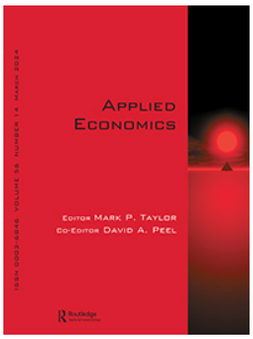

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Does the extent of branchless banking adoption enhance the social and financial performance of microfinance institutions?

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ABSTRACT

We examine the impact of the extent of branchless banking adoption on the social and financial performance of an international sample of microfinance institutions (MFIs). We find that increasing the number of branchless banking points of service in MFIs is associated with productivity enhancements and improved social outreach. However, this occurs at the expense of adverse credit risk and profitability outcomes. Our results are robust to alternative measures of social and financial performance and the use of multiple methodologies including generalized method of moments, two and three-stage least squares. By introducing a quadratic specification, we unveil a parabolic relationship between the extent of branchless banking adoption and MFIs' credit risk and profitability, which indicates that positive profitability and risk outcomes can eventually be achieved in MFIs with extensive branchless banking networks. This presents an important contribution to explaining the variations in insight in extant literature. These findings are relevant to policy makers as they indicate that investments in branchless banking present promising outcomes by encouraging financial inclusion, enhancing productivity and efficiency, and improving long-term profitability and repayment rates among MFIs. However, the initial adversity to profitability and credit risk may be a sufficient deterrent from BB investments for financially-oriented MFIs.

KEYWORDS

Branchless banking; microfinance; financial inclusion; financial performance

JEL CLASSIFICATION

G21; D64; I30; O10

I. Introduction

Microfinance institutions (MFIs) play a key role in serving financially excluded demographics where commercial banking may be scarce or entirely non-existent. The International Monetary Fund's Financial Access Survey indicates that the average number of MFI branches and borrowers in countries around the world has increased over the last twenty years (Figure 1). Yet outreach to the economically disadvantaged in remote geographic regions remains hindered by considerations of financial feasibility (Gupta and Kanungo 2022). According to the World Bank's 2021 Findex report, approximately 1.4 billion adults worldwide remain unbanked (Demirgüç-Kunt et al. 2022). Branchless banking services can provide financial resources to otherwise excluded populations, allowing MFIs to extend their presence to a greater number of locales without establishing physical branches. Due, in part, to the lower investment involved, the potential increase in numbers of clients, and the advent of technology that makes remote banking convenient, the adoption of branchless banking has become increasingly widespread (Figure 1). This study aims to examine whether the extent of branchless banking adoption is associated with an enhancement in the social and financial performance of MFIs.

According to the Consultative Group to Assist the Poor (CGAP), branchless banking (BB hereafter) is defined as 'the delivery of financial services outside conventional bank branches, often using agents and relying on information and communications technologies to transmit transaction details – typically card-reading point-of-sale (POS) terminals or mobile phones' (CGAP 2010, 1). In essence, BB provides basic financial facilities to those with no access, through simplified products delivered via a network of retail outlets as opposed to physical bank branches and ATMs (Dermish et al. 2011). Retail stores, supermarkets, gas stations, postal outlets, and mobile banking are

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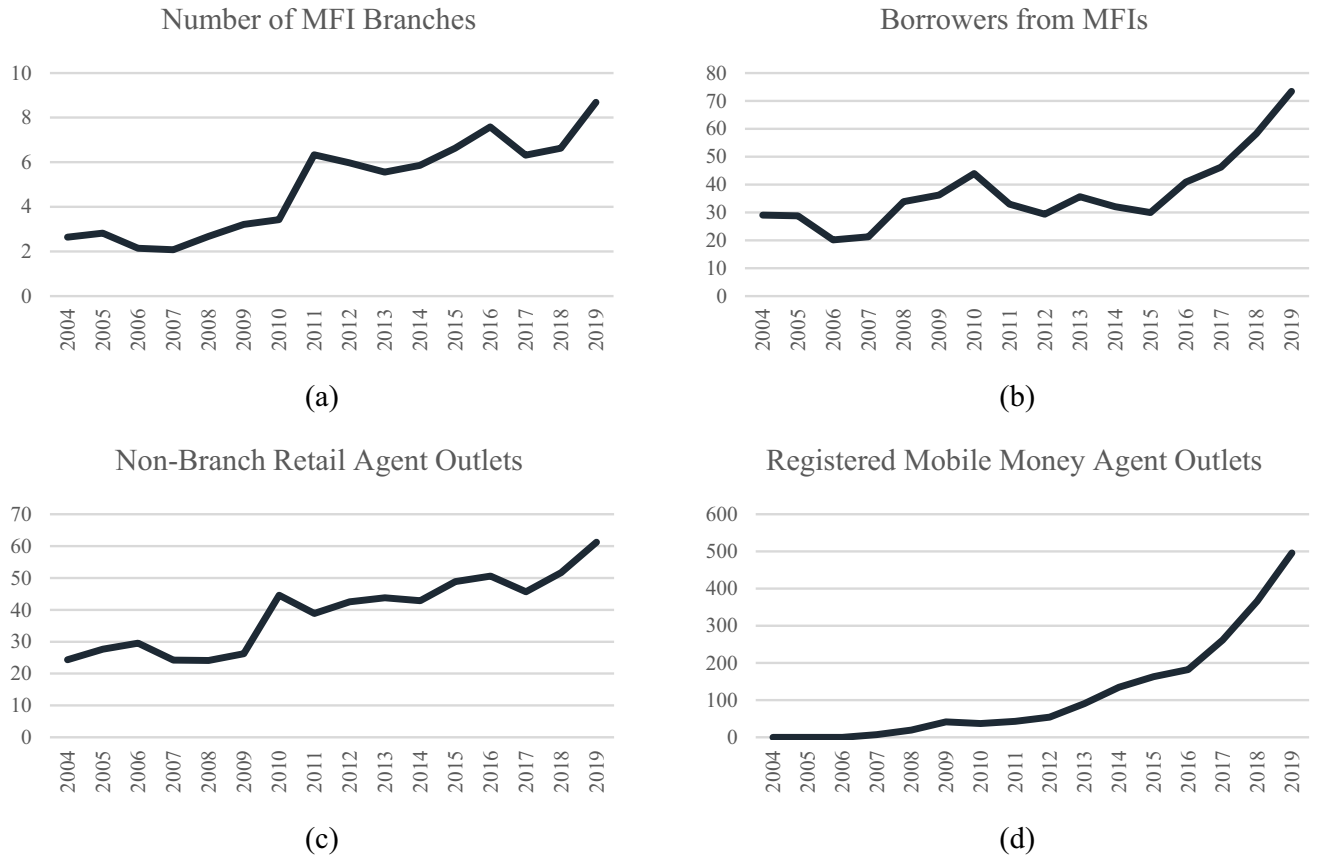

Figure 1. Growth in microfinance and branchless banking over time around the world.

involved as the front end of the delivery of financial services in places where MFIs are absent, serving as a local distribution network (Buri et al. 2018; Zahid et al. 2021).

Despite international growth of branchless banking in recent years (International Monetary Fund 2021) and existing discourse examining its implications for MFI customers and agents (eg. Cull et al. 2018; Buri et al. 2018; Chamboko et al. 2021), an empirical assessment of the social and financial implications of this expansion for MFIs remains lacking. Addressing this is of merit as the social and financial outcomes of MFIs are of concern to their donors and subsidy providers (Bajde, Chelekis, and van Dalen 2021), yet Dermish et al. (2011) highlights the shortage of existing insight into the incentives for stakeholders to adopt BB. Due to high initial set up costs (Cull et al. 2018), risks involved (CGAP 2010), and agency problems that may ensue (Tchakoute-Tchuigoua and Soumaré 2019), an investment in BB is only worthwhile to stakeholders and funders if it can contribute to attaining performance outcomes that align with their objectives. Considering the longstanding social-orientation of MFIs (Hermes and Hudon 2018), coupled with the recent focus on financial performance by MFI donors (Tanima et al. 2021), and the increasing emphasis among MFIs on achieving operational sustainability (N'guessan and Hartarska 2021), an empirical examination of social and financial implications of expanding MFI BB networks is of importance. Since the perceived benefits that would accrue to MFIs are among the reasons that may motivate adoption (Ammar, Ahmed, and McMillan 2016), evaluating the social and financial viability of investments in BB may help guide MFIs in their decision to adopt BB.

This study addresses an evident gap in the literature examining implications of BB on MFIs' financial and social performance. To the best of our knowledge, this study is the first to explore the relationship between the extent of BB adoption and the social and financial performance of MFIs using an international sample of MFIs. Evidence of such a relationship may guide the decision of MFIs to adopt BB facilities. We study an international

sample of MFIs spanning 123 countries during 1999–2019. The results indicate that MFIs with more extensive BB networks exhibit productivity, efficiency, and financial inclusion enhancements. We also provide new insight into the form of the relationship of MFIs' credit risk and profitability with BB, discovering an inverted u-shape relationship between credit risk and BB, and a u-shape relationship between profitability and BB adoption. Although MFIs may initially experience high start-up costs that limit their profitability, and may find it difficult to monitor clients to ensure satisfactory repayment rates, our findings indicate that MFIs eventually benefit from economies of scale and improvements in their credit risk management with the expansion of BB adoption beyond a certain threshold. With time, they are also able to build client credit history records that can be used to develop credit rating systems (Dermish et al. 2011), which enable effective risk mitigation. However, this threshold occurs at a relatively large network size exceeding 1,520 BB outlets which may deter financially-oriented MFIs from engaging in BB.

Our findings carry important implications for both policy makers and MFIs' management. Our results present insight for policy-makers as they exhibit an initial trade-off between the adverse impact of BB adoption on MFIs' risk and profitability on one hand, and a positive impact on financial inclusion on the other. This tradeoff diminishes as BB networks expand, due to the quadratic relation of BB with credit risk and profitability, but only once a large network is established. Socially-oriented MFI managers may favour the social outreach potential of BB and its role in enhancing financial inclusion and may thus find it worthwhile to manage the initial trade-off by incorporating risk management tools such as dynamic incentives (Armendariz and Morduch 2000) to mitigate risk exposure as their BB networks expand and client credit histories are developed. Such MFIs can benefit from considering the long-term social and financial benefits that arise from investments in BB adoption. However, MFI managers that prioritize short-term financial outcomes may be deterred by the interim increase in credit risk and decreased profitability, potentially deeming it financially infeasible to engage in BB.

These findings may help explain variations in theory concerning profit and credit risk presented in extant literature from the commercial banking sector, where contradicting conclusions on the relationship between BB and bank risk and profit can be drawn (eg. Short 1979; Mwando 2013; Scott, Van Reenen, and Zachariadis 2017; Ozili 2018). Furthermore, our findings support the theoretical literature that BB reduces the administrative, operational and transaction costs of financial service providers and enhances financial inclusion (CGAP 2010; McKay and Pickens 2010). Our results are robust to the use of alternative measures of social and financial performance and the use of two-stage least squares (2SLS) and generalized method of moments (GMM) models to address concerns of endogeneity, as well as a three-stage least squares (3SLS) system of equations to account for possible linkages between the measures of performance examined.

The following section of this paper introduces relevant literature and develops the research hypotheses. Section III presents the data and methodology utilized in the empirical examination of the research question. Section V discusses the results, and the final section concludes.

II. Literature review and hypothesis development

BB has provided MFIs with an alternative channel to extend services to the poor in a manner that seeks to overcome challenges associated with establishing a physical presence in remote locations. Dermish et al. (2011) note a lack of literature discussing incentives for relevant stakeholders to adopt BB as a tool to enhance financial inclusion. This study contributes to this discussion by identifying how the size of an MFI's BB network relates to its social and financial performance in order to provide insight into the implications of utilizing BB by MFIs, rather than relying on traditional physical branches. Specifically, we examine how the adoption of BB affects MFIs' financial inclusion, profitability, efficiency, productivity, and credit risk.

Much of the current body of literature addressing branchless banking in the microfinance sector focus on the determinants of adopting BB.

For example, Dorfleitner, Nguyen, and Röhe (2019) examine the determinants of adopting mobile financial services among MFIs. The implications for MFIs of such adoption appear to have been overlooked by prior studies, particularly for the broader definition of BB which encompasses the provision of financial services through retail agents. Similarly, Cull et al. (2018) examine how agent banking and market characteristics are associated with the volume of transactions undertaken by agents of the largest MFIs in the Democratic Republic of Congo. Our study extends upon the work of Cull et al. (2018) and Dorfleitner, Nguyen, and Röhe (2019) by examining the implications of MFIs' BB adoption, of which agent and mobile banking are subsets.

In another stream, Mwando (2013) examines the influence of agency banking on the financial performance of commercial banks in Kenya, documenting improvements in market share, profitability, reduced transaction costs and greater accessibility. We extend upon the work of Mwando (2013) by investigating whether the performance of MFIs exhibits similar patterns to that of commercial banks. Other studies focus on the impact of BB adoption on the agents of commercial banks, rather than examining the implications for the banks themselves (Margaret, Ruth, and McMillan 2019; Palaon, Wiryono, and Faturohman 2020). Buri et al. (2018) find that clients of agent banking experience lower transaction costs than clients engaging in transactions carried out through MFI branches. Herein we explore whether such benefits are mirrored by the MFIs by examining the relationship between the profitability of MFIs and the extensiveness of their BB network.

In theory, BB has the potential to reduce the administrative, operational and transactional costs of financial service providers (CGAP 2010; McKay and Pickens 2010). BB grants clients access to basic banking services through retail outlets that are more accessible to the poor and are usually already established, saving the MFI substantial costs. Scott, Van Reenen, and Zachariadis (2017) finds that the benefits of information and communication technology (ICT) adoption include improvements in banks' profitability, but no such investigation has been conducted on MFIs. Moreover, operational expansion through agent banking has the potential to increase the market share of financial institutions, which may translate into profitability enhancements (Mwando 2013).

On the other hand, it is not clear whether MFIs are in a position to benefit from such cost advantages. Although not empirically tested among MFIs, there are suggestions in the literature that high initial set-up costs may limit the ability of MFIs to experience favourable outcomes until BB operations have expanded to a larger scale (Furst, Lang, and Nolle 2002; Kumar, McKay, and Rotman 2010). Financial institutions may also opt to sacrifice short-term profits to expand their market reach in anticipation of greater future profits (Short 1979). As such, we expect that MFIs adopting BB would exhibit a decline in profitability, particularly if they have only recently expanded in this field. We test the following hypotheses for the relationship of BB and profitability.

H1a: *There is a significant positive relationship between the adoption of BB and the profitability of MFIs*

H1b: *There is a significant negative relationship between the adoption of BB and the profitability of MFIs*

Our analysis also explores the aforementioned conflicting insight in the literature regarding the direction of the relationship between BB adoption and profitability. We assess whether this can be explained by the existence of a quadratic functional form that would depict varying results depending on the extent of BB adoption. Based on theory suggested by Short (1979), Furst, Lang, and Nolle (2002), and Kumar, McKay, and Rotman (2010), and in light of the initial start-up costs that MFIs incur to establish a BB presence (Cull et al. 2018), we expect this relationship to take the form of an inverted u-shape, where MFIs are able to reap the profit benefits of BB once it is implemented at a larger scale:

H1c: *There is a significant quadratic relationship between the adoption of BB and the profitability of MFIs*

On the operational level, digital finance grants clients greater control over personal finance, and expedites financial decision-making and completion of payments (Ozili 2018). Economist Robert Solow famously proclaimed the presence of a productivity paradox, whereby the adoption of ICT had not effectively translated into productivity enhancements (Solow 1987). Prakash, Singh, and Sharma (2021) present evidence from the commercial banking sector showing that technological advancement does amount to positive efficiency and productivity outcomes, proving this paradox no longer applies in the current day. In addition to the anticipated reduction in operational costs and administrative costs (CGAP 2010; McKay and Pickens 2010), Prior and Mora (2019) attribute enhanced efficiency from BB adoption to the ability to achieve a greater number of transactions with lower transaction costs. We build upon the extant literature from the commercial banking sector (Prakash, Singh, and Sharma 2021) and insight from Moroccan MFI client-level data (Prior and Mora 2019) to examine whether the same is exhibited in our analysis on the MFI level. Accordingly, the second hypothesis we test is:

H2: *There is a positive relationship between the adoption of BB and the efficiency and productivity of MFIs*

We believe that the adoption of BB may improve repayment rates as borrowers may otherwise need to travel for hours to reach a physical branch of a financial institution (Diniz, Birochi, and Pozzebon 2012), rendering financial transactions increasingly difficult. By providing accessible facilities near their areas of residence, financial transactions, including loan repayments, become much more convenient. Moreover, mobile payments allow service providers to develop credit history records for clients to assist with screening in future loan applications or in the development of a credit rating system (Dermish et al. 2011). Studies have shown that borrowers with access to phones exhibit better repayment rates (Al-Azzam, Carter Hill, and Sarangi 2012). ICT helps MFIs remove distance barriers and improve services for rural customers, while simultaneously enabling MFIs to enact more effective monitoring of distant locales, which has the potential to reduce moral hazard and improve repayment rates (Kauffman and Riggins 2012).

Digital finance, however, tends to have an inherently riskier client base as it frequently attracts individuals deemed to be too risky to be serviced by commercial banks, consequently threatening the stability of providers if the risk profile of the client base is excessively high (Ozili 2018). A similar risk can arise when MFIs rely on BB to serve borrowers in remote areas where they lack a formal physical presence, as it becomes more difficult to undergo rigorous screening of borrowers, which may result in a high-risk client base. Indeed, there is evidence that more geographically diversified MFIs are exposed to greater credit risk as monitoring operations becomes increasingly difficult (Zamore, Beisland, and Mersland 2019). It is important to recognize that MFIs' ability to benefit from client credit history records (Dermish et al. 2011) will only come with time as clients engage in borrowing through the BB outlets. As the literature does not provide a conclusive indication of the relationship to be expected between BB adoption and credit risk, and due to the likelihood that the credit risk benefits of BB come with scale, the following hypotheses will be tested:

H3a: *There is a significant positive relationship between the adoption of BB and the credit risk of MFIs*

H3b: *There is a significant negative relationship between the adoption of BB and the credit risk of MFIs*

H3c: *There is a significant quadratic relationship between the adoption of BB and the credit risk of MFIs*

Importantly, BB may also enhance financial inclusion as it potentially allows economically disadvantaged populations access to more affordable financial products (CGAP 2010; McKay and Pickens 2010) and is accompanied by positive financial outcomes for the poor (Kochar 2018). There is evidence that BB services are beneficial for the financial inclusion of women facing

restrictions on mobility (World Bank Group 2018), as well as for reaching formerly unbanked populations in Kenya and Brazil (McKay and Pickens 2010), and it would be prudent to determine whether this holds for BB elsewhere. Digital finance is often cited as an important vehicle to advance financial inclusion (Ozili 2018; Mushtaq and Bruneau 2019) and can increase reach by overcoming transportation barriers (Zhu et al. 2021). With the number of mobile phone users exceeding the number of banked people, the use of mobile banking can become transformational in facilitating access among segments that have previously been deemed unbanked (Porteous 2006). The use of BB to administer loans and loan repayments allows clients convenient access to funds and repayment even if they are located at a significant distance from an MFI (Dermish et al. 2011). These qualities contribute to both financial and social performance of MFIs. Accordingly, we test the following hypothesis:

H4: *There is a positive relationship between the adoption of BB and the social outreach of MFIs*

The findings of this study would serve as guidance for MFIs in their decision-making process. Making investments in developing a BB network may be costly, but if it may help mitigate credit risk and enhance profitability, productivity and social outreach, it can prove to be a worthwhile investment. This could encourage MFIs to invest more into non-physical points of service to enhance financial performance and inclusion.

III. Data and methodology

Data description and variable definitions

The data used in this study is retrieved from the Microfinance Information Exchange (MIX) Market database. This database has been extensively used by recent studies (eg. Ahmad, Lensink, and Mueller 2020; Hossain et al. 2020; Soumaré, Tchakoute-Tchuigoua, and Hessou 2020) and is the most utilized database in microfinance literature (Reichert 2018). MIX Market provides annual firm-level data on MFIs across the world during 1999–2019. We use the full international sample of MFIs listed on MIX Market, producing an unbalanced panel of 2,996 MFIs located in 123 countries. It is important to acknowledge, however, that the MIX Market data is self-reported by MFIs and may be subject to limitations. Still, it provides a rich source of insight into the microfinance industry. We also control for country-level corruption, for which data is obtained from the World Bank's Country Policy and Institutional Assessment (CPIA) database. Table 1 lists the definitions of the variables used in our analysis.

We measure the extent of BB adoption as the number of points of service, other than physical MFI branches, through which clients can access MFI services. Rather than focusing on different forms of BB individually, such as financial transactions delivered through mobile banking or merchant retailers, we rely on a broad measure that may encompass several forms of BB offerings collectively. This is because such a break down would suffer from an excess of missing observations on MIX Market. The measure we use is aligned with CGAP's definition that BB is 'the delivery of financial services outside conventional bank branches, often using agents and relying on information and communications technologies to transmit transaction details – typically card-reading point-of-sale (POS) terminals or mobile phones' (CGAP 2010, 1).

We incorporate different aspects of financial and social performance in our analysis. Social performance is measured by MFI outreach. The depth of MFIs' outreach is commonly measured as the average loan size per borrower (D'espallier, Hudon, and Szafarz 2017). Since the poor tend to require the smallest amounts of financing, lower values indicate greater outreach to the poor. We use the average loan size per borrower as a ratio of per capita gross national income (GNI) as it is more appropriate for cross-country comparisons (Reichert 2018; Ahmad, Lensink, and Mueller 2020). To assess the robustness of our findings, we also consider the number of MFI clients below the poverty line and the number of active borrowers that an MFI has. By serving a greater number of borrowers, MFIs contribute to achieving greater financial inclusion and attain a greater breadth of outreach (Hossain et al. 2020; Fall et al. 2021).

Table 1. Variable definitions.

Notation	Variable Name	Description	Source
BB	branchless banking	the number of points of service (in thousands), other than physical MFI branches, through which clients can access MFI services	MIX Market
Performance Measures			
PAR90	portfolio at risk over 90 days	total principal value outstanding of loans that have at least one payment that is more than 90 days overdue, as a ratio of the gross loan portfolio	MIX Market
PAR30	portfolio at risk over 30 days	total principal value outstanding of loans that have at least one payment that is more than 30 days overdue, as a ratio of the gross loan portfolio	MIX Market
COMP	composite credit risk	a composite measure of credit risk equal to the portfolio at risk over 30 days plus the write-off ratio, which is the total value of loans written off, as a ratio of the average gross loan portfolio	MIX Market/Authors' calculations
ZSCORE	z-score	calculated by subtracting the mean composite risk from each MFI's composite risk, divided by the standard deviation of the composite risk measure ($\frac{comp_{i,t}-\overline{comp}}{\sigma_{comp}}$)	MIX Market/Authors' calculations
ILA	impairment loss allowance	the provisions kept to cover the risk of experiencing losses in the gross loan portfolio arising as a result of defaults, as a ratio of the gross loan portfolio	MIX Market
AVGBALANCE	depth of outreach	average loan balance per borrower as a percentage of per capita gross national income	MIX Market
BORROWERS	breadth of outreach	the average number of active borrowers in the MFI	MIX Market
BELOWPOV	outreach to the poor	The proportion of borrowers with an income level that falls below the poverty line	MIX Market
ROE	return on equity	net operating income minus taxes, as a ratio of the average total equity	MIX Market
OSS	operational self-sufficiency	financial revenue divided by the sum of financial expenses, net impairment losses and operating expenses	MIX Market
GLPTA	efficiency	gross loan portfolio as a ratio of total assets	MIX Market
BORRSTAFF	productivity	the number of active borrowers as a ratio of the number of MFI staff	MIX Market
Control Variables			
PRTFYIELD	portfolio yield	financial revenue generated from the loan portfolio divided by the average gross loan portfolio	MIX Market
GROUP	group lending	the proportion of the gross loan portfolio disbursed to groups	MIX Market
RURBORR	rural borrowers	the number of active borrowers that are in rural locations as a ratio of the total number of active borrowers	MIX Market/Authors' calculations
FEMBORR	female borrowers	the number of active borrowers that are female as a ratio of the total number of active borrowers	MIX Market/Authors' calculations
CORRUPTION	corruption	A measure of transparency, accountability, and corruption in the public sector used as an indicator of corruption levels. It is a categorical variable taking values from 1 to 6, with 6 indicating high corruption levels (i.e. low transparency and accountability) and 1 indicating low corruption (i.e. a high degree of accountability and transparency)	CPIA/Authors' calculations
LTA	total assets	the natural logarithm of total assets	MIX Market
TAGROWTH	total assets growth	the annual growth rate of total assets ($\frac{TA_{i,t}-TA_{i,t-1}}{TA_{i,t-1}}$)	MIX Market/Authors' calculations
DEPTA	deposits to total assets	deposits as a ratio of total assets	MIX Market
MATURE	MFI age	dummy variable equals 1 if the MFI is categorized as mature in age and equals 0 otherwise	MIX Market

To measure financial performance, we use return on equity (ROE) to measure profitability as it measures how effectively an MFI utilizes its equity capital to generate financial returns (Reichert 2018). Following Louis, Seret, and Baesens (2013), we measure efficiency using the value of the gross loan portfolio as a ratio of total assets. We also use the number of borrowers per staff member to measure productivity (Sun and Liang 2021).

To overcome concerns that our results may be sensitive to the measures of performance used, we also examine alternative measures of profitability and productivity. Operational self-sufficiency (OSS) is calculated by dividing financial revenue by the sum of financial expenses, net impairment losses and operating expenses. It provides an indicator of an MFI's ability to cover its costs using its operating income (Al-Azzam 2019) and is used in the literature as a measure of both profitability and organizational sustainability (Reichert 2018).

We rely on two alternative measures of credit risk as each contributes a different dimension of credit risk (Mohamed and Elgammal 2023). We

consider the portfolio-at-risk exceeding 30 days as microfinance loans are typically issued for short periods. This measure is commonly used in microfinance studies (Tchakoute-Tchuigoua, Soumaré, and Hessou 2020) and it provides an indication of the actual short-term delinquencies experienced by MFIs. The second measure of credit risk is the impairment loss allowance held by an MFI, as a ratio of its gross loan portfolio (Zamore, Beisland, and Mersland 2019). Such allowances are indicative of a weak quality loan portfolio for which losses are to be expected (Banto and Monsia 2020). This measure provides additional insight into the MFI's perceived credit risk exposure, in addition to the regulatory standards concerning provisions that it is subject to.

Moreover, in order to ensure the robustness of our results, we introduce three additional measures of credit risk. We consider a composite measure calculated as the sum of the portfolio-at-risk over 30 days and the write-off ratio (Chakravarty and Pylypiv 2015), where the write-off ratio indicates the proportion of the gross loan portfolio that is removed due to highly unlikely repayment (Gyapong, Gyimah, and Ahmed 2021). This measure adds an additional dimension to our analysis of credit risk as there may be a degree of subjectivity incorporated in the MFIs decision on whether a loan should be written off as unlikely to be repaid. Combining the write-off ratio with the portfolio-at-risk over 30 days allows us to account for both the effective and subjective dimensions of credit risk (Mohamed and Elgammal 2023). Alternatively, we examine the portfolio-at-risk exceeding 90 days to capture the proportion of the MFI's loan portfolio that is over 90 days past due (Chikalipah 2018; de Oliveira-Leite, dos-Santos-Mendes, and de-Lacerda-Moreira 2020). This measure is consistent with the proposition by the Basel Committee on Banking Supervision (Basel Committee on Banking Supervision 2016) that exposures over 90 days due are unlikely to be repaid. Finally, to provide an indicator of an MFI's credit risk relative to its peers, we also examine the z-score, measured as the MFI's credit risk minus the average composite risk for all MFIs, as a ratio of the standard deviation of the composite risk (Zamore, Beisland, and Mersland 2019).

Descriptive statistics and correlations

Table 2 presents descriptive statistics. The adoption of BB in MFIs ranges from 0 to 2,866 points of service, indicating that some MFIs in the sample have established an extensive BB network while others have yet to introduce one. Most MFIs in the sample lie towards the lower end of this spectrum, with the average MFI offering 61 BB service points. Table 3 presents the correlations and variance inflation factor (VIF). Multicollinearity is unlikely to pose a serious concern as the correlations among

Table 2. Descriptive statistics.

Variable	Mean	Std.Dev.	Min	Max
PAR90	.049	.084	0	.551
PAR30	.07	.104	0	.655
COMP	.087	.115	0	.71
ZSCORE	.055	.685	−.465	3.765
ILA	.044	.056	0	.375
AVGBALANCE	.718	1.314	.017	9.438
BORROWERS	53773.12	160000	42	1210000
BELOWPOV	.421	.29	0	1
ROE	.054	.454	−2.561	1.626
OSS	1.138	.405	.132	2.871
GLPTA	.741	.199	.113	1.287
BORRSTAFF	124.743	101.811	4	578
BB	.061	.333	0	2.866
PRTFYIELD	.326	.18	.046	.985
GROUP	.347	.42	0	1
RURBORR	.534	.334	0	1
FEMBORR	.647	.272	.04	1
CORRUPTION	3.097	.539	1.5	5
LTA	15.539	2.209	10.256	20.937
TAGROWTH	.353	.656	−.466	4.416
DEPTA	.261	.301	0	.934
MATURE	.201	.401	0	1

Table 2 presents the descriptive statistics for the dependent and independent variables included in our analysis. Variables are winsorized at the top and bottom 1% to address outliers.

Table 3. Correlations and variance inflation factors.

Variables	VIF	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) BB	1.05	1.000									
(2) PRTFYIELD	1.33	−0.112	1.000								
(3) GROUP	1.26	−0.005	0.065	1.000							
(4) RURBORR	1.14	0.031	−0.127	0.211	1.000						
(5) FEMBORR	1.54	−0.005	−0.035	0.400	0.156	1.000					
(6) CORRUPTION	1.19	−0.037	0.198	−0.018	0.076	−0.165	1.000				
(7) LTA	1.28	0.213	−0.308	−0.149	−0.058	−0.170	0.002	1.000			
(8) TAGROWTH	1.04	−0.031	0.167	0.107	−0.033	0.074	0.021	−0.079	1.000		
(9) DEPTA	1.18	0.119	−0.154	−0.087	−0.116	−0.206	0.006	0.300	−0.020	1.000	
(10) MATURE	1.53	0.060	−0.271	0.225	0.236	0.388	0.141	0.151	−0.039	0.093	1.000

Table 3 presents the Pearson correlation coefficients and the variance inflation factors for the explanatory variables included in our analysis.

the explanatory variables are low, and the VIF values are consistently below 2, far below the rule of thumb of 10 (Marquardt 1970).

IV. Methodology

Equation 1 presents the general specification of our model.

$$Performance_{i,t} = \alpha_0 + \alpha_1 BB_{i,t} + \sum_{j=1}^{J} \beta_j C_{j,i,t} + \varepsilon_{i,t} \quad (1)$$

The dependent variable, $Performance_{i,t}$, represents each of the 12 financial and social performance indicators used, for MFI *i*in year *t*. We use the social performance measure *AVGBALANCE* (depth of outreach) then check the robustness of our findings by repeating our analysis using *BORROWERS* (breadth of outreach) and *BELOWPOV* (outreach to the poor). The financial performance measures are: *PAR30* (portfolio-at-risk over 30 days), *ILA* (impairment loss allowance), *ROE* (profitability), *GLPTA* (efficiency), and *BORRSTAFF* (productivity), in addition to *PAR90* (portfolio-at-risk over 30 days), *COMP* (composite credit risk), *ZSCORE*, and *OSS* (operational self-sufficiency). Equation 1 is estimated for each of the 12 measures. The main independent variable of interest is branchless banking, denoted by *BB*. It represents the extent of BB adoption by MFI *i*in year *t*. *C* denotes a set of *J* control variables, namely *PRTFYIELD*, *GROUP*, *RURBORR*, *FEMBORR*, *CORRUPT*, *LTA*, *TAGROWTH*, *DEPTA*, and *MATURE* (defined in Table 1). Outliers are addressed by winsorization at the 1% level.

We estimate two-stage least squares (2SLS) models with lags of the dependent variable used as instruments (Greene 2003). The validity of the instruments is verified by the Hansen J over-identification test, for which the null hypothesis is not rejected. We also fail to reject the null hypothesis of the Difference-in-Hansen test, indicating insufficient evidence against the exogeneity of the instruments. We test for first- and second-order serial correlation in the residuals and rule out misspecification in our models (Arellano and Bond 1991).

We also use a dynamic two-step system generalized method of moments (GMM) approach with robust standard errors, which is appropriate for our unbalanced panel with a small time dimension (*T*) and a large cross-sectional dimension (*N*) (Arellano and Bond 1991). We use forward orthogonal deviation transformations rather than first differences to mitigate the amplification of the gaps in our unbalanced panel (Roodman 2009). Similar to the 2SLS models, we use the lags of the dependent variable as instruments and verify that the instruments are valid and exogenous and that the models are not subject to misspecification.

Finally, we introduce a quadratic term (BB^2) to the model to investigate the presence of a parabolic relationship between BB and the measures of credit risk and profitability:

$$CreditRisk_{i,t} = \gamma_0 + \gamma_1 BB_{i,t} + \gamma_2 BB_{i,t}^2 + \sum_{j=1}^{J} \theta_j C_{j,i,t} + u_{i,t} \quad (2)$$

$$Profitability_{i,t} = \lambda_0 + \lambda_1 BB_{i,t} + \lambda_2 BB_{i,t}^2 + \sum_{j=1}^{J} \rho_j C_{j,i,t} + \nu_{i,t} \quad (3)$$

V. Results and discussion

Primary results

The 2SLS and GMM results (Table 4) consistently indicate a positive relationship between BB and credit risk as measured by both *PAR30* and *ILA;* MFIs experience an increase in loan repayment delinquencies as they expand their involvement with BB facilities. This finding establishes empirical insight into the implications of BB on the credit portfolio quality of MFIs. We suggest that the absence of a physical branch, which would allow MFIs to directly oversee the repayment behaviour of borrowers, may give rise to agency problems and result in a deterioration in repayment rates. This complements the findings of Tchakoute-Tchuigoua and Soumaré (2019) on decentralized MFI loan approval decisions, as well the findings of Zamore, Beisland, and Mersland (2019), that geographic diversification makes monitoring the operations of MFIs more challenging, which translates into an elevated risk exposure. This result may also be attributable to the risk profile of the clients served by BB outlets. As mentioned prior, BB may attract clients that are deemed too risky to be served by commercial banks, which establishes an inherently riskier client base (Ozili 2018). This result is contrary to evidence on the effect of mobile banking on repayment rates in MFIs (Al-Azzam, Carter Hill, and Sarangi 2012).

We proceed to examine the relationship between the size of BB networks and the profit outcomes of MFIs. Our results indicate that larger BB networks tend to be adversely related to the profit (*ROE*) of MFIs. This may be attributable to the presence of cost-inefficiencies, particularly among recent adopters (Furst, Lang, and Nolle 2002). Overall, the results derived when using credit risk and profitability as measures of performance indicate a decline in the financial performance of MFIs coinciding with the extent of their branchless banking adoption, posing a noteworthy concern to MFI stakeholders. With the recent orientation towards improving financial performance by MFI donors (Tanima et al. 2021) and achieving operational sustainability among MFIs (N'guessan and Hartarska 2021), these findings present stakeholders with concerns about the viability and financial feasibility of investments in BB networks.

However, the other performance indicators present a more positive outlook: MFIs experience efficiency (*GLPTA*) and productivity (*BORRSTAFF*) improvements as they increase the number of BB points of service. The positive relation with *GLPTA* indicates an increase in efficiency as MFIs allocate a larger portion of their assets towards their loan portfolio, rather than other nonessential activities. The efficiency enhancements can be explained by the reduction in transaction costs attributable to BB adoption which would allow MFIs to scale up their operations (Prior and Mora 2019). Moreover, an increase in the number of borrowers per staff member (*BORRSTAFF*) suggests that MFIs with wider BB networks are able to serve more clients with a given number of personnel, reflecting an increase in staff productivity. This aligns with evidence from commercial banks (Prakash, Singh, and Sharma 2021), suggesting that implications for productivity in commercial banking can be extended to the microfinance sector.

The results on social performance show that adopting larger branchless banking networks increases the average loan size issued by MFIs, as reported in Table 4. Smaller loans tend to be issued to poorer clients, suggesting that MFIs, on average, issue fewer loans to the financially disadvantaged. This could imply an adverse outcome for financial inclusion; however, caution should be exercised when interpreting the results for this measure of outreach since small and large loans may be issued concurrently, providing misleading information on the true outreach to the financially disadvantaged. It is common that MFIs may compensate for an increase in small loans with a simultaneous increase in larger loans to balance the risk exposure of their loan portfolio (D'espallier, Hudon, and Szafarz 2017).

Robustness check: system equation model

We acknowledge the possibility that there may be linkages across the different performance measures examined, which can be accounted for through the estimation of a system of equations that jointly considers the different performance measures. We repeat the analysis using a three-stage least squares (3SLS) methodology which would account for correlations in the residuals across the individual models formerly

Table 4. Two-stage least squares (2SLS) and generalized method of moments (GMM) results.

	Panel A Two-Stage Least Squares						Panel B Generalized Method of Moments					
	(1) PAR30	(2) ILA	(3) AVGBALANCE	(4) ROE	(5) GLPTA	(6) BORRSTAFF	(7) PAR30	(8) ILA	(9) AVGBALANCE	(10) ROE	(11) GLPTA	(12) BORRSTAFF
BB	0.026***	0.035**	0.084***	−0.378***	0.105***	52.470***	0.143***	0.037***	0.306***	−0.480***	0.100***	49.641***
	(0.008)	(0.016)	(0.010)	(0.083)	(0.037)	(11.724)	(0.018)	(0.011)	(0.056)	(0.108)	(0.038)	(13.329)
PRTFYIELD	−0.096*	−0.076***	−1.589***	4.764***	0.049	−128.303***	−0.232***	−0.038*	0.464	3.881***	0.130	−99.376***
	(0.050)	(0.021)	(0.439)	(0.314)	(0.092)	(33.306)	(0.056)	(0.023)	(0.406)	(0.286)	(0.082)	(35.953)
GROUP	−0.030***	0.006	−0.941***	0.235***	0.050**	89.074***	−0.055***	0.017**	−0.540***	0.533***	0.081***	115.565***
	(0.010)	(0.005)	(0.097)	(0.065)	(0.020)	(10.527)	(0.011)	(0.007)	(0.094)	(0.088)	(0.029)	(12.428)
RURBORR	0.010	0.043***	−1.188***	0.660***	−0.169***	29.552***	−0.032**	0.025***	−1.763***	0.806***	−0.103***	30.544***
	(0.013)	(0.007)	(0.075)	(0.094)	(0.028)	(9.133)	(0.016)	(0.009)	(0.073)	(0.099)	(0.029)	(9.944)
FEMBORR	0.023	−0.253***	−0.262***	0.932***	0.313***	160.553***	−0.035	−0.248***	1.181***	0.559***	0.383***	159.415***
	(0.015)	(0.018)	(0.096)	(0.080)	(0.059)	(18.812)	(0.023)	(0.019)	(0.085)	(0.083)	(0.051)	(21.686)
CORRUPTION	−0.043***	0.018***	1.569***	0.031	0.049***	−17.285***	−0.018***	0.022***	1.332***	−0.000	0.025	−17.059***
	(0.007)	(0.003)	(0.078)	(0.044)	(0.014)	(5.343)	(0.007)	(0.002)	(0.082)	(0.045)	(0.019)	(5.662)
LTA	0.032***	−0.011***	0.383***	0.313***	−0.011	−7.813***	0.016***	−0.013***	0.395***	0.311***	0.003	−14.649***
	(0.004)	(0.001)	(0.021)	(0.027)	(0.009)	(2.697)	(0.006)	(0.001)	(0.023)	(0.027)	(0.007)	(2.598)
TAGROWTH	−0.151***	−0.044***	0.374***	0.112***	0.018	25.366***	−0.171***	−0.049***	0.306***	0.056**	−0.030***	23.918***
	(0.010)	(0.002)	(0.034)	(0.032)	(0.012)	(3.777)	(0.012)	(0.003)	(0.031)	(0.028)	(0.007)	(4.080)
DEPTA	−0.220***	−0.015	2.205***	−0.809***	−0.319***	−2.676	−0.170***	−0.023*	2.005***	−0.569***	−0.633***	23.882
	(0.034)	(0.012)	(0.135)	(0.219)	(0.067)	(21.693)	(0.039)	(0.013)	(0.111)	(0.205)	(0.045)	(23.209)
MATURE	0.268***	0.032***	−0.214***	−0.072*	0.074**	3.010	0.341***	0.039***	−0.254***	0.021	0.017	−0.541
	(0.044)	(0.006)	(0.072)	(0.044)	(0.029)	(11.149)	(0.048)	(0.014)	(0.095)	(0.048)	(0.026)	(12.871)
Constant	−0.290***	0.334***	−9.067***	−7.448***	0.682***	180.188***	−0.034	0.341***	−9.949***	−7.043***	0.522***	268.227***
	(0.069)	(0.029)	(0.492)	(0.582)	(0.149)	(55.161)	(0.100)	(0.031)	(0.474)	(0.540)	(0.118)	(51.889)
Model Statistics												
Obs.	1190	1223	1228	1223	1230	1228	1190	1223	1228	1223	1230	1228
Wald Chi2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hansen	0.460	0.540	0.649	0.788	0.100	0.525	0.460	0.540	0.649	0.788	0.100	0.674
Diff-Hansen	0.685	0.948	0.508	0.505	0.671	0.602	0.685	0.948	0.508	0.505	0.671	0.739
AR(1)	0.398	0.209	0.493	0.274	0.121	0.045	0.398	0.209	0.493	0.274	0.121	0.116
AR(2)	0.632	0.753	0.708	0.216	0.748	0.483	0.632	0.753	0.708	0.216	0.748	0.429

Panel A of Table 4 presents the results of the two-stage least squares (2SLS) estimation. Panel B presents the results of the two-step system GMM estimation. The dependent variables are the measures of social performance and financial performance. Robust standard errors are in parenthesis. Wald Chi2 reports the p-value for the Wald Chi-Squared test for model fit. Hansen reports the p-value of the Hansen J over-identification test, testing the null hypothesis that the instruments used are valid. Diff-Hansen reports the p-value of the Difference-in-Hansen test, for which the null hypothesis is that the set of instruments used is exogenous. AR(1) and AR(2) report the p-value of the Arellano-Bond autocorrelation test for first-order and second-order serial correlation. The null hypothesis is that there is no serial correlation. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively. Variable definitions are in Table 1.

estimated (Panel A, Table 5). For all but one, which is now insignificant, the relation of the different measures of social and financial performance with BB adoption is consistent with the results found initially, suggesting the robustness of our findings to the methodology used and the presence of a link across the different measures of performance.

Robustness check: alternative set of performance measures

An alternative set of financial and social performance measures is examined to provide an additional robustness check for our findings and to clarify our social performance results (Panel B, Table 5). The results are consistent with those obtained using the initial set of measures, and are not sensitive to the use of particular measures of financial performance. Branchless banking remains positively related to credit risk and negatively related to profit.

To further investigate our finding on social performance, we examine an additional two measures of social outreach, *BORROWERS* and *BELOWPOV*. When using these measures, we are able to confirm that *BB* is associated with improvements in social performance. We confirm that MFIs hosting more extensive branchless banking networks are able to serve a greater number of total borrowers. In addition, they tend to serve a greater number of borrowers in poverty. These results provide clarification on the social outreach results reported initially for *AVGBALANCE*, and present additional support for the finding that BB is accompanied by improvements in financial inclusion. This builds empirically on the proposition in CGAP (2010) and McKay and Pickens (2010) that the affordability of financial products delivered through BB is anticipated to translate into greater outreach to economically disadvantaged populations. This finding presents promising insight for MFI managers and funders that are concerned with upholding the social mission of MFIs, also known as 'the microfinance promise' (Morduch 1999).

Quadratic relationship between BB and MFIs' performance

We extend our analysis and examine quadratic models where a squared term for BB is introduced (Table 6). The findings indicate the presence of a quadratic relationship between BB and credit risk as well as between BB and profitability, which suggests that our initial findings on credit risk and profitability do not necessarily reflect the nature of the relationship across all levels of BB adoption. Rather, the direction of the relationship changes as BB networks expand.

BB exhibits a negative relationship with profit up to a particular threshold beyond which a positive relation is observed, taking the form of a u-shape. This finding contributes to reconciling the conflicting insight from existing literature and is aligned with our hypothesis drawn from extant theory that suggests that the initial decline in profitability may be attributable to high start-up costs incurred by MFIs as they initially roll out BB facilities (Short 1979; Furst, Lang, and Nolle 2002; Kumar, McKay, and Rotman 2010; Cull et al. 2018). MFIs likely benefit from economies of scale, reducing their costs with expansion. At this stage we find that MFIs exhibit the positive profitability outcomes documented by another stream of the literature (CGAP 2010; McKay and Pickens 2010; Mwando 2013; Scott, Van Reenen, and Zachariadis 2017). It should be noted, however, that this holds when *OSS* is used to measure profitability and that when using *ROE* instead, there is no statistically significant evidence of a quadratic relationship.

The results on credit risk are consistent across all measures of credit risk and indicate that it initially increases with BB adoption, then gradually declines as MFIs' BB network expands depicting an inverted-u shape. The initial increase in credit risk confirms the findings of Zamore, Beisland, and Mersland (2019) that larger networks of operations may make it more challenging to screen and monitor clients. It also supports insight from Tchakoute-Tchuigoua and Soumaré (2019) that decentralized operations may result in agency problems. Our findings additionally provide empirical evidence in support of the theory presented in Dermish et al. (2011) suggesting that the increase in credit risk among smaller BB networks may be experienced during an initial adjustment phase until MFIs are able to develop client credit history records that can be relied on to effectively mitigate credit risk with time and as their BB offerings expand. This understanding may help make sense

Table 5. Robustness checks.

	Panel A Estimating a System of Equations						Panel B Alternative Set of Financial and Social Performance Measures					
	(1) PAR30	(2) ILA	(3) AVGBALANCE	(4) ROE	(5) GLPTA	(6) BORRSTAFF	(7) PAR90	(8) COMP	(9) ZSCORE	(10) OSS	(11) BORROWERS	(12) BELOWPOV
BB	0.035*	0.020***	0.550**	−0.159*	−0.059	66.743***	0.054**	0.097***	0.404*	−0.067*	27010.165***	2.264***
	(0.020)	(0.007)	(0.276)	(0.087)	(0.039)	(23.795)	(0.024)	(0.023)	(0.211)	(0.036)	(2360.624)	(0.529)
PRTFYIELD	0.112	0.004	−7.358**	2.311**	0.543	−397.599	−0.288***	−0.315***	−0.175	0.933***	543190.387***	−0.696**
	(0.222)	(0.080)	(3.041)	(0.957)	(0.426)	(262.401)	(0.039)	(0.035)	(0.389)	(0.252)	(39126.791)	(0.315)
GROUP	0.001	−0.003	−0.466***	−0.051	−0.016	29.935**	−0.041*	0.095***	0.056	0.196***	−21719.439***	0.066**
	(0.012)	(0.004)	(0.163)	(0.051)	(0.023)	(14.105)	(0.022)	(0.022)	(0.098)	(0.052)	(3649.141)	(0.026)
RURBORR	0.017	0.003	−1.113***	0.250***	0.065*	−6.567	−0.051**	0.030**	0.146	0.453***	9751.954**	0.021
	(0.018)	(0.007)	(0.252)	(0.079)	(0.035)	(21.782)	(0.024)	(0.012)	(0.102)	(0.091)	(4586.048)	(0.067)
FEMBORR	−0.063***	−0.020**	−1.264***	0.253**	0.252	67.195**	−0.003	−0.261***	−2.448***	−0.185	143952.282***	−0.261
	(0.024)	(0.009)	(0.330)	(0.104)	(0.046)	(28.511)	(0.043)	(0.028)	(0.292)	(0.156)	(12283.926)	(0.167)
CORRUPTION	−0.021	0.002	0.898***	−0.127*	−0.025	−35.203*	−0.046***	0.002	−0.209***	0.056	−74613.250***	−0.002
	(0.017)	(0.006)	(0.228)	(0.072)	(0.032)	(19.664)	(0.013)	(0.002)	(0.053)	(0.046)	(4653.928)	(0.088)
LTA	0.013	−0.001	−0.593**	0.173**	0.096***	−65.609***	0.031***	−0.007*	−0.161***	0.159***	154966.464***	0.007
	(0.018)	(0.006)	(0.245)	(0.077)	(0.034)	(21.164)	(0.008)	(0.004)	(0.027)	(0.022)	(2030.870)	(0.023)
TAGROWTH	−0.046***	−0.018***	0.264**	0.018	−0.009	2.922	−0.160***	−0.372***	−1.434***	0.275***	−101423.314***	0.008
	(0.009)	(0.003)	(0.117)	(0.037)	(0.016)	(10.127)	(0.021)	(0.020)	(0.107)	(0.036)	(4366.982)	(0.041)
DEPTA	0.016	0.005	1.432***	−0.080	−0.296***	73.077**	−0.263***	−0.228***	−0.946***	0.319**	−462912.624***	−0.518***
	(0.026)	(0.009)	(0.357)	(0.112)	(0.050)	(30.775)	(0.055)	(0.024)	(0.244)	(0.139)	(14503.575)	(0.092)
MATURE	0.020	0.004	−0.385	0.104	−0.033	39.765*	0.189***	0.171***	2.371***	−0.129	−218809.700***	−0.006
	(0.020)	(0.007)	(0.270)	(0.085)	(0.038)	(23.308)	(0.038)	(0.037)	(0.343)	(0.079)	(23240.347)	(0.128)
Constant	−0.077	0.069	11.315**	−3.395**	−1.007	1347.541***	−0.128	0.502***	4.772***	−2.201***	−2276811.760***	0.631
	(0.325)	(0.117)	(4.458)	(1.403)	(0.625)	(384.716)	(0.120)	(0.075)	(0.515)	(0.369)	(33440.917)	(0.586)
Model Statistics												
Obs.	1174	1174	1174	1174	1174	1174	1189	1129	1129	1228	1203	182
Wald Chi2	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hansen							0.394	0.176	0.302	0.989	0.667	0.583
Diff-Hansen							0.776	0.331	0.622	0.977	0.924	0.522
AR(1)							0.303	0.723	0.633	0.021	0.647	0.266
AR(2)							0.787	0.562	0.781	0.704	0.896	0.869

Panel A of Table 5 presents the results of the robustness check using a three-stage least squares (3SLS) methodology, estimating the results for columns 1–6 as a system of simultaneous equations. The dependent variables are the measures of social performance and financial performance. Standard errors are in parenthesis. Chi2 reports the p-value for the Chi-Squared test for model fit.

Panel B presents the results of the robustness tests using two-step system GMM. The dependent variables are the measures of social performance and financial performance. Robust standard errors are in parenthesis. Wald Chi2 reports the p-value for the Wald Chi-Squared test for model fit. Hansen reports the p-value of the Hansen J over-identification test, testing the null hypothesis that the instruments used are valid. Diff-Hansen reports the p-value of the Difference-in-Hansen test, for which the null hypothesis is that the set of instruments used is exogenous. AR(1) and AR(2) report the p-value of the Arellano-Bond autocorrelation test for first-order and second-order serial correlation. The null hypothesis is that there is no serial correlation.

*, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively. Variable definitions are in Table 1.

Table 6. Non-Linear Relationships.

	(1) PAR30	(2) ILA	(3) PAR90	(4) COMP	(5) ZSCORE	(6) ROE	(7) OSS
BB	1.084***	0.260***	0.498***	1.043***	6.461***	0.013	−0.270**
	(0.053)	(0.030)	(0.073)	(0.072)	(0.793)	(0.149)	(0.124)
BB2	−0.372***	−0.071***	−0.168***	−0.370***	−2.273***	−0.158	0.087**
	(0.018)	(0.010)	(0.025)	(0.025)	(0.268)	(0.099)	(0.043)
PRTFYIELD	−0.324***	−0.047*	−0.366***	−0.071**	0.767***	4.018***	0.928***
	(0.059)	(0.025)	(0.045)	(0.033)	(0.248)	(0.285)	(0.250)
GROUP	0.014	0.023***	−0.053***	0.110***	0.070	0.484***	0.175***
	(0.012)	(0.007)	(0.017)	(0.010)	(0.133)	(0.089)	(0.054)
RURBORR	−0.063***	0.026**	−0.027	0.090***	0.248*	0.831***	0.423***
	(0.017)	(0.011)	(0.022)	(0.014)	(0.138)	(0.104)	(0.094)
FEMBORR	−0.064**	−0.222***	−0.027	−0.025	−1.318***	0.543***	−0.142
	(0.030)	(0.017)	(0.045)	(0.039)	(0.315)	(0.084)	(0.161)
CORRUPTION	−0.075***	0.014***	−0.046***	−0.070***	−0.560***	−0.027	0.057
	(0.009)	(0.003)	(0.014)	(0.004)	(0.079)	(0.048)	(0.044)
LTA	0.023***	−0.013***	0.028***	0.017***	0.109**	0.291***	0.176***
	(0.005)	(0.002)	(0.006)	(0.003)	(0.043)	(0.029)	(0.021)
TAGROWTH	−0.191***	−0.049***	−0.158***	−0.297***	−1.410***	0.037	0.297***
	(0.010)	(0.003)	(0.019)	(0.014)	(0.070)	(0.025)	(0.035)
DEPTA	−0.183***	−0.023*	−0.301***	−0.284***	−1.981***	−0.434**	0.413***
	(0.035)	(0.012)	(0.046)	(0.025)	(0.304)	(0.190)	(0.133)
MATURE	0.239***	0.054***	0.185***	0.130***	1.504***	0.038	−0.157**
	(0.049)	(0.012)	(0.035)	(0.034)	(0.264)	(0.049)	(0.080)
Constant	0.111	0.344***	−0.051	0.050	0.772	−6.700***	−2.496***
	(0.084)	(0.034)	(0.096)	(0.073)	(0.594)	(0.590)	(0.334)
Model Statistics							
Obs.	1190	1223	1189	1129	1129	1223	1228
Wald Chi2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hansen	0.329	0.765	0.374	0.564	0.877	0.709	0.972
Diff-Hansen	0.512	0.925	0.555	0.881	0.976	0.703	0.946
AR(1)	0.094	0.060	0.058	0.137	0.126	0.320	0.021
AR(2)	0.202	0.449	0.210	0.367	0.274	0.183	0.693

Table 6 presents the results of estimating two-step system GMM models where a quadratic term for branchless banking (BB2) is introduced to identify whether BB exhibits a non-linear relationship with credit risk and profitability. The dependent variables are the measures of credit risk and profitability. Robust standard errors are in parenthesis. Wald Chi2 reports the p-value for the Wald Chi-Squared test for model fit. Hansen reports the p-value of the Hansen J over-identification test, testing the null hypothesis that the instruments used are valid. Diff-Hansen reports the p-value of the Difference-in-Hansen test, for which the null hypothesis is that the set of instruments used is exogenous. AR(1) and AR(2) report the p-value of the Arellano-Bond autocorrelation test for first-order and second-order serial correlation. The null hypothesis is that there is no serial correlation. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively. Variable definitions are in Table 1.

of the varying conclusions in the relevant literature (Al-Azzam, Carter Hill, and Sarangi 2012; Ozili 2018; Zamore, Beisland, and Mersland 2019).

A noteworthy implication of the quadratic relation found is that MFIs tend to exhibit an initial tradeoff between the adverse impact of BB on credit risk and profitability on one hand, and attaining a positive impact on financial inclusion on the other. This tradeoff between social and financial performance diminishes as BB networks expand due to the quadratic relation of BB with credit risk and profitability. Specifically, we calculate that the threshold for credit risk and profitability occurs at an average of approximately 1,520 and 1,550 branchless banking points of service, respectively. This is a relatively large network size that would require considerable expansion for the average MFI in our sample, which has far fewer BB outlets.

Overall, the results indicate that MFIs experience a tradeoff across the different financial performance outcomes as they expand engagement in branchless banking and increase the number of branchless points of service they operate. While positive efficiency and productivity outcomes are evident, MFIs should be prepared to endure adverse profit and credit risk outcomes until a large BB network size is established. During this stage, managers may benefit from incorporating different risk management tools such as dynamic incentives (Armendariz and Morduch 2000) to reduce credit risk, which ultimately may also enhance MFI's profitability. With time, developing credit history records and building a credit rating system for clients should help mitigate their credit risk exposure. It would be ideal for MFI donors and subsidy providers to look past the early tradeoff

towards the long-term social and financial benefits that can arise from investments in BB adoption. However, in practice, MFIs are receiving decreasing amounts of funding (Tomilova and Dokle 2019) and donors are shifting to prioritizing financial performance over social outreach (Tanima et al. 2021). This decreases the likelihood that MFI stakeholders will be willing to sustain BB expansion until the threshold network size is established. Depending on their prioritization of objectives, it lies upon MFI stakeholders to decide whether the heightened risk and deteriorated profits can be outweighed by the improvements in productivity and efficiency, in addition to the favourable social performance outcomes associated with BB adoption. While the financial inclusion enhancements may be a sufficient motive for BB adoption among socially-oriented MFIs, stakeholders and funders that are more interested in seeking immediate financial outcomes may find it preferable to limit their involvement in BB.

VI. Conclusion

This study examined how branchless banking adoption contributes to the social and financial performance of MFIs. Our results indicate an improvement in social performance as we find that MFIs cater to a greater number of poor borrowers as they extend their BB offerings. MFI managers and funders looking to increase financial inclusion may find promising potential in expanding their BB networks as it helps facilitate financial transactions for MFI borrowers without the need to physically travel to an MFI branch. Branchless banking is also associated with enhancements in financial performance when measured using efficiency and productivity. We provide new insight into the relationship of branchless banking with credit risk and profitability as we find that the relationships are quadratic, respectively taking the form of an inverted u-shape and a u-shape.

Our results are of relevance to MFI policy makers considering investments in BB as we find that it is associated with an initial tradeoff between social outreach and enhanced financial inclusion on one hand, and a deterioration in profitability and credit risk on the other hand. This trade-off diminishes as BB networks expand, allowing MFIs to eventually exhibit improvements in their repayment rates and profitability, but a relatively large BB network size will need to be established before this turning point is reached. While investments in BB infrastructure may reduce profitability in the short term, they may also cut long-term operational costs. It tends to be viable for financial institutions to forgo short-term profits in anticipation of acquiring a greater market share and future profit (Short 1979), which may explain the initial negative association with profit that we find, although further research may directly examine the extent to which this occurs in MFIs to confirm this proposition. Additionally, high initial start-up costs may make BB appear to be an unattractive investment for MFI managers at first before they can reap the benefits of economies of scale (Furst, Lang, and Nolle 2002; Kumar, McKay, and Rotman 2010). Therefore, the viability of BB adoption will depend on the priorities of MFI managers and funders and whether they are willing to endure the initial adversity to their profit and credit risk for the sake of financial inclusion, efficiency, and productivity enhancements, as well as eventually reaping the long term risk and profit benefits of BB. The current study can be extended by delving into the extent of the initial tradeoff to provide greater insight into the financial feasibility of investing in BB. Moreover, limited by restrictions in available observations in the dataset utilized in this study, it was not possible to separately conduct our analysis among the subsets of BB such as agent banking or mobile banking. Such an analysis may present a beneficial extension to our findings.

Importantly, the increase in outreach associated with BB is critical to the social mission of MFIs and is a promising finding for donors and subsidy providers for whom financial inclusion is a primary objective. Our findings suggest that branchless

banking may be an important tool to consider in the strive to improve the financial inclusion of unbanked populations around the world by facilitating access to finance among financially-excluded demographics.

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