TENDENCIAS
Journal of the Faculty of
Economic and Administrative Sciences
Universidad de Nariño
ISSN-E 2539-0554
Vol. XXV No. 1 – 1st 2024 Semester
January - June – Pages 139-165

RESEARCH ARTICLE

Banking technology and MSMEs

FINANCIAL INCLUSION AND INFORMATION TECHNOLOGIES AND COMMUNICATIONS IN SMALL AND MEDIUM-SIZE ENTERPRISES IN COLOMBIA. MICROBUSINESS CASE PERIOD 2019-2021

INCLUSIÓN FINANCIERA Y TECNOLOGÍAS DE LA INFORMACIÓN Y COMUNICACIÓN EN LAS MIPYMES EN COLOMBIA. CASO MICRONEGOCIOS PERÍODO 2019-2021

INCLUSÃO FINANCEIRA E TECNOLOGIAS DE INFORMAÇÃO E COMUNICAÇÃO EM MICRO E PME'S NA COLÔMBIA. CASO DAS MICROEMPRESAS PERÍODO 2019-2021

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Received: July 7, 2023 **Approved: November 14, 2023**

DOI: https://doi.org/10.22267/rtend.242501.244

Abstract

Microbusinesses represent more than 90% of the Colombian business sector; however, most are informal, unbanked, and lack information technologies to enhance their competitiveness. For this reason, this research aims to analyze the probability of achieving financial inclusion and the adoption of Information and Communication Technologies (ICT) in the formalization of microbusinesses in Bogotá during the 2019-2021 period. Methodologically, a mixed approach was used, based on qualitative analysis (characterization and results analysis) and quantitative analysis, drawing on a database of 15,026 microbusinesses from the Encuesta de Micronegocios [Microbusiness Survey] by the Departamento Administrativo Nacional de Estadística [National Administrative Department of Statistics] (DANE). A Probit model was implemented to calculate the probability of achieving formalization and financial inclusion through probabilistic analysis and marginal effects. The study concludes that financial inclusion and ICT adoption are essential to ensure the growth of microbusinesses, although some remain informal and unable to access these tools that ensure their sustainability. The results of the Probit model demonstrate that formality increases when businesses register with the Chamber of Commerce and obtain the Registro Único Tributario [Single Tax Registry] (RUT).

Keywords: small enterprises, technology, banks, competitiveness, entrepreneurs, organizational change.

JEL: D21, D52, M15, M20, M21.

Resumen

Los micronegocios representan más del 90% del tejido empresarial colombiano; sin embargo, la mayoría son informales, no están bancarizados y carecen de tecnologías de información para ser más competitivos; por tal razón, el objetivo de esta investigación es analizar la probabilidad de lograr procesos de inclusión financiera y adopción de Tecnologías de la Información y Comunicación (TIC) en la formalización de los micronegocios en Bogotá durante el periodo 2019-2021. Desde el punto de vista metodológico, se utilizó un esquema mixto, basado en un análisis cualitativo (caracterización y análisis de resultados) y un análisis cuantitativo, a partir de la base de datos de 15,026 micronegocios, tomados de la Encuesta de Micronegocios del Departamento Administrativo Nacional de Estadística (DANE), donde se implementó un modelo Probit para

calcular la probabilidad de alcanzar la formalización y bancarización mediante un análisis probabilístico y de efectos marginales. El estudio concluye que la inclusión financiera y la adopción de TIC, son fundamentales para garantizar el crecimiento de los micronegocios, aunque algunos continúen en la informalidad y no puedan acceder a estas herramientas que garanticen su sostenibilidad. Los resultados del modelo Probit demuestran que la formalidad aumenta cuando las empresas se formalizan en la Cámara de Comercio y obtienen el Registro Único Tributario (RUT).

Palabras clave: pequeña empresa, tecnologías de la información, banco, competencia, empresario, cambio organizacional.

JEL: D21, D52, M15, M20, M21.

Resumo

Os microempreendimentos representam mais de 90% do tecido empresarial colombiano; no entanto, a maioria opera de forma informal, não possui serviços bancários e carece de tecnologias de informação para aumentar sua competitividade. Portanto, o objetivo desta pesquisa é analisar a probabilidade de alcançar processos de inclusão financeira e adoção de Tecnologias de Informação e Comunicação (TIC) na formalização dos microempreendimentos em Bogotá durante o período de 2019-2021. Do ponto de vista metodológico, foi utilizado um enfoque misto, baseado em análise qualitativa (caracterização e análise de resultados) e análise quantitativa, utilizando uma base de dados de 15.026 microempreendimentos da Pesquisa de Microempreendimentos do Departamento Administrativo Nacional de Estadística (DANE). Um modelo Probit foi implementado para calcular a probabilidade de alcançar a formalização e bancarização por meio de uma análise probabilística e de efeitos marginais. O estudo conclui que a inclusão financeira e a adoção de TIC são fundamentais para garantir o crescimento dos microempreendimentos, mesmo que alguns permaneçam informais e não possam acessar essas ferramentas para garantir sua sustentabilidade. Os resultados do modelo Probit demonstram que a formalidade aumenta quando as empresas se formalizam na Câmara de Comércio e obtêm o Registro Único Tributário (RUT).

Palavras-chave: pequena empresa, tecnologia da informação, banco, concorrência, empreendedor, mudança organizacional.

JEL: D21, D52, M15, M20, M21.

Introduction

In Colombia, more than 90% of its business sector is made up of MSMEs, and a large percentage of these productive units operate under informal conditions, facing multiple challenges to stay in the market. One of the main issues is access to financial resources and the use of new technologies that can help improve productivity and competitiveness, while also encouraging gross fixed capital formation to increase production, achieve higher sales, and generate more income.

Access to resources through traditional banking system loans is one of the main concerns for these agents, as they need to use productive factors efficiently and acquire the necessary inputs to boost production. Producers also face imperfect loan markets, where asymmetric information, moral hazard, and adverse selection from financial institutions persist. To address this difficulty, they turn to alternative financing methods, assuming high-interest rates and informal conditions, which negatively affect their cash flows and result in low profitability.

Another limiting factor is access to innovative new technologies that can improve the development of their productive activities, increase competitiveness, and stimulate the supply of products. These platforms facilitate entry into new markets at lower costs, offering services such as Fintech, virtual payment methods, and real-time access to financial indicators.

According to studies by the Asociación Nacional de Instituciones Financieras [National Association of Financial Institutions] (ANIF, 2013), some of these productive units are discouraged from seeking credit from formal banks due to the rigorous compliance with numerous procedures and requirements for application review, prolonged response times, and additional costs when loans are approved, including the request for guarantees and good credit history (Banca de las Oportunidades and the Superintendencia Financiera de Colombia, 2018).

In 2006, the Consejo Nacional de Política Económica y Social [National Council for Economic and Social Policy] (CONPES) defined a public policy for financial inclusion called Banca de las Oportunidades, aimed at promoting the use of credit and other products and encouraging MSMEs operating under informal conditions to engage in financial inclusion processes (National Planning Department, 2006).

Based on the above, the purpose of this document is to analyze the impact of financial inclusion and the adoption of Information and Communication Technologies (ICT) on the formalization processes of microbusinesses in the country during the 2019-2021 period. To this end, the following topics are addressed: theoretical aspects, methodology, and results analysis. Finally, a theoretical model of financial inclusion is proposed, along with conclusions.

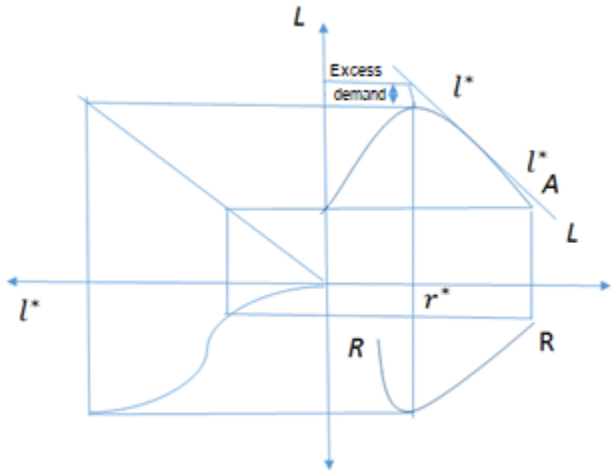
Theoretical Aspects

This article is based on the context of credit rationing and imperfect information, with the main authors who have developed this topic being Stiglitz & Weiss (1981). They proposed the approach of credit rationing under a market equilibrium scenario, where some investors are unable to obtain the necessary resources due to financial costs and high-interest rates. It is worth noting that when banks operate under an oligopolistic structure (Jaffee & Modigliani, 1969), they select those who meet certain credit conditions, but there are failures, problems of incomplete information, moral hazard, and adverse selection.

In Figure 1, it is shown that in a loanable funds equilibrium situation l^*, there is credit rationing, which can occur at a long-term equilibrium interest rate r^*, but it is not necessarily optimal, as some entrepreneurs are excluded from the credit market due to difficulties in paying a high-interest rate. In this sense, banks incur high capital costs by limiting supply, knowing that not all micro and small entrepreneurs apply for loans. They only provide resources to companies that are solvent, willing to bear the credit costs, and able to generate profits from their projects (Stiglitz & Weiss, 1981).

Figure 1

Market equilibrium determination



Source: Stiglitz & Weiss (1981).

Under this theoretical perspective known as credit rationing, one can explain one of the forms of financial exclusion for MSMEs, as there exists an imperfectly competitive market with many coordination and information problems, limiting access to resources. For this reason, it becomes necessary to turn to alternative sources to continue the development of their businesses.

In addition to the theoretical framework proposed above, from the perspective of access to ICT, this study references several theoretical models, such as the technology adoption models developed by Davis (1989) and Pfeffer (1982), who predict the use of technologies and their utility in the development of productive activities (Davis, 1989). Among the various variables that encourage the use of new technologies, two determinants are suggested: the first is the tendency to use applications that optimize work, and the second is the effort required by entrepreneurs when using a new application, considering both its utility and the ease of managing an innovative product (Pfeffer, 1982).

Methodology

Qualitative Aspects of the Study

Incorporation into the banking system and the availability of ICT have become fundamental strategies for economic development in Colombia, with one of the most important banking products being the granting of credit. However, in recent years, low levels of financial inclusion and the adoption of new technologies have been observed, limiting the banking access of many microbusinesses. According to Cabrero (2006), ICT is defined as "a way to modernize the communication system that revolves around three mediums: microelectronics, telecommunications, and computing, interconnected, immediate, immaterial, and interactive, with the goal of creating new communication frameworks" (Cabrero, 2006, pp. 10-15).

Since 2012 and until 2021, the Departamento Administrativo Nacional de Estadística [National Administrative Department of Statistics] (DANE) has been conducting a series of surveys on different micro-establishments located in the main urban centers of the country, which are considered "economic units where up to nine (9) people work, engaging in productive activities of goods and services to generate income" (DANE-EMICRON, 2023, p. 3). However, after 2019, the concept of microbusinesses was introduced. This information collected by DANE provides greater insight into the depth of the country's business landscape and the promotion of business formalization (DANE, 2021). Table 1 shows the number of microbusinesses in the city of Bogotá as a result of these surveys.

Table 1

Number of Microbusinesses in Bogotá, 2019-2022

City	2019	2020	2021	2022
Bogotá D.C.	685,648	671,154	569,529	463,199
Total	5,215,035	4,819.,29	4,921,210	5,150,956

Source: Data from DANE – EMICRON (2022).

As observed, in 2019, there were approximately 685,648 microbusinesses, decreasing to 463,199 in 2022. According to estimates on informality derived from the Gran Encuesta Integrada de

Hogares [Large Integrated Household Survey] (GEIH), referring to microbusinesses that are not registered as a natural person or company, it is estimated that the percentage of informality relative to the total is 24.6%. Additionally, these businesses are highly heterogeneous. High levels of informality have significant economic and social effects, restricting growth, productivity, and the quality of life of their workers, including the lack of affiliation with the comprehensive social protection system. Among the major challenges to the formalization process are financial exclusion or self-exclusion and access to the use of ICT. Table 2 shows the companies registered between 2019 and 2021.

Table 2

Formalization of Microbusinesses in Colombia

	2019	**2020**	**Variation 20/19**	**2021**	**Variation 21/20**
Registro Único Tributario [Single Tax Registry] (RUT)	75,9	76,5	0,6	77,3	0,8
Commercial Registry	67,9	68,7	0,8	69,6	0,9

Note: Percentage of informal microbusinesses by indicator, National Total (2019-2021).
Source: Data from DANE-EMICRON (2021).

According to this information, the percentage of informal microbusinesses in Colombia through the RUT has increased from 0.6 to 0.8 points, while the Commercial Registry showed a slight increase from 0.8 to 0.9 points (Table 2) during the period from 2020 to 2021 as a result of the Covid-19 pandemic.

Regarding the use of ICT in microbusinesses in trade, industry, and services where up to nine people work, it allows these economic units to increase their productivity and competitiveness. The survey conducted by DANE found that these microbusinesses had a low percentage of connectivity or internet use by 2021, which increased from 24.4% in 2014 to 25.8% in 2015,

reaching 48.9% in 2021. The percentage of micro-establishments with a website is very low, at only 4.9%, meaning that about 93.6% of these units, especially informal ones, have not had access to or used the internet, citing a lack of need or resources to access these tools, or due to their high cost.

Despite efforts to establish multidimensional formalization campaigns, the adoption of new technological and financial development processes remains insufficient. These units have faced difficulties such as high levels of business informality and lack of credit history, access to the financial sector, low affordability of information technologies, inadequate training for their human resources, and low levels of associativity and innovation capabilities, among others (National Planning Department, 2020).

A recent study presented by Gómez et al. (2022) considers that the difficulty in achieving a greater degree of financial depth lies in payment capacity, over-indebtedness, credit management reports, lack of payment capacity, and the type of economic activity that many of these units engage in under informal conditions.

Aspects of the Study, Model Description, and Results

For the development of this research, the EMICRON microbusiness survey conducted by DANE was referenced, targeting microbusinesses consisting of a maximum of nine individuals engaged in trade, industry, and services. The survey was conducted throughout the year but was suspended from March to July 2020 due to the health emergency.

To analyze the impact of ICT and financial inclusion on the formalization of these productive units from a quantitative perspective, the 2021 Encuesta de Micronegocios [Microbusiness Survey] was used, involving 77,157 microbusinesses located in the 24 main cities of the country and their metropolitan areas. A questionnaire focusing on economic aspects was administered, with the assumption of a relationship between the company, employment, and the individual.

It is worth noting that the Organisation for Economic Co-operation and Development (OECD) defines financial inclusion as:

> A process of promoting timely and adequate access to a range of regulated financial products and services and expanding their use by all segments of society through innovative approaches such as financial education and awareness (Zuleta, 2016, p. 15).

A non-linear Probit econometric model was designed, based on a cumulative normal distribution. In this model, it is posited that the formalization of a company is influenced by its registration in the RUT at the Chamber of Commerce. An index I is used to identify the binary dependent variable, where 1 indicates that the microenterprise is registered, and 0 indicates that it is not; formal businesses pay taxes, while informal ones do not (Ydrobo, 2010). The following independent variables were considered: internet access, social media usage, credit requests, the average profit from the last month, and the use of electronic banking. The decision to formalize or not for the i-th microenterprise is linked to an unobservable convenience index Ii (also called a latent variable), which is formed from one or several explanatory variables, such as internet access, Xi. In this context, the higher the value of index Ii, the greater the probability that the business will opt for formalization. This expression of index Ii is understood as the record that businesses make to obtain their formalization (Equation 1) (Gujarati and Porter, 2010, p. 566).

The model is expressed as follows:

Equation 1: Basic Binary Model of Business Formalization.

$$Ii = \beta 1 + \beta 2 \mathrm{Xi} \qquad (1)$$

In a binary model, the influence of explanatory variables on the probability of choosing the option given by $yi = 1$ does not depend solely on the value of the coefficients but also on the values they take; for example, the most significant marginal effect will be observed when Pr (y = 1) = 0,5. Among the independent variables, dichotomous variables were included to define the characteristics of the companies from the perspective of access to technologies and financial inclusion (Santa and Rozo, 2009).

For the proposed financing model, the analysis was approached from a microeconomic perspective, specifically the marginalist theory of production, which proposes a profit-maximization model for producers, subject to constraints such as indebtedness. The aim is to

determine a credit value that does not incur high financial costs, with a low interest rate that is affordable for these producers and poses a lower credit risk

Model of the Impact of ICT Access and Financial Inclusion on Business Formalization

The following model aims to analyze the effect of ICT use and financial inclusion on the formalization of microbusinesses. For this purpose, the database from the 2021 EMICRON Encuesta de Micronegocios [Microbusiness Survey] conducted by DANE was used, focusing on a refined sample of 15,026 productive units out of a total of 77,157 records, utilizing the methodology of binary cross-sectional analysis and a Probit model with the following characteristics.

Dependent Variable: This is referred to as the RUT of the micro establishment at the Chamber of Commerce. It is a binary variable, where 1 indicates that the micro establishment has RUT and 0 indicates that it does not. This is considered one of the established criteria for formalizing the operation of the microbusiness. According to information provided by the Cámara Colombiana de Comercio Electrónico [Colombian Chamber of Electronic Commerce], as of 2021, only 22.7% of microbusinesses had RUT, while a very small proportion of 1.4% were registered with a Chamber of Commerce (Cámara Colombiana de Comercio Electrónico, 2023).

Independent Variables: These include device usage, mobile phone access, internet service access, whether the business has a website, credit requests in the last 12 months within the banking system, the use of electronic banking and other financial services, and the variation in the average monthly profit generated by the business, referred to as "benefit." Tables 3, 4, 5, and 6 display the results of the probabilistic regression, the marginal effects, and the model predictions, which are explained subsequently.

Table 3

Results of the Probabilistic Regression

Probit	**regression**	**Number**	**of**	**obs**	**=**	**15,026**
		LR		chi2(6)	=	655,60

		Prob	>	chi2	=	0,0000
Loglikelihood	-85967248		Pseudo	R2	=	0,0367
RUT	Coef.	Std.Err.	z	P>|z|	[95%Conf.	Interval]
CREDITS	.0074614	.029104	0,26	0,798	-.0495815	.0645043
Devices	.4168177	.026778	15,57	0,000	.3643337	.4693017
MOBILE	.4715712	.0947447	4,98	0,000	.2858751	.6572673
WEB	-.1756142	.0624264	-2,81	0,005	-.2979677	-.0532606
Electronic Banking	.3861421	.0306792	12,59	0,000	.326012	.4462723
Benefits	.0296387	.0095459	3,10	0,002	.010929	.0483484
_cons	-1,614.075	.1567708	-10,30	0,000	-192,134	-130,681

Source: Prepared by the authors.

Table 4

Marginal Effects

Marginal effects after Probit							
	Y	=	Pr (RUT)	(predict)			
	=	.27486672					
Variable	dy/dx	Std.Err.	Z	P>|z|	[95% C.I.]		X
CREDITS*|	.0024927	.00974	0,26	0,798	-.016591	.021577	.174764
Devices~s*|	.1461002	.00973	15,01	0,000	.127026	.165175	.259617
MOBILE*|	.1333225	.02167	6,15	0,000	.090849	.175796	.983828
WEB*|	-.0555472	.01862	-2,98	0,003	-.092039	-.019055	.032078
Electronic Banking ~o*|	.1373368	.01146	11,99	0,000	.114884	.159789	.16558
Benefits ~s	.0098872	.00318	3,11	0,002	.003647	.016128	129,611
(*)	dy/dx is for discrete change of dummy variable from o to 1						

Source: Prepared by the authors.

Table 5

Model Prediction

Probit model for RUT						
True --------						
Classified		D		~D		Total
		600		584		1184
		3623		10219		13842
Total		4223		10803		15026
Classified + if predicted Pr(D) >= .5						
True D defined as RUT != 0						
Sensitivity					Pr (+ D)	14,21%
Specificity					Pr(-~D)	94,59%
Positive predictive value					Pr (D +)	50,68%
Negative predictive value					Pr (~D -)	73,83%
False + rate for true ~D					Pr(+~D)	5,41%
False - rate for true D					Pr (- D)	85,79%
False + rate for classified +					Pr (~D +)	49,32%
False - rate for classified -					Pr (D -)	26,17%
Correctly classified						72,00%
estat	ic	and				
Akaike's information criterion criterion Bayesian						
Model	Obs	ll(null)	ll(model)	df	AIC	BIC
.	15,026	-8,924,523	-8,596,446	8	17208,89	17269,83

Source: Prepared by the authors.

Table 6

Variance-Covariance Matrix of the Model

e(V)	**RUT**						
RUT	**Devices**	**Mobile**	**Internet**	**Web**	**Electronic Banking**	**Credits**	**Benefits**
Devices	|						
Mobile	.00071883						
Internet	.00030095	.00900753					
Web	.00043699	-.00154224	.12449571				
Electronic Banking	.00024965	-.0000955	-.00020105	.00389748			
Credits	.00008692	.00085768	-.00016392	.00094758			
Benefits	-2,67E-03	-.00004501	.00020073	-4,92E-04	.00002648	.00084738	
_cons	4,32E-03	4,42E-03	.00002259	-.00001228	1,14E-03	5,47E-03	.00009114
	.00006033	-.00745903	-.12320766	.00042641	-.00087509	-.0003796	-.00121168

Source: Prepared by the authors.

Results

The findings of this research are presented below. According to the results of the Probit model, the selected independent variables were highly explanatory. As expected, the request for credits shows a somewhat insignificant incidence on formalization; specifically, for each unit increase in RUT requests, the increase is only 0.007. This means that credits obtained from the financial system may disincentivize these entrepreneurs from legalizing their ventures due to financial costs, the response times in approving requests, the fear of being reported to credit agencies, lack of income, and the number of documents required to obtain these resources. Another reason cited is that some studies suggest that credit is not an indispensable instrument for the development of their economic activities (Castro et al., 2020). According to the microbusiness survey conducted by DANE, 63%

of micro establishments use their savings as a source of resources, reducing the use of bank credits (Asociación Colombiana de las Micro Pequeñas y Medianas Empresas [ACOPI], 2023).

The variables regarding the use of devices and mobile phones had the greatest impact on formalization through the RUT. Specifically, for each unit increase in the use of devices and mobile phones, business formalization increases by 0.41 and 0.47, respectively. This result reflects that the adoption of ICT has a positive impact on business formalization. Similarly, the use of electronic banking had a positive effect, where each additional unit in the use of ICT encourages legalization by 0.38.

The variation in benefits also positively influences formalization, but it is very marginal; for each unit increase in formalization, it only increases by 0.029 (Table 3). This result corroborates that the financial inclusion program proposed in government development plans serves as an important source for digitalizing payments and banking operations, aiming to achieve greater use and access to the financial products offered by formal banking (Vera and Tamayo, 2022).

In contrast to the effects of the previously described variables, the use of websites does not facilitate the formalization of microbusinesses. According to the results recorded through the coefficients found, for each unit increase in the use of these platforms, the formalization of the business decreases by 0.17. This is due to the nature of the ventures, as most are informal and prefer direct sales or mobile phone transactions.

Electronic banking has evolved as one of the financial instruments that has somewhat allowed the formalization of ventures and has significantly supported the development of their productive activities, innovating in the financial inclusion of businesses, thereby improving efficiency (Vera and Tamayo, 2022). According to the results of the linear regression, for each additional unit that the microenterprise utilizes of the electronic banking service, its formalization increases by 0.38, meaning a 38% increase. It is the financial product that is most well-received among microbusinesses since it best fits their financial needs.

Marginal Effects

The analysis of the estimated marginal effects for the different variables in the proposed model shows the following results: formalization, measured by the RUT of a microbusiness, increases the probability of using devices by 14% and mobile telephony by 13%. Regarding the use of electronic banking, it has an incidence of 13.7%. On the other hand, the variation in benefits also positively influences formalization, but the probability of formalizing the microbusiness is only 0.09%, meaning that the marginal effect is almost negligible.

A noteworthy result is the negative marginal effect caused by the use of websites. Given that these are small ventures, this effect shows that for each additional unit of website use, the effect on business formalization is -0.5%. In other words, the use of these websites disincentivizes these entrepreneurs from legalizing their businesses. Therefore, prior knowledge is required to organize these platforms, but they have low budgets for their sustainability. In this regard, education in new technologies and basic financial aspects would encourage the use of websites. A recent study conducted by Durán and Rios (2022), researchers at the University of Santiago de Cali, corroborates the results of this research, demonstrating that business formalization is directly related to the use of ICT, and that having registration with the Chamber of Commerce and RUT enables greater use of information technologies (Durán and Rios, 2022).

It is important to clarify that business formalization includes the requirements for business registration with the Chamber of Commerce, hiring workers with their respective legal requirements (health, pension, and occupational risk insurance), and declaring their businesses for tax payments, with the relevant parameter considered in this study being the RUT. According to a recent competitiveness report, the creation of new companies in Colombia involves high costs due to the number of procedures and requirements, along with tax burdens considered among the highest in OECD member countries (Consejo Privado de Competitividad, 2022).

Summary of the Main Findings of the Research

The impact of ICT and banking inclusion on the formalization of microbusinesses shows that the use of devices, as well as mobile telephony, are the means that most contribute to the formalization of some of these productive units. However, the design of websites generates the opposite effect,

possibly because developing these applications requires skilled personnel, which many producers cannot afford. Moreover, they associate the use of these websites with taxation processes and other payments that incur higher costs. Some technology adoption models consider that the size of the company affects the resources available for investing in these processes, not only the budget but also human capital (Dini et al., 2022).

From the perspective of banking inclusion processes, the reference was made to the use of electronic banking and access to credit in the formalization of microbusinesses. Both variables generated a positive effect, although loans were less significant. This indicates that these ventures rely more on their own resources for funding and avoid new debt.

Proposal for a Financial Inclusion Model

The objective of this section is to define a theoretical model of financial inclusion for micro, small, and medium-sized enterprises (MSMEs), considering that the objective function of these economic units is to maximize benefits while being subject to technological restrictions based on the cost of credit when financially included in the banking system.

As a starting point for constructing the model, it can be considered that MSMEs operate in a scenario of perfect competition, where companies enter and exit the market without restrictions. They are price takers in the market and can enter and exit at any time. The goal is to remain in the market and obtain some profit.

In a competitive market situation, MSMEs maximize their profits (π) and decide on their production plan (Nicholson, 2008), which is defined as (Equation 2):

Equation 2: Profit Optimization.

$$\max_{y} py - c(y) \;\; ; \;\; Profit\, \pi = py - wl - rk \qquad (2)$$

The financial inclusion model takes as a reference a Cobb-Douglas production function (Mankiw, 2017) and considers the following parameters (Equation 3):

Equation 3: Cobb-Douglas Production Function.

$$y = f(k, l) = K^{\alpha} L^{1-\alpha} \qquad (3)$$

K: represents fixed capital; L: Represents labor; p: is the market price taken by producers; py: represents the income of the company; α: proportion of fixed capital K that participates in the production of the company; $(1 - \alpha)$: Proportion of labor L that participates in the production of the company; $c(y) = wL + rK$ corresponds to total costs, where w corresponds to the payment of labor, that is, salaries, and r is the cost of fixed capital.

The production function is subject to the following restrictions: the company has its own resources or accumulated assets to expand its production plans, and entrepreneurs request loans from the banking system to support their investment projects. The parameters of the restriction b are, d: the debt or the value of the credits, which is financed at an interest rate (1+r), and the acquisition of new units of capital is financed with the credits (Equation 4).

Equation 4: Budget Constraint.

$$b = wL - (1 + r)d \qquad (4)$$

Other constraints faced by micro establishments are the debt percentage (Equation 5) and the amount of debt (Equation 6).

Equation 5: Debt Percentage.

$$\beta \leq \text{Maximum debt percentage to finance fixed capital: } d \leq \beta K \qquad (5)$$

The other constraint is that the capital invested by the microentrepreneur comes from the amount of debt.

Equation 6: Amount of Debt.

$$k = d + b \qquad (6)$$

To determine the first-order conditions regarding labor supply, in relation to fixed capital (Equation 7), the Lagrangian is formulated as follows:

Equation 7: Labor Supply.

$$L = pK^{\alpha}L^{1-\alpha} + \lambda[b - wL - (1+r)\beta K] \qquad (7)$$

$$\frac{\partial L}{\partial K} = \alpha pK^{\alpha-1}L^{1-\alpha} + \lambda(-\beta - r\beta) = 0$$

$$\alpha pK^{\alpha-1}L^{1-\alpha} = \beta(1+r)$$

Then, the interest rate r is determined, which applies to the cost of fixed capital (Equation 8).

Equation 8: Interest Rate.

$$\frac{\alpha pL^{1-\alpha}}{\beta K^{1-\alpha}} - 1 = r \qquad (8)$$

Is isolated: $\lambda\beta((1+r) = \alpha pK^{\alpha-1}L^{1-\alpha}$

$$\lambda = \frac{\alpha pK^{\alpha-1}L^{1-\alpha}}{\beta(1+r)} = \frac{\alpha pL^{1-\alpha}}{\beta(1+r)K^{1-\alpha}} \;\; ; y \geq 0$$

$$\frac{\partial L}{\partial L} = (1-\alpha)pK^{\alpha}L^{1-\alpha-1} - \lambda w = 0$$

The Technical Rate of Substitution (*TRS*) is given by the ratio between the marginal productivities of capital and labor, as referenced in Equation 9, and subsequently solving for labor supply in Equation 10.

Equation 9: Technical Rate of Substitution.

$$TRS = \frac{\frac{\alpha pL^{1-\alpha}}{\beta(1+r)K^{1-\alpha}}}{\frac{(1-\alpha)pK^{\alpha}}{wL^{\alpha}}} = \frac{\alpha pL^{1-\alpha}wL^{\alpha}}{\beta(1+r)K^{1-\alpha}(1-\alpha)pK^{\alpha}} = \frac{\alpha wL}{(1-\alpha)\beta(1+r)K} \qquad (9)$$

$$\lambda = \frac{(1-\alpha)pK^{\alpha}L^{-\alpha}}{w} = \frac{(1-\alpha)pK^{\alpha}}{wL^{\alpha}}$$

is set equal λ : $\frac{(1-\alpha)pK^{\alpha}L^{-\alpha}}{w} = \frac{(1-\alpha)pK^{\alpha}}{wL^{\alpha}}$

Equation 10: Solution for the labor offer L.

$$L = \frac{(1-\alpha)pK^{\alpha}}{(1-\alpha)pK^{\alpha}} = 1 \qquad (10)$$

This value is substituted into the budget constraint, and K is solved to calculate the desired capital value for the microentrepreneur, as shown in Equation 11, leading to Equation 12, where the relationship between fixed capital, interest rate, and salary is displayed.

Equation 11: Desired Capital Value.

$$b = w - (1 + r)\beta K \qquad (11)$$

Equation 12: Relationship Between Fixed Capital, Interest Rate, and Salary.

$$(1 + r)\beta K = w - b \qquad (12)$$

Finally, the use of the desired fixed capital by the entrepreneur is determined, allowing them to maximize profit (Equation 13).

Equation 13: Fixed Capital Factor.

$$K = \frac{w-b}{(1+r)\beta} \qquad (13)$$

Table 7 presents the general data that allows for a simulation of fixed capital indebtedness to carry out an investment project for a microentrepreneur, where the following variables are related: the price of productive factors such as labor payment (w) in a project to expand production, financed at an interest rate (r) of 10%, which represents the cost of fixed capital, and a level of indebtedness of 70%.

Table 7

Simulation of fixed capital indebtedness variables

w	**Labor payment**	$ 2,000,000
b	Production expansion plan b	$ 600,000
r	Cost of fixed capital	10%
B	Indebtedness percentage	70%
k	Desired value of fixed capital	$890,909

Source: Prepared by the authors.

The desired value of fixed capital K (Equation 13) is the amount that the microentrepreneur could finance with a low-interest rate; for example, given an indebtedness percentage of 70%, a reduction in the interest rate encourages the acquisition of fixed capital for microentrepreneurs. In the proposed example, it was 10%, which is a favorable interest rate for these productive units. Furthermore, it can be observed that increasing the percentage of indebtedness at favorable rates stimulates the acquisition of this fixed capital, as it increases its absolute value (Table 7).

On the other hand, as the difference between wage payments and own resources increases, the possibility of acquiring more units of fixed capital also increases (Table 8).

Table 8

Simulation of the percentage of indebtedness for the acquisition of fixed capital

		Indebtedness percentage					
	$890,909	40%	50%	60%	70%	80%	90%
Cost of	8%	$518,519	648,148	$777,778	$907,407	$1,037,037	$1,166,667
Fixed	10%	$509,091	636,364	$763,636	$890,909	$1,018,182	$1,145,455
Capital	12%	$500,000	$625,000	$750,000	$875,000	$1,000,000	$1,125,000
	14%	$491,228	$614,035	$736,842	$859,649	$982,456	$1,105,263
	16%	$482,759	$603,448	$724,138	$844,828	$965,517	$1,086,207
	18%	$474,576	$593,220	$711,864	$830,508	$949,153	$1,067,797
	20%	$466,667	$583,333	$700,000	$816,667	$933,333	$1,050,000

Source: Prepared by the authors.

As shown in Table 8, with a 70% indebtedness and a 10% interest rate, the desired fixed capital is $890,909, which increases to $1,018,182 if an 80% indebtedness is desired. However, with a decrease in the interest rate from 10% to 8%, this capital increases to $907,407.

Conclusions

Financial inclusion and the inclusion of information and communication technologies (ICT) are fundamental processes that ensure the growth of microenterprises. However, nearly half of them operate informally and lack sufficient resources to access these tools that promote the growth of their businesses. According to DANE, by 2021, only one in four companies had a RUT, and only 10% made social security payments for their employees.

One of the main reasons for the lack of banking is that some producers do not turn to formal credit options for their investments, as they do not consider it a necessary tool to improve their productive activity. Instead, they prefer to use their own resources or alternative forms of financing, which further accentuates informality and financial exclusion.

Since access to financing is considered an important aspect in the growth and formalization of a company, rediscounting entities such as Bancóldex encourage lines of credit under somewhat favorable conditions for these producers, providing working capital and modernization resources to economic sectors participating in business formalization programs, in collaboration with chambers of commerce and business associations in the country.

Furthermore, it is essential to develop new financial products tailored to the needs of productive units, which promote banking and the adoption of innovative technologies. One mechanism to assist microenterprises is to obtain capital and liquidity immediately to sustain these activities. Therefore, the Fintech model of financial technology can be an effective tool to generate new opportunities for financial technology at a lower cost for the development of these ventures, offering services like crowdfunding and crowdlending to facilitate resource acquisition and financing at lower costs, using electronic media platforms to match donor supply with resource demand (Banco Interamericano de Desarrollo, 2022).

Financial inclusion and the use of ICT are key factors in improving the formalization and productivity of micro and small enterprises (MSMEs) in Bogotá. It is necessary to implement

financial education plans and adapt technological infrastructure to the needs of these productive units. Such financial education plays a crucial role in strengthening entrepreneurs, allowing them to better understand the available financial products and services and make more informed decisions for the sustainability of their businesses.

It is essential to implement public policies and programs that promote banking and the use of ICT in microenterprises, especially among the most vulnerable and smaller ones, while also encouraging financial and technological education. The government and other institutions are committed to implementing policies and programs to foster access to financing, financial education, and the use of ICT, which have been promoted since 1999 through laws 527 and 1341 of 2009, known as the ICT Law (Rovira et al., 2013).

The adoption of ICT is seen as a fundamental mechanism that enables increased productivity and a way to reduce business informality. Therefore, it is necessary to promote the acquisition of these technologies through credits with more flexible conditions so that they are sustainable (Monsberger and del Rosal, 2021).

Ethical Considerations

This research did not require ethical approval since it was based on official documents and literature reviews.

Conflict of Interest

All authors made significant contributions to the document and declare that there are no conflicts of interest related to the article.

Author Contribution Statement

Gustavo Adolfo Diaz Valencia: Conceptualization, Methodology, Formal Analysis, Writing, Project Administration.

Álvaro Villa Martínez: Data Curation, Writing, Review and Editing, Visualization, Validation.

Funding Source

This article is part of the project titled "Inclusión Financiera y TIC en las MiPymes en Colombia Caso Micronegocios Periodo 2019-2021 [Financial Inclusion and ICT in MSMEs in Colombia: The Case of Microenterprises (2019-2021)]" from the Universidad Piloto de Colombia.

References

(1) Asociación Colombiana de las Micro Pequeñas y Medianas Empresas [ACOPI]. (2023). *Encuesta de desempeño empresarial.* Departamento de Estudios Económicos.

(2) Asociación Nacional de Instituciones Financieras [ANIF]. (2013). *La Gran Encuesta Pyme.* Centro de Estudios Económicos.

(3) Banca de las oportunidades y la Superintendencia Financiera de Colombia. (2018). *Estudio de Demanda de Inclusión Financiera.* Banca de las Oportunidades.

(4) Banco Interamericano de Desarrollo. (2022). *Fintech en América Latina y el Caribe. Un Ecosistema consolidado para la recuperación*. Sarah Schineller (A&S Information Partners, LLC). https:// creativecommons.org/licenses/by-nc-nd/3.0/igo/legalcode

(5) Cabrero, J. (2006). *Nuevas Tecnologías aplicadas a la educación.* Mc Graw Hill. https://uogestiondelaprendizaje.files.wordpress.com/2015/03/5-libro-nuevas-tecnologc3adas-aplicadas-a-la-educacic3b3n-julio-cabero.pdf

(6) Cámara Colombiana de Comercio Electrónico. (2023). *Los Micronegocios en Colombia 2021: énfasis en el comercio electrónico y la economía popular*. https://www.ccce.org.co/noticias/los-micronegocios-en-colombia-2021-enfasis-en-el-comercio-electronico-y-la-economia-popular/

(7) Castro, F., Londoño, D., Parga, A. y Peña, C. (2020). *¿Qué factores inciden en la demanda de crédito de la microempresa en Colombia?* Departamento Nacional de Planeación. https://imgcdn.larepublica.co/cms/2020/11/25163040/Que-factores-inciden-en-la-demanda-de-credito-de-la-microempresa-en-Colombia-2.pdf

(8) Consejo Privado de Competitividad. (2022). *Informe Nacional de Competitividad 2022-2023.*

(9) DANE. (2021). *Colombia Encuesta de Micronegocios.* Dirección de metodología y producción estadística.

(10) DANE-EMICRON. (2021). *Encuesta de Micronegocios.*

(11) DANE-EMICRON. (2022). *Encuesta de Micronegocios.*

(12) DANE-EMICRON. (2023). *Encuesta de Micronegocios Emicron -primer trimestre 2023.*

(13) Davis, F. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly, 13*(3), 319-340. https://www.jstor.org/stable/249008

(14) Departamento Nacional de Planeación. (2006). *La Banca de las Oportunidades una Política para promover el acceso al crédito y a los demás servicios financieros buscando equidad social.https://www.bancadelasoportunidades.gov.co/sites/default/files/2017-03/conpes_3424_banca_oportunidades.pdf*

(15) Departamento Nacional de Planeación. (2020). *Política Nacional de Inclusión y Educación Económica y Financiera.*

(16) Dini, M., Nicolo, G. y Patiño, A. (2022). *Transformación digital de las mipymes, Elementos para el diseño de políticas.* CEPAL.

(17) Durán, P. J. y Rios, O. J. (2022). *Uso de TIC y sus determinantes en las microempresas de Colombia.* Universidad Santiago de Cali.

(18) Gómez, H. J., Vera, A. y Montoya, G. (2022). *Lecturas sobre Banca y Moneda en Colombia 2022.* ASOBANCARIA.

(19) Gujarati, D. y Porter, D. (2010). *Econometría* (5.ª ed.). Mc Graw Hill.

(20) Jaffee, D. & Modigliani, F. (1969). A Theory and Test of Credit Rationing. *The American Economic Review*, *59*(5), 850-872. https://www.jstor.org/stable/1810681

(21) Mankiw, G. (2017). *Macroeconomía* (M. Esther, Trad.; 8.ª ed.). Antoni Bosch. (Primera publicación en 2013).

(22) Monsberger, R. y del Rosal, V. (2021). *El futuro de la Inclusión financiera: Tecnologías y Estrategias Fintech para Microfinanzas inclusivas y sustentables*. Sparkassenstiftung alemana.

(23) Nicholson, W. (2008). *Teoría Microeconómica, principios básicos y ampliaciones* (8.ª ed.).Cengage Learning.

(24) Pfeffer, J. (1982). Organizations and Organization theory. *Administrative Science Quarterly, 29*(4), 640-643.

(25) Rovira, S., Stumpo, G. y Europea, U. (2013). *Entre mitos y realidades TIC políticas públicas y desarrollo productivo en América Latina.* CEPAL.

(26) Santa, M. y Rozo, S. (2009). Análisis cualitativo y cuantitativo de la informalidad empresarial en Colombia. *Desarrollo y Sociedad,* (63), 269-296. https://www.redalyc.org/articulo.oa?id=169113809008

(27) Stiglitz, J. E. & Weiss, A. (1981). Credit Rationing in Markets with Imperfect Information. *The American Economic Review, 71*(3), 393-410. https://www.jstor.org/stable/1802787

(28) Vera, A. y Tamayo, C. E. (2022). *Ensayos de inclusión financiera en Colombia*. ASOBANCARIA.

(29) Ydrobo, E. C. (2010). *Informalidad empresarial en Colombia: un obstáculo a la destrucción creativa* [Trabajo de Grado, Universidad de los Andes]. http://hdl.handle.net/1992/11182

(30) Zuleta, L. A. (2016). *Inclusión financiera de la pequeña y mediana empresa en Colombia*. CEPAL.http://hdl.handle.net/11362/40771

How to cite this article: Díaz, G. y Villa, Á. (2024). Inclusión financiera y tecnologías de la información y comunicación en las MiPymes en Colombia. Caso micronegocios período 2019-2021. *Tendencias, 25*(1), 139-165. https://doi.org/10.22267/rtend.242501.244