DO CROWDFUNDED PLATFORMS IMPROVE SUSTAINABILITY AND OUTREACH IN MICROFINANCE INSTITUTIONS?

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Abstract

Economic and financial profitability is a prerequisite for social, and environmental sustainability. Several risk factors endanger the Microfinance Institutions (MFIs) and their precarious equilibrium, dwarfing their outreach potential towards the financially excluded.

The research question analyses the impact of crowdfunding platforms on the MFIs economic and financial equilibrium, to detect if and how sustainability and outreach may be improved. This hypothesis is tested with an empirical simulation and then interpreted with innovative network theory modeling. It is shown that networked platforms and related innovations as crowdfunding, reduce transaction costs, and operational risk. Another source of savings is given by reduced cost of capital: whereas it is difficult and expensive for MFIs to raise capital (equity or debt), crowdfunding (especially if reward- or donation- based) makes it easier and cheaper. Reward, donation, or equity crowdfunding, with its flexible approach and declinations, may represent a viable mix of complementary solutions that soften core microfinance criticalities, providing subsidized capital and cost-cutting technology.

Digital platforms act as pivoting nodes within the microfinance networked ecosystem, intermediating value co-creation, and sharing among cooperative stakeholders. Digital savings improve financial inclusion, fostering microfinance outreach.

The model is applicable to group lending practices that become digitized and may be extended to either individual borrowing or to peer-to-peer lending where direct connections eliminate the MFI intermediation.

Keywords: Network orchestration; outreach; financial inclusion; impact investments; Sustainable Development Goals.

1. Introduction

The success of microcredit does not imply that it can solve all the existing socio-economic problems that affect the poor: this false and simplified conviction is both dangerous and deceiving, as it generates exaggerate expectations that are not going to be satisfied. Microfinance is neither the philosopher's stone nor the Columbus egg and is also not what the poorest primarily need.

MFIs are limited in their ability to serve the poorest (this being a significant practical but also a theoretical obstacle to optimal outreach), for many complementary reasons such as the poorest natural unwillingness to borrow – life is already risky enough without taking on debt – or exclusion (often self-exclusion) from group members. The poorest also desperately need primary goods and services such as food, grants, or guaranteed employment before they can make good use of financial products.

Highly subsidized safety net programs are what the destitute at the bottom of the economic ladder primarily need.

The microfinance business is often unprofitable or – in the luckiest cases – offering only decent returns and consequently it does not easily attract ambitious and profit-maximizing managers unless they have a charitable background, looking for "values" beyond money and success; greater and well established MFI, transformed into formal banks, might generally be more seductive but the problem is to let them arrive at such a level; good strategic management is strongly needed even in this complex field, where poor management is often offered to indigent clients, creating a vicious circle challenging to sort out.

As Nourani et al. (2020) point out, attaining efficiency becomes crucial because donors, funders and investors now require MFIs to be self-sustainable and operate without donations or concessionary funds as these sources

have become insufficient. Ensuring resource efficiency will facilitate achievement of the intended dual objectives of MFIs—which is to achieve a wider coverage via financial inclusion (i.e., extend quality services to the poor) and attain self-sustainability (financial viability).

The key for a feasible and progressive solution of the main microfinance target – maximizing outreach and impact while preserving long-term, possibly unsubsidized, sustainability – is to insist on the search for financial innovation, to find smart and unconventional solutions to unorthodox problems.

There are three main types of crowdfunding that can interact with microfinance:

1. *Reward crowdfunding* is when people offer money in exchange for a tiered system of rewards. Even though this method offers backers a reward, it is still generally considered a subset of donation-based crowdfunding since there is no financial or equity return.
2. *Donation crowdfunding* is when people donate money, with no expectation of reward or equity.
3. *Equity crowdfunding* allows investors to become shareholders.

Consistently with this framework, the research question focuses on the impact of crowdfunding platforms on traditional microfinance activities rotating around group lending patterns. The target is to show if and to which extent crowdfunding platforms can improve microfinance economic viability, through a mix of sponsor- and reward- targeting capital, and technological savings originated by digital platforms, so promoting outreach to the unbanked.

The study aim is compliant to the 17 Sustainable Development Goals (https://sdgs.un.org/goals), specifically considering the first target (no poverty), and its positive impact on the others since microfinance-driven socio-economic sustainability, fostered by crowdfunding platforms, represents a prerequisite for all these goals.

According to the European Commission (2020), for microfinance, two areas of technological innovation are most relevant: payments and borrowings. The important innovations in the payments sphere relate to remittances, mobile payments, mobile points of sale, peer-to-peer (P2P) payments and B2B transactions. When it comes to borrowings, non-bank microfinance providers are increasingly applying credit risk assessment, Internet-based platform lending, crowdfunding, and auto-underwriting (technology-driven underwriting process that provides a computer-generated loan decision).

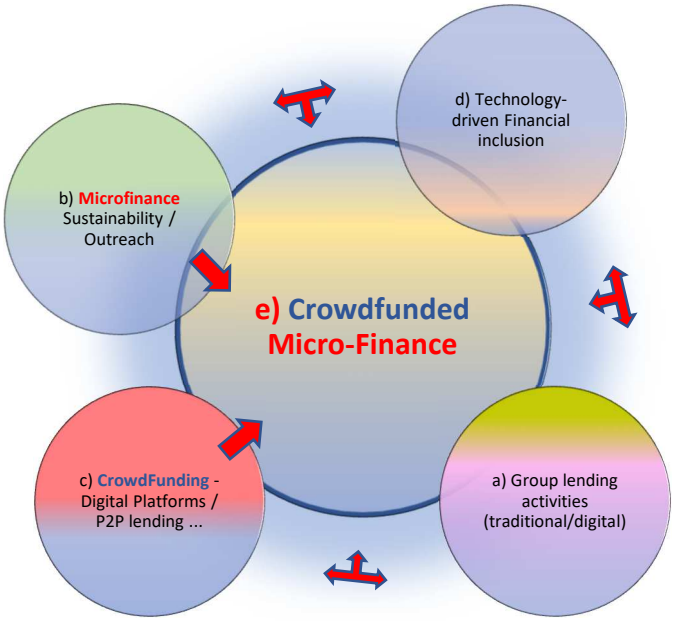
Based on these premises, the outline of the paper is the following:

a) a brief literature exam will framework the topic, showing its originality;
b) Crowdfunded digital platforms will be illustrated;
c) A methodological section will introduce the empirical setting, consistently with the research question, analysing the sustainability versus outreach trade-off;
d) Networking crowdfunding platforms will be introduced, showing how they can add value to the whole microfinance ecosystem;
e) The partitioning of the added value among the main stakeholders will be examined;
f) A discussion will critically reassess the main findings;
g) A conclusion will summarize the whole paper, with some tips for further research.

2. Literature

The interacting literature streams exemplified in Figure 1 are consistent with the outlay of the research question that can be reinterpreted as follows: traditional group lending activities (a), which represent a core business feature of the microfinance business model (b) with its sustainability constraints and outreach targets, are scaled up by crowdfunding platforms (c) that foster technology-driven financial inclusion (d), eventually bringing to crowdfunded microfinance (e).

Figure 1 – *Interacting Literature Streams*



In particular:

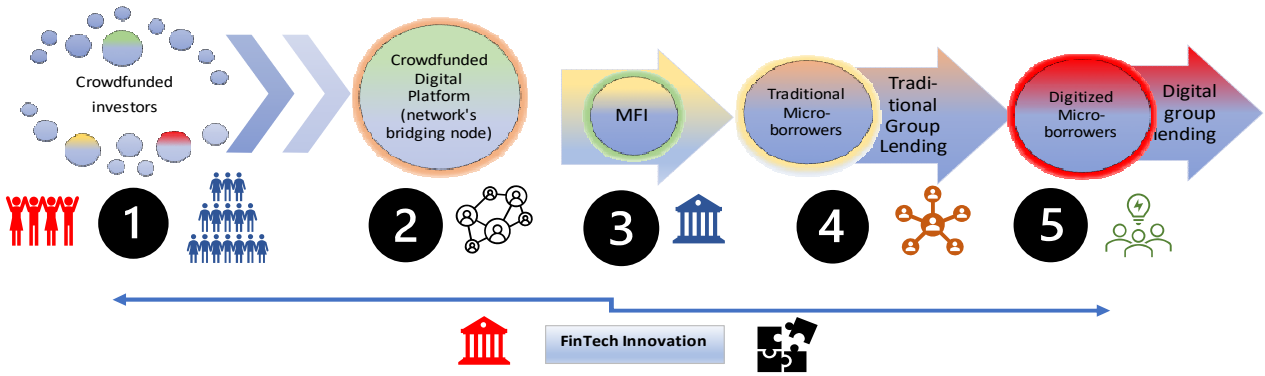
a) *Group lending activities* (suitable to accommodate for crowdfunding innovations) are illustrated in Shah et al. (2019) and Sangwan and Nayak (2020);
b) *Microfinance sustainability and outreach trade-off* issues are analyzed in comprehensive surveys (Armendariz de Aghion and Morduch, 2010; Beck, 2015; Moro Visconti, 2016), and in more specific papers (Quayes, 2012; García-Pérez et al., 2017; Wry and Zhao, 2018; Hermes and Lensink, 2011; Awaworyi Churchill, 2020);
c) *Crowdfunding* is another increasingly investigated topic, synthesized in specific surveys (Cai et al., 2019; McKenny et al., 2017), and defined in Beaulieu et al. (2015) or Kietzmann (2017). The sustainability implications are examined in Messeni Petruzzelli et al., (2019).
d) *Technology-driven financial inclusion* (see Jenik et al., 2017), induced by crowdfunding (Kim and De Moor, 2017), consistently with the Millennium or Sustainable Development Goals (Chibba, 2009) in the form of cooperation between crowdfunding platforms and MFIs (see point e) but also FinTech's impact on unbanked clients (Arner et al., 2018);
e) *Intersections between crowdfunding and microfinance* are illustrated in Allison et al. (2015), Anglin et al. (201), Arshad et al. (2020), Assadi et al. (2018), Attuel-Mendes (2016), Berns, Shahriar et al. (2020), Berns, Figueroa-Armijos et al. (2020), Blakstad and Allen (2018), Bruton et al. (2015), Dorfleitner et al. (2020), Marakkath and Attuel-Mendes (2015), Marom (2013), Martínez-Climent et al. (2019), Motylska-Kuzma (2018), Sancha-Navarro et al. (2018), Sherwani et al. (2018), Yum et al. (2012), and Royal and Windsor (2014); for specific studies on the Kiva.org platform see Hartley (2010), Sarkar and Alvari (2018), Berns et al. (2021).

The emergence of crowdfunded microfinance - the pairing of localized MFIs in impoverished communities with nonprofit crowdfunding - provides a potential solution to the capital constraints faced by MFIs (Moss et al., 2015), and allows for risk-sharing. The research question of this paper is original, and departs from the quoted literature, investigating new interdisciplinary streams.

3. Crowdfunded Digital Platforms interacting with Microfinance Institutions

The interaction between crowdfunded platforms and MFIs, already anticipated in the literature review, can be tentatively synthesized in Figure 2.

Figure 2 – *From Crowdfunded Investors to Digital Group Lending*



While there are many possible business models, the core interaction is between the crowdfunded platform (2) backed by its investors (1) and the MFI (3) with its traditional clients (4) that can become digitized (5). FinTech-driven innovation inspires the top-down workings of crowdfunded platforms (1) but is also influenced by bottom-up feedbacks of digitized micro-borrowers (5), intermediated by the MFI (3), making the whole process circular and self-fulfilling. Crowdfunded platforms can contribute to the globalization and affordability of microfinance (Sun and Liang, 2021).

Whereas Figure 1 considers the group lending case, it will be shown that crowdfunding may also strengthen individual lending practices, consistently with the pattern exemplified in Figure 3.

Underfunding is a major issue for most MFIs, due also to their precarious sustainability that represents an impediment to further equity raising.

On the other hand, crowdfunding platforms may not have on-field knowledge of the actual and potential micro-borrowers (should this be the case, they may eventually disintermediate the supply chain, directly approaching the ultimate clients, and bypassing the MFI). The pairing of MFIs located in impoverished communities with wealthier nonprofit crowdfunding organizations provides a potential solution to the MFI's capital constraints. Crowdfunding platforms may not only provide MFIs with additional resources, but also decrease the MFI cost of collecting capital (cost of equity for investments, cost of debt for crowdfunded loans, and their weighted average, represented by the WACC), thanks also to philanthropic investments.

Risk diversification may be present at the beginning and the end of the supply chain represented in Figure 1, if both crowdfunded investors and MFI clients are many and uncorrelated among themselves, due also to careful assortative mating.

The MFI affiliates clients with its retail intermediation activity, signaling to the crowdfunder their quality and features, so reducing information asymmetries (Moss et al., 2015). Even the handling of the loan (concession, monitoring, repayment) is performed locally by the MFI, proving a further rationale for its existence.

4. Methodology

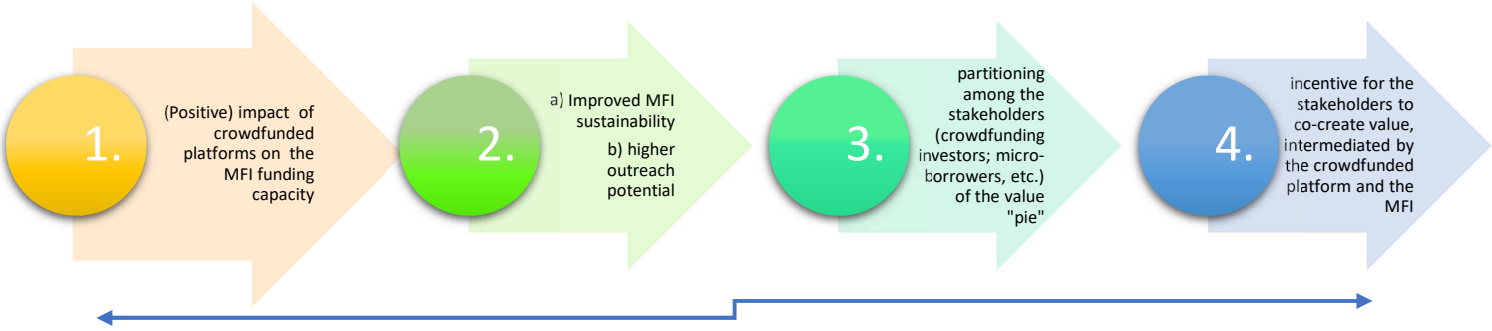
As anticipated in the introduction, the research aim of this study focuses on the impact of digital platforms on traditional microfinance activities rotating around group lending patterns. The target is to show if and to

which extent digitalization (and its extension represented by crowdfunded platforms) can improve microfinance sustainability, eventually fostering outreach to the unbanked.

The sensitivity simulation is based on a business plan template of a traditional MFI, along with eight years (three years of startup activity, followed by five years of consolidation). Digitalization is assumed to impact both revenues and OPerating EXpenses (OPEX), improving economic and financial marginality. This improves economic sustainability and fosters outreach (which is concerned with social, and environmental sustainability).

The analysis will start from the compared "without-with" analysis of a straightforward network with that of a "smart" platform-driven network where new nodes are introduced. This methodology is consistent with the "with or without" differential approach traditionally used to estimate intangibles (e.g., comparing a firm with or without a patent), as illustrated in the International Valuation Standard 210 (par. 80.1).

Figure 2 - *Value-generating Process Ignited by Crowdfunded Platforms*



The methodology is based on a base case of a MFI with an 8-year business plan (3 startup years followed by 5 years of full operativity), where digital savings are introduced with a sensitivity analysis, impacting economic margins, and eventually affecting its overall sustainability. Two complementary methodologies will be used:

a) An economic-financial sensitivity analysis with digital savings impacting on key sustainability parameters, (paragraph 5);

b) A mathematical interpretation, based on network theory, where the stakeholders of two ecosystems – respectively, without and with a digital platform – are compared (paragraph 6).

4.1. Sustainability metrics

Is microfinance business sustainable and affordable? If it is so, outreach may be pushed, provided that economic and financial positive marginality is not diluted up to the point of turning the business into an unprofitable adventure.

The starting point to answer this key question is accounting metrics of economic and financial flows, together with their assets and liability structure. The answer should possibly be not static, following an evolutionary pattern where different scenarios may be envisaged and tested.

MFI can reach their economic equilibrium only if revenues exceed costs and they can reach financial equilibrium only if cash inflows are higher than cash outflows. A positive cash flow balance is essential to maintain the capacity to cover the expenses in the medium to long-term.

The main costs of an MFI are concerned with staff and infrastructural amounts and with the payment of negative interests to depositors, should the institution be enabled to collect funds from savers. We already know that the business model of an MFI is hardly scalable, especially if its dimensions are small and the clients are poor, with limited *pro capite* loans that are time and human resources consuming.

In the understanding of the MFI metrics, it is necessary to make a comprehensive, integrated analysis of the balance sheet, the income statement, and the cash flow statement, to link the structural dimension of the MFI

assets and liabilities (with its equity emerging as a differential) with its economic marginality and the cash flow balance. To the extent that the MFI is profitable, its net result increases the equity, and it is likely to produce a positive net cash flow, whereas a negative result erodes the equity and absorbs cash, typically demanding capital contributions or liquidity injections. This metrics quantitatively defines sustainability and – with it – the possibility of extending the MFI's outreach.

The balance sheet, with its variation from one year to the other, is to be linked to the income statement, to automatically generate the cash flow statement (as prescribed, for instance, by IAS 7).

Cashed-in incomes and cashed-out expenses are recorded in the income statement and then reported in the cash flow statement. Survival liquidity is a key indicator both for the MFI and its clients; when cash burnouts occur, rapid intervention is needed; the problem is particularly challenging if it concerns a deposit-taking MFI, with a potential systematic impact on the market that Central Banks accurately must monitor and, eventually, solve as a lender of last resort. Sources of cash for the MFI are also to be considered, together with their different origin: domestic sources, not linked to foreign fundraising, are more stable during international crises and do not bear any currency risk, whereas they are more exposed to local shocks.

Economic sustainability can be detected considering the income statement of a typical MFI and the impact of technology (for a template, see European Central Bank, 2019 and 2021) that can disrupt and re-engineer existing business models, as exemplified in table 1.

Table 1. - *MFI Income Statement and Impact of Technology*

MFI - Income Statement	Impact of Technology (FinTech-driven)
1. Interest income	Increase in Outreach boosts loan volumes and interest revenues , and improves customer centricity
2. Interest expenses	Higher competition may partially decrease funding costs
3. Net Interest Margin	
4. Net Operating (non-interest) income	
4.a. Fees and commissions receivable	Increase in Outreach boosts revenues
4.b. Fees and commissions payable	Shorter and digitalized supply chains may reduce negative commissions
4.c. Net profit or loss on financial operations	
4.d. Other operating income	
5. Contribution margin	
6. Operating expenses (Monetary OpEx)	
6.a. Staff costs	product and process innovation (reduction of physical branches, automatization, alternative delivery channels, etc.) cuts costs
6.b. Property costs	delocalization, virtual branching, clouding, digitalization of documents, optimization of processes and dematerialization cut costs
6.c. Other operating expenses	IT automation reduces sundry expenses and operational risk
7. Net income before provisions ≈ EBITDA	a higher EBITDA improves sustainability and fosters outreach
8. Net provisions	
8.a. Provisions on loans	artificial intelligence fueled by big data stored in the cloud improves credit scoring reducing delinquency; blockchains validate transactions
8.b. Other net provisions	
9. Income before tax	
10. Income tax	
11. Net income after tax	a higher net income improves sustainability and outreach,

The dynamic interpretation of Table 1. represents the canvas for the answer to the research question.

MFIs traditionally face high staff costs (6.a) and related operating expenses (6.c.) for their core credit scoring and lending activities. Delinquency from untrustworthy borrowers represents another significant cost that contributes to the economic and financial absorption of resources and can be reduced with digitalization and automation. The cost of handling transactions via agents is about 25 percent lower than through physical

branches (Rodriguez and Conrad, 2018). An analysis of the impact of digital delivery channels on MFIs is contained in the Mix-Market database (https://datacatalog.worldbank.org/dataset/mix-market).

To the extent that technology contributes to decreasing costs, economic marginality automatically improves. This surplus can be allocated, at least partially, to decreasing unitary interest rate margins, converging towards fair loan rates (Jarrow and Protter, 2018). MFIs may be tempted to cash in these extra margins, with a consequent mission drift from their original vocation; competition and the will of philanthropic shareholders may, however, minimize this risk, pushing towards a decrease in the level of interest rates. This reduction improves outreach, and so higher volumes of loans may partially compensate for lower marginality, preventing sustainability concerns.

Technology can improve the supply and value chain on different layers, reducing the costs but also improving the revenues, not only with outreach-driven higher volumes but even with extra gains from innovative business models. For instance, the digitalization of information from profiling customers produces big data that represent a worthy asset, whose revenues can be shared with the clients, following a value co-creation pattern. New technologies increase efficiency through automation, reduce operational costs, and improve service quality by cutting down on waiting times and offering more convenient access and reduced cost to the end-consumer (International Finance Corporation, 2014).

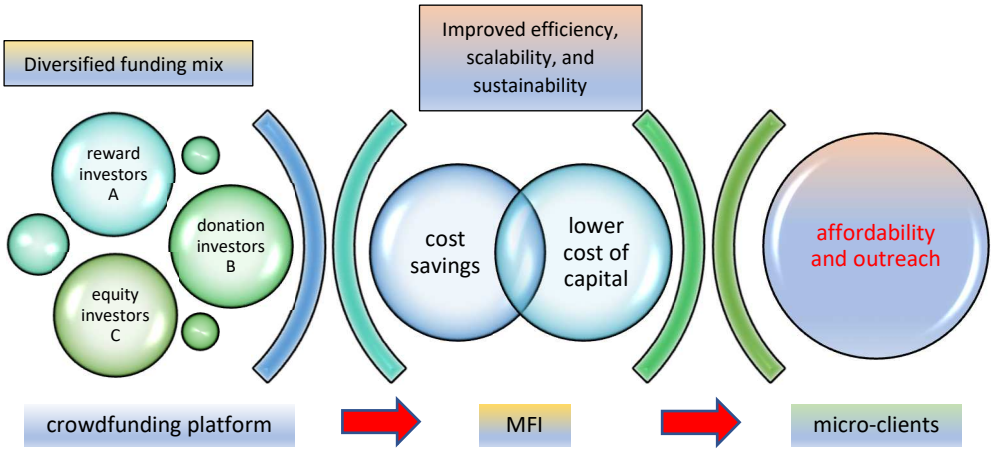
Business model extensions can also derive from the interaction with complementary activities and stakeholders. For instance, digital group lending through social networks eases the convergence with peer-to-peer lending (Nisar et al., 2020), as shown later.

A core component of sustainability is represented by the business scalability that represents the capability to handle growing revenues, dramatically improving economic marginality, so contributing to making the business profitable. The main indicators of MFIs sustainability (see also Rai and Rai, 2012) are reported in Table A.1 in the Appendix.

Sustainability issues may be considered examining the impact of crowdfunding on MFIs that can be summarized in two main factors (represented in Figure 3):

1. Crowdfunding platforms provide MFIs with outsourced resources that reduce operating costs and may increase the revenues, making the overall MFI business more scalable;
2. Crowdfunding investors strengthen the MFI financial capacity, providing low-cost capital and debt.

Figure 3 – *Impact of crowdfunding platforms on MFI sustainability and outreach*



5. Sensitivity Simulation

An empirical analysis of the impact of digitalization of MFIs is still missing, due to the novelty of the topic.

The simulation will so be conducted starting from a base case representing a MFI along 8 years (3 years of startup phase, followed by 5 years of management), analyzing the potential impact of digitalization on its revenues and costs.

This empirical setting is consistent with the research question, as it provides a theoretical story of the main accounting and financial indicators that preside over the sustainability issues, and the interrelations among the stakeholders. The sensitivity analysis, with the impact of digitalization, shows the potential effect of digital savings on the life-long parameters of the investment, consistently with the "without or with (digitalization) approach" indicated in the methods (paragraph 4) and illustrated (in paragraph 4.2) in the comparison between case a) and b) of Figure 3.

A synthetic comparison is reported in Table 2. Starting from the base case, decreases of 2%, 5%, 10%, 15%, and 20% in operating costs, mostly monetary OpEx, are evidenced in each column. The last column also considers a +10% revenue increase.

Benefits of PaaS (Platform as a Service) include reduced costs and increased speed. The potential cost savings of IaaS (Infrastructure as a Service) are clear - rent computing resources only when needed. PaaS can operate in a similar fashion to IaaS by allowing companies to use a PaaS service during development and deployment instead of having to purchase many different independent tools.

Table 2 - *Impact of Digitalization on the MFI main parameters*

	Base case					
Impact of digitalization on operating costs / revenues	**0%**	**-5%**	**-10%**	**-15%**	**-20%**	**-20% costs/ +10% revenues**
Cumulated operating revenues (3+5 years)	52,793,068					85,088,304
Cumulated operating costs (3+5 years)	34,860,766	27,705,968	21,964,578	17,385,343	13,755,853	13,755,853
Cumulated net interest margin (3+5 years)	26,439,475	26,735,091	26,973,031	27,163,526	27,315,226	45,059,861
Cumulated contribution margin (3+5 years)	32,821,054	36,956,632	40,268,553	42,903,477	44,985,388	77,280,624
Cumulated pre-tax result (3+5 years)	14,191,435	21,346,361	27,087,874	31,667,228	35,296,834	66,784,689
Cumulated net result (3+5 years)	9,934,005	14,942,452	18,961,512	22,167,060	24,707,784	46,749,282
Cumulative EBITDA (3+5 years)	17,932,302	25,087,100	30,828,490	35,407,725	39,037,215	71,332,451
Cumulative unlevered cash flow (3+5 years)	- 973,117	5,689,496	11,068,544	15,385,412	18,828,412	43,783,776
Cumulative levered cash flow (3+5 years)	3,303,884	6,192,153	8,649,836	10,724,284	12,460,484	27,969,491
Average WACC	6.60%	6.62%	6.65%	6.66%	6.68%	6.79%
IRR equity	1.89%	14.07%	20.76%	25.24%	28.48%	49.02%
IRR project	-1.51%	7.69%	13.80%	18.23%	21.56%	38.01%
NPV equity	- 578,748	1,251,014	2,808,350	4,124,000	5,226,611	15,096,570
NPV project	- 3,844,664	572,677	4,150,516	7,033,470	9,343,654	25,320,240
Payback Period	T7	T6	T5			T4
Average Debt Service Cover Ratio	1.00	1.57	2.05	2.46	2.79	4.98
Average Leverage	1.60	1.53	1.48	1.43	1.38	1.32
Operational Self Sufficiency	1.58	2.02	2.63	3.49	4.72	7.91
Financial Self Sufficiency	1.52	1.93	2.47	3.19	4.17	6.40
Staff Costs / Loans	0.42	0.33	0.25	0.19	0.15	0.10
Return on Assets (ROA)	0.12	0.16	0.19	0.21	0.23	0.29
Net Income to Expenditure	0.58	1.02	1.63	2.49	3.72	6.91
Equity to Asset Ratio	0.39	0.45	0.49	0.52	0.55	0.59

The (positive) impact on the overall MFI performance, including bankability, is evident from the sensitivity analysis of the main indicators, as a response to the improvements in the economic marginality due to digital platforms:

a) the Net Present Value of the project substantially increases, and so does the Internal Rate of Return of the project (both parameters incorporate debt service, being based on unlevered operating cash flows), showing respectively a greater amount of wealth creation, and a higher hurdle rate compared to a break-even cost of capital ($IRR_{project}$>WACC);

b) even the residual remuneration of shareholders (NPV_{equity} and IRR_{equity}) consistently improves, indicating that after debt compensation is positive and substantial;
c) the payback period shortens, witnessing a lower financial break-even;
d) the average debt service cover ratio substantially grows, showing an excess of operating cash flows created each year to properly serve the expiring financial debt (the threshold rate is 1); this is possibly the most important parameter for bankability, as it shows if and to which extent the MFI can generate enough liquidity to properly serve expiring debt;
e) the financial leverage also decreases, showing a lower ratio of financial debt to equity;
f) the WACC is the only parameter that (slightly) worsens, but this is just due to a weighting adjustment (improved economic/financial margins accelerate debt payback, so decreasing the leverage and increasing the equity weights; since the cost of equity is higher than the cost of debt, the WACC increases);
g) ROA, Net Income to Expenditure and Equity to Asset ratio are used to measure the MFI's performance (Parvin et al., 2020) and are all improving, showing a positive sensitivity to cost savings.

In synthesis, the parameters are highly reactive to marginal economic and financial improvements that affect the overall bankability of the MFI.

The digital-driven value increase of the "pie" is mainly witnessed by the cumulative Net Present Value (in coordination with the other parameters) that can be shared among the involved stakeholders (represented in subsequent Figure 3). Digitized supply and value chains also become more reactive and resilient.

Another source of savings is given by reduced cost of capital: whereas it is difficult and expensive for MFIs to raise capital (equity or debt), crowdfunding (especially if reward- or donation- based) makes it easier and cheaper. Cost of capital savings are recorded in the income statement after the operating profit (negative interests remunerate financial debt collection, whereas the cost of equity is remunerated with net earnings and subsequent dividends). The sensitivity analysis of Table 2 captures cost of capital savings, for instance, in the NPV_{equity}, IRR_{equity} and capital / asset ratio that substantially improve. This is consistent with Parvin et al., (2020), according to which "capital structure plays an important role in organizational performance. Sources of funds for micro-finance institutions (MFIs) and their performance and financial sustainability become an important topic for the MFIs and poverty alleviation initiatives to achieve sustainable development goals of the UN".

The revenue model that presides over economic sustainability is mainly driven by a margin and volume mix that can be positively influenced by crowdfunding platforms:

- economic marginality is improved by technology-driven decreasing unitary costs of the lending activities;
- volumes can grow, so leveraging margins (if positive), up to the point of igniting scalability patterns that, however, remain difficult in financial intermediation.

The network theory interpretation, illustrated in paragraph 6, is consistent with the granularity of this margin/volume mix: interacting nodes can be extended (so improving "volumes"), especially if they are characterized by intrinsic sustainability (each node is profitable).

6. Network Theory Interpretation: From Intermediating Crowdfunded Platforms to Value Co-Creation and Sharing

Crowdfunding digital platforms add value to the whole microfinance ecosystem thanks to their networking properties (see Possega et al., 2015). A comparison between traditional group lending in unsophisticated MFIs and digital (crowdfunded) group lending is illustrated in Figure 4. In this example, two platforms coexist: one is the (external) crowdfunded platform, and the other is the (internal) digital platform within the microfinance workings (represented, for instance, by a social network of the group micro-borrowers).

Figure 4 – *Traditional versus Digital Group Lending Wired Diagram*

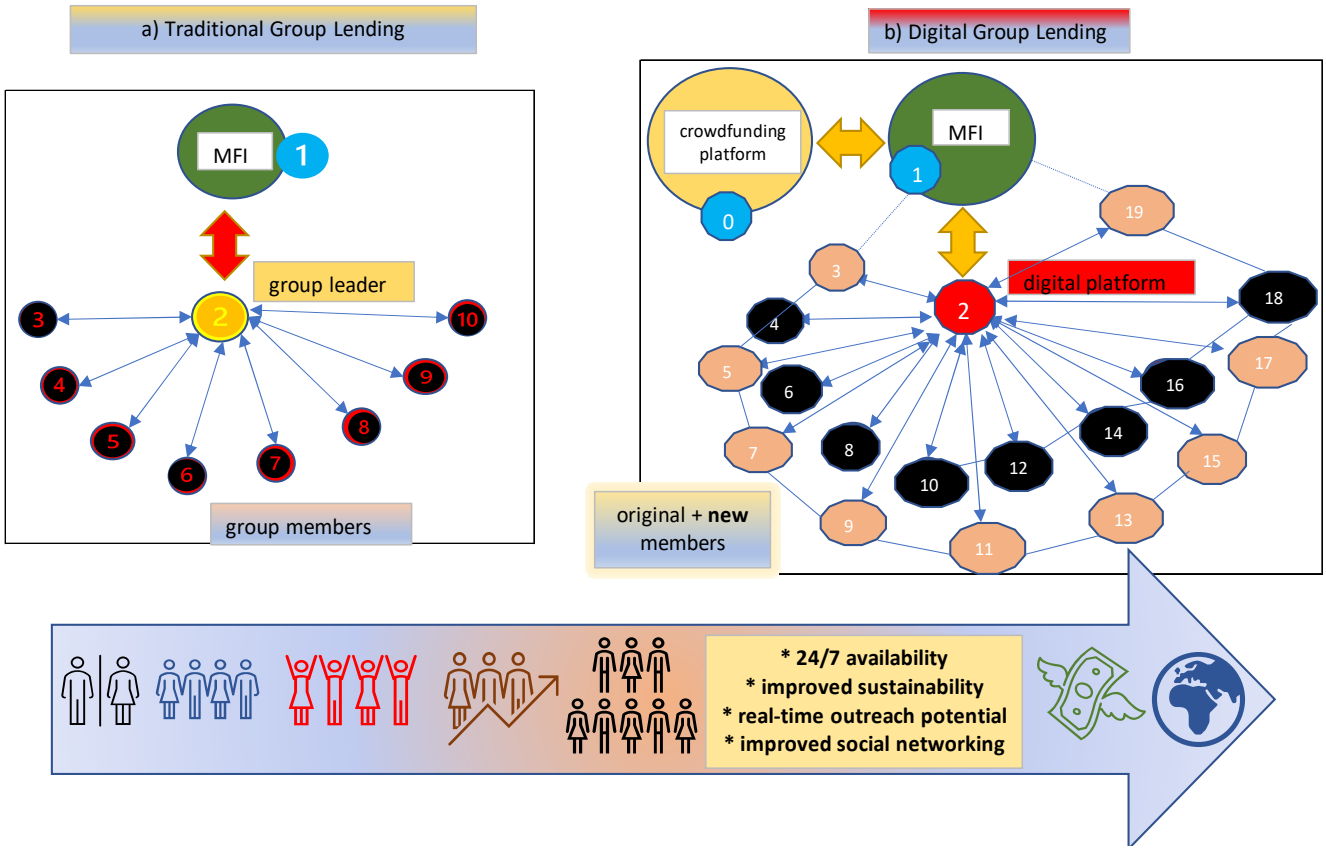


Figure 4 backs the "without-with" comparison described in paragraph 4, showing - with a simplified wiring diagram - a standard group lending network (a), and, respectively, a digital network mastered by a platform (b). In Figure 4.b, two platforms interact: the crowdfunded platform that collects investors, and the group platform that links the MFI with the micro-borrowers. Network orchestration through platforms fosters value co-creation of connected stakeholders (Perks et al., 2017).

The embedded added value of digitized group lending can be interpreted with network theory analysis (Barabási, 2016), with a mathematical measurement of the degree of the nodes (number of links with other nodes), and a consequent estimate of their economic value. New connecting nodes with a system's centrality convey both information and economic transactions, partially reflecting the value increases of the parameters, as shown in Table 2.

The real finite network (Barabási, 2016) exemplified in Figure 3 is a complex system, bearing vulnerability due to interconnectivity (any "blackout" concerning the digital platform may bring severe problems for the whole ecosystem). The links of Figure 3 are bi-directional, so increasing the potential flow of data and transactions. In the standard case reported on the left, there is an intermediation function of the group leader that prevents a direct interaction between the MFI and the group members. In the digital upgrade, bidirectionality is complete and everybody can interact with anybody. This pattern is so consistent with individual group lending.

A first sight comparison of the traditional versus digital diagram shows that the latter graph, mastered by the digital platform (acting as a hub or central node) has more nodes and more (intense) connections that might be measured from the MFI parameters synthesized in Table 2.

In graph (network) theory, an adjacency matrix is a square matrix used to represent a finite graph like Figure 3. The elements of the matrix indicate whether pairs of vertices (nodes) are adjacent or not in the graph. In this case, the adjacency matrix is a symmetric and (0,1)-matrix with zeros on its diagonal.

The degree of each node represents the number of links with other nodes and is mathematically expressed with a (symmetric) adjacency matrix that is the following for traditional group lending (with 10 nodes):

Table 3 - *Adjacency matrix of a traditional 10x10 group lending Network*

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	0	1	0	0	0	0	0	0	0	0
2	1	0	1	1	1	1	1	1	1	1
3	0	1	0	0	0	0	0	0	0	0
4	0	1	0	0	0	0	0	0	0	0
5	0	1	0	0	0	0	0	0	0	0
6	0	1	0	0	0	0	0	0	0	0
7	0	1	0	0	0	0	0	0	0	0
8	0	1	0	0	0	0	0	0	0	0
9	0	1	0	0	0	0	0	0	0	0
10	0	1	0	0	0	0	0	0	0	0

Table 3, consistently with Figure 3, shows the pivoting role of the group leader (node 2).
The (symmetric) adjacency matrix for digitalized group lending (19 nodes) is reported in Table 4.

Table 4 - *Adjacency matrix of a Digitized 19x19 group lending Network*

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
7	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
8	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
9	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1
10	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1
11	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1
12	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1
13	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1
14	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
15	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1
16	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1
17	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1
18	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
19	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0

The compared analysis of the traditional versus digital group lending diagram shows that in the latter the digital platform acts as an intermediating (bridging) hub, increasing the number of nodes (vertices) – and so the overall value and consistency of the network - but especially the quantity and quality of the links. For instance, any interaction between two agents mediated through the platform is digitally recorded in real-time and may fuel big data gathering and artificial intelligence elaboration.

The19x19 matrix has more nodes and more links than 10x10 matrix. As shown in Figure 4a or 4b, the links are undirected (bi-directional). A key property of each node, summarized in tables 3 and 4, is its degree, representing the number of links it has to other nodes. The adjacency matrices track the network's links and is symmetric in undirected networks. The degree k_i of node i can be directly obtained from the elements of the adjacency matrix. For undirected networks, a node's degree is a sum over either the rows or the columns of the matrix, i.e.:

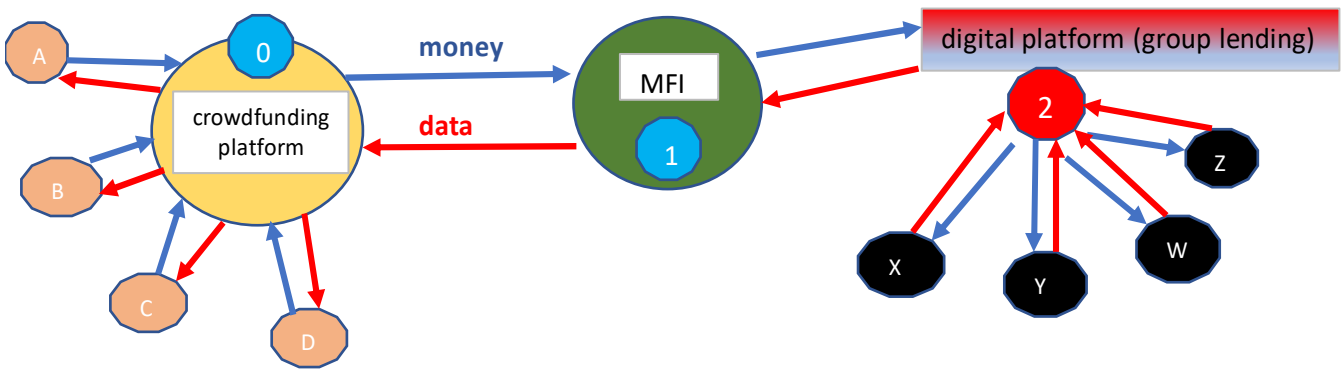
$$k_i = \sum_{j=1}^{N} A_{ji} = \sum_{ji=1}^{N} A_{ji} \quad [1]$$

The networks represented in Figure 4a / Table 3, or Figure 4b / Table 4, are weighted, since each link has a different weight that represents the intensity of the links with the other nodes (in Figure 4b, the crowdfunding platform, the MFI, and the lending platform intermediate more "traffic" - data and economic transactions – than other nodes). Both crowdfunding and group lending platforms improve the clustering coefficient that captures the degree to which the neighbors of a given node link to each other.

Centrality indicators identify the most important vertices within a graph and are represented, in Figure 4b by the three bridging nodes: the crowdfunding platform (0), the MFI (1), and the digital platform (2) that also improve the clustering coefficient (degree to which the neighbors of a given node link to each other). The node influence metrics depends on their position (centrality) and role (hierarchical degree) within the network.

The addition of a single bridge link (between nodes 0 and 1 in Figure 4.b) turns two disconnected networks (respectively concerning crowdfunding and microfinance activities) into a single connected component, forming a crowdfunded microfinance ecosystem. The edges that connect the crowdfunding platform (node 0) with the MFI (node 1) and then the MFI with the digital group lending platform (node 2) represent the backbone of the network's system, through which money is exchanged for information (data), as shown in Figure 5.

Figure 5 – *Bridging Edges (O ↔1 ↔2) between Crowdfunding and Microfinance*



The value of each network can be estimated with Metcalfe's law, according to which the value of a network is proportional to the square of the number of its nodes, i.e., N^2. So, $network_{traditional\ group\ lending} = 100$, and $network_{digital\ group\ lending} = 361$ (considering, for simplicity, that both networks have the same weights that measure the value of each link. This underestimates the real value of the links of the platform).

The digital platform, operating always (24/7) and everywhere, reduces paths and distances, through its intermediating function that minimizes the number of links among the other nodes (shortest path). It also increases the network connectedness, creating additional paths between otherwise disconnected nodes (in traditional group lending, each node is linked only to the group leader who acts as a bridging pass-through between the single nodes and the MFI; in digital group lending, the platform is again, like the group leader, the bridge between the MFI and the clients that are, however, linked among them through the platform).

The role of digital platforms bears some important consequences:

a) It makes it easier to transform collective clients into individual borrowers, allowing them to be linked just to the platform, whose coordinating function is somewhat different from that of the group leader;
b) It allows to (digitally) increase the number of clients, making the whole ecosystem scalable;
c) It can be easily extended to P2P or crowdfunding applications.

A comparison between the 10x10 matrix (table 3) and the 19x19 matrix (table 4), inspired by the confrontation between figure 3a and 3b, shows at first sight not only that the latter network is bigger but also that its nodes are more heavily linked. This is the case especially concerning individual clients that – thanks to the bridging function performed by the platform – become linked among themselves. A mathematical confrontation between the two matrices can contribute to further explain the issue.

It is so basically shown even in mathematical terms that the digitally-mastered network outperforms the original (simple) network. The impact on sustainability, although not directly calculated, is deemed to be positive. This also derives from the network robustness, fostered by the digital plasticity of resilient platforms that adapt in real-time to external changes.

A further extension of the network interpretation of Figure 3 may be represented by multilayer networks (Bianconi 2018) that are connected thanks to the presence of bridging digital platforms, as shown in Figure 6.

Figure 6 - *Multilayer networks with a bridging digital platform*

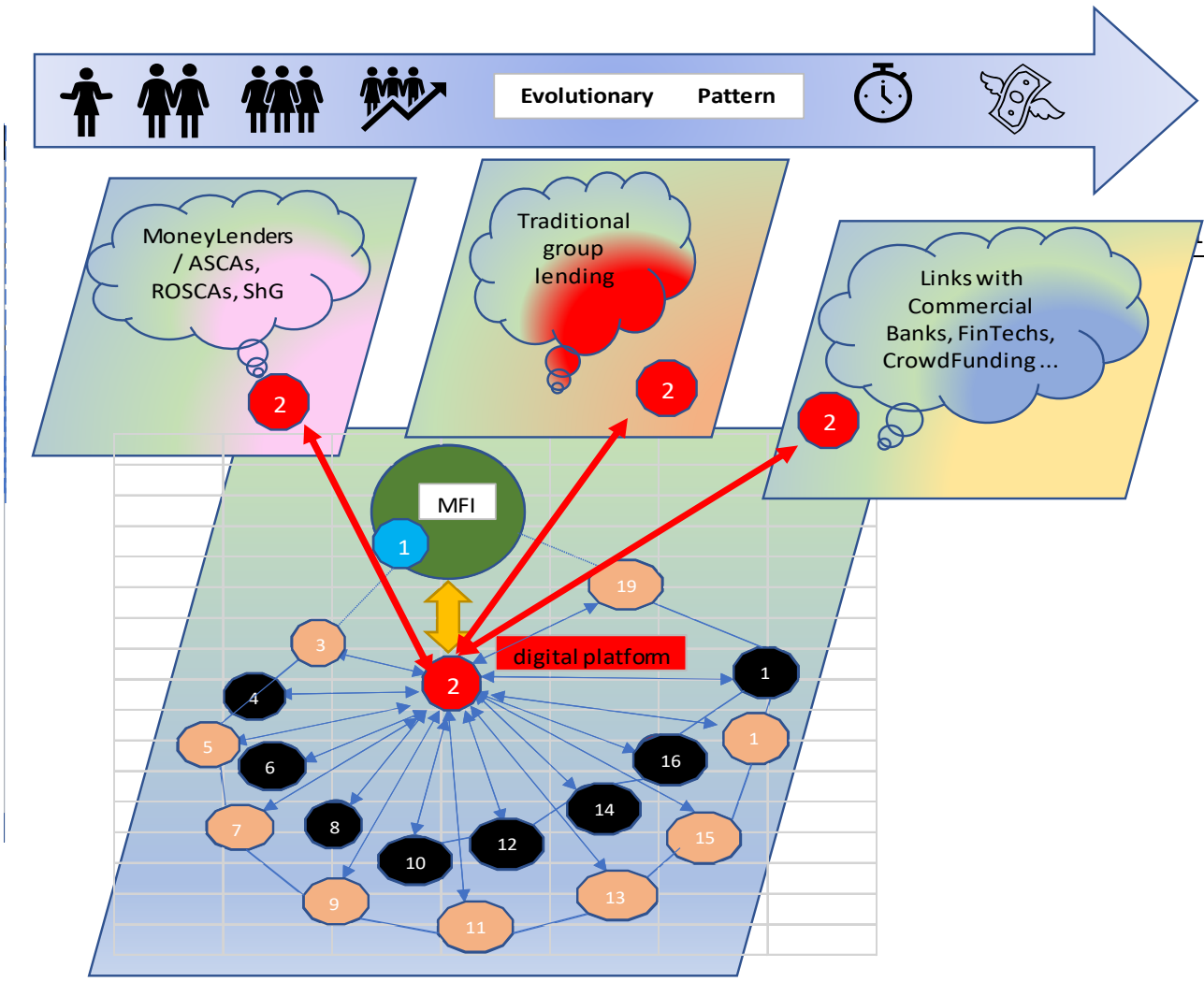


Figure 6 illustrates the centripetal impact of the digital platform on the layers that get closer and superimposed in some areas, sharing some common node, and intensifying intra-layer and inter-layer edges. Multilayer networking increases the overall value of the microfinance ecosystem and may inspire frontier interdisciplinary

research on information gains, value co-creation ignited by synergistic layers, dynamic processes over the evolutionary process of the microfinance ecosystem, etc.

7. Discussion

Sustainability issues represent a vital concern for any firm, including MFIs. Economic viability somewhat precedes social and environmental aspects (no money, no party). A core microfinance dilemma (Bhanot and Bapat, 2015) is represented by the very fact that many MFIs heavily depend on donor (subsidized) funds to meet the high costs induced by a collateral free delivery approach, as well as a high-interest rate called a "Poverty Penalty" paid by poor borrowers (Gutiérrez-Nieto et al., 2016). On a complementary side, commercial funding may stimulate microfinance efficiency (often threatened by spoiling donors) but also encourage mission drift, overlooking social targets (Quayes, 2020). MFI social and financial performance differs depending on their funding behavior (Tchuigoua et al., 2017).

The examined cases cover a small part of the possible interactions between digital platforms and MFIs and their clients. Whereas the paper concentrates on the interaction between an external crowdfunding platform and a MFI that relies on an internal coordinating platform, other potential solutions may be envisaged, concerning for instance:

a) Peer-to-peer lending that directly connects platform-related lenders to micro-borrowers, bypassing the MFI; lenders may be sometimes replaced by micro-equity underwriters;

b) A crowdfunding-MFI structure that eventually addresses individual borrowers.

These scenarios are deeply different from the ones selected in this analysis, even if they share some common features. Most notably, they can all be interpreted with network theory, and they show different imbalances in the trade-off between transaction costs and information asymmetries. Whenever the supply chain shortens and gets simpler (as is the case with P2P lending), transaction costs tend to decrease but information asymmetries may rise, due to the absence of signaling actors like the MFI (Moss et al., 2015).

8. Conclusion

This study has shown that crowdfunding investors can easily interact with MFIs, as is witnessed by the success of Kiva or other platforms, impacting group lending practices. Two digital platforms interact in the proposed model: the crowdfunded platform that collects investors, and the group platform that links the MFI with the micro-borrowers. The study indicates that connected stakeholders co-create value through network (platform) orchestration, as reflected by the higher economic and financial marginality of the MFI that improves its sustainability and outreach potential.

Both crowdfunding and group lending can be interpreted in networking terms, considering the pivoting nodes (represented by the digital platform) and their links to other vertices (respectively, crowdfunding investors or micro-borrowers belonging to the group). This innovative interpretation is fully consistent with the resilient architecture of the financial ecosystem and may be interpreted even in mathematical terms. There is, however, wide room for under-investigated issues that may also concern a multilayer extension of the networks, linking the different players of the supply/value chain and considering their temporal evolution.

Crowdfunding contributes to the reduction of typical microfinance bottlenecks like capital inadequacy, with a positive effect on the rest of the financial supply chain. Crowdfunded MFIs become more sustainable, being so enabled to boost their outreach potential to the unbanked. Digital savings improve financial inclusion (Bharadwaj and Tavneet, 2020). This positive effect is consistent with the taxonomy of reward, donation, or equity crowdfunding. With its flexible approach and declinations, crowdfunding may represent a viable mix of complementary solutions that can soften core microfinance criticalities, providing subsidized capital and cost-cutting technology. A mix of these variants adds spicy differences to the capital sources of MFIs; for

instance, donation can be blended with mild reward policies, even in the form of equity stakes, following Results-Based Financing (or Pay for Performance) patterns. This requires, however, further scrutiny.

Practical implications for the whole value chain illustrated in Figure 2, from crowdfunded investors through the MFI and eventually the micro-borrowers, are many and potentially impressive, albeit still mostly underexplored. A more flexible funding system, combined with technology-driven cost cutting, can boost efficiency, softening the traditional sustainability versus outreach trade-off.

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Appendix

Table A.1. – *Sustainability Indicators*

sustainability indicator	Formulation
Average debt service cover ratio (ADSCR)	Unlevered (operating) cash flow / debt service $=\Sigma \frac{Operating_{cash\ flow}}{Financial\ Debt\ Service}$
Internal Rate or Return $_{project}$ (makes $NPV_{project}=0$)	$NPV_{project} = \frac{CFO_1}{1+IRR_{project}} + \frac{CFO_2}{(1+IRR_{project})^2} + \ldots + \frac{CFO_n}{(1+IRR_{project})^n} - CF_0 = 0$ where: CFO = Operating Cash Flow CF_0= initial investment
Internal Rate or Return $_{equity}$ (makes $NPV_{equity}=0$)	$NPV_{equity} = \frac{CFN_1}{1+IRR_{equity}} + \frac{CFN_2}{(1+IRR_{equity})^2} + \ldots + \frac{CFN_n}{(1+IRR_{equity})^n} - CF_0 = 0$ where: CFN = Net Cash Flow CF_0= Initial investment
Net Present Value $_{project}$ ($NPV_{project}$)	$NPV_{project} = \sum_{t=1}^{n} \frac{CFO_t}{(1+WACC)^t} - CF_0$ where: CFO = Operating Cash Flow t = time CF_0= initial investment

Net Present Value $_{equity}$ (NPV_{equity})	$$NPV_{equity} = \sum_{t=1}^{n} \frac{CFN_t}{(1+K_e)^t} - CF_0$$ where: CFN = Net Cash Flow t = time CF_0= initial investment
Financial Leverage	Financial debt / equity
Payback Period	Initial investment / net cash flow for period
WACC (average)	$$WACC = k_e \frac{E}{D_f + E} + k_d (1-t) \frac{D_f}{D_f + E}$$ Where: D_f = Financial debts E = Equity K_e = Cost of equity K_d = Cost of debt t = Corporate tax rate
Financial self-sufficiency	Operating income / (operating expenses + financial cost + loan cost provision)
Operational self-sufficiency	Operating revenues / operating expenses
Return on Assets (ROA)	Net profit / Assets
Net Income to Expenditure	(Operating revenues - Operating Costs) / Operating Costs
Equity to Asset Ratio	Equity / Total Assets