statistics, physics, biology, chemistry, medicine, engineering, political sciences, education, economics, finance, etc. The technique is quite useful, not only in understanding and modeling the phenomenon under investigation, but, more important, in policy implications and decision-making.

5.2. Agent based models in microfinance

The field that focuses on the study of economic processes modeled as dynamic systems of interacting agents is called Agent-based Computational Economics (ACE) [6]. According to Tesfatsion [69]:

"The use of ACE model economies might also facilitate the development and experimental testing of integrated theories that build on theory and data from many different fields of social science. In particular, ACE frameworks could encourage economists to address growth, distribution, and welfare issues in a more comprehensive manner embracing a variety of economic, social, political, and psychological factors, thus restoring the broad vision of early political economists."

Since they use individual interactions and behaviors to simulate the dynamics of the macroeconomic level, agent-based models enable not only to test the impact of microfinance in poverty alleviation but also the impact of a set of qualitative variables such as the social norms, the willingness to work, the social happiness. In the last decade, a number of academic studies focused on the use of agent-based models to apprehend some of the microfinance dynamics.

For example, Barnaud [70] presents an original model combining agent-based modeling and role playing games in order to explore rules for rural credit in a highland farming community of Northern Thailand. This experiment suggests that the usefulness of models relies much more on the modeling process than on the model itself, because a model is usually useless if it is misunderstood by its potential users, or if it does not respond to their current preoccupations. In Suarez [71], a preliminary ABM is proposed, but it is not implemented, which is the modeling of multiple levels for the regulation of the Mexican microfinance industry. This work contains a philosophical discussion taking the Compartamos MFI as a loose case study to suggest that the structure formation within groups is driven by function optimizing clients and that this in turn depends on their collective behavior.

Another model is the one developed by Rashid [26]. This ABM proposes a high-level abstraction for testing the effects of implementing a MFI policy. It includes processes for changing the income level of clients and repayment ratio of microcredit over time. Agents have different behaviors that are broadly grouped as either poor or non-poor. The simulation of the model was conducted in Netlogo [72] and it was found that the increase of available funds, easy access for producers and lower interest rates increases the effectiveness of Microfinance. Saqalli [73] proposes an ABM framework for analyzing the impact of development interventions on different Nigerian Villages. The model uses two distinct parameters to model the rationality of farmers' decision making: gain or loss either in economic value or reputation. Finally, Lee [74] used the network theory to build an agent-based model that obeys the stylized rules of microfinance industry. They found that in a deteriorating economic environment confounded with adverse selection, latent moral hazard is likely to cause a regime shift from high to low loan payment probability. In order to apprehend and manage credit risk in microfinance, they propose a new perspective based on spontaneous cooperation and social capital.

6. CONCLUSION

Microfinance services have known a significant evolution through centuries, going from simple money lending operations to sophisticated products and markets, reaching their peak in the 70s with the Grameen revolution. Yet, although several scientific studies preach the positive impact of microfinance and its discernible role in poverty alleviation, many critics argue that these studies lack quantitative and realistic approaches.

The present work explored the existing approaches addressing microfinance as a complex system and highlighted the relevance of its main features, especially the appropriateness of agent based modeling regarding the nature of microfinance operations. In fact, modeling methodologies and simulation environments are needed to better assess and improve the impact of microfinance services toward poverty alleviation. Such model based analysis will allow defining and choosing the most effective solutions among the new and innovative products that microfinance offers.

One interesting perspective of this research is to develop a number of new agent-based modeling patterns which could more accurately simulate innovative microfinance techniques and products such as profit and loss sharing contracts.

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