Determinants of the level of financial inclusion in Mexico: an analysis using neural networks

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Abstract

This article analyzes the socio-economic and demographic determinants of financial inclusion in Mexico. Using microdata from the 2021 National Survey of Financial Inclusion (ENIF, for its acronym in Spanish), a financial inclusion index is created that includes the following products: credit card, savings account, investment fund, mortgage loan, insurance and pension fund. The main socio-economic and demographic determinants of the level of inclusion by income levels were estimated using artificial neural networks. The evidence indicates that the level of financial inclusion is based on level of income, level of education and occupation.

Keywords: financial inclusion; inclusion factors; artificial neural networks.

1. INTRODUCTION

Financial inclusion refers to access to basic financial services, such as bank accounts, credit, insurance and electronic payments, by individuals and businesses in a society. Financial inclusion is considered a key component in achieving at least seven of the 17 Sustainable Development Goals (SDGs).[1] Financial inclusion is therefore a key element of sustainable economic development as it facilitates the reduction of extreme poverty and the promotion of general well-being (World Bank [WB], 2022).

The G20 member governments agreed to take a series of actions to promote financial inclusion by implementing the group's high-level principles for digital financial inclusion. These actions are based on the idea that people should have a savings account, as this allows them to save money, make transfers and payments, and access other products, since financial institutions have information on income or savings (Ilham *et al.*, 2019; Demirgüç-Kunt *et al.*, 2020).

Financial services, such as credit, provide access to resources for productive activities, such as investment. Greater investment increases employment and income in the medium term. As the availability of resources increases so does productive investment. This improves business performance in the short and long term, promoting the achievement of objectives and alleviating the impact of contingencies (Shofawati, 2019; Oshora *et al.*, 2021). It also allows for the financing of asset acquisition and expands the horizon for consumption and investment.

Although progress has been made globally, the Findex survey (WB, 2022) reveals that there is still much to be done, given that in 2017, one-third of adults had no access to banking services. It should be noted that half of adults without access to banking services are women living in rural areas and in poverty, or who are unemployed.

Financial inclusion is also a tool that enables women to achieve economic and financial independence by providing them with the means to accumulate assets, generate income, manage financial risks, and participate more effectively in the economy (Bhatia and Singh, 2019; Duvendack and Mader, 2020; ILO, 2020). In addition to the above, financial inclusion facilitates women's access to microcredit and other financing services, enabling them to start or expand their businesses (WB, 2024).

Furthermore, financial inclusion can also stimulate entrepreneurship and innovation. Individuals and small businesses that have access to financial services can access capital to start or expand their ventures (Demirguc-Kunt and Klapper, 2013). In this way, increased entrepreneurship and innovation could promote job creation, higher incomes and technological development, leading to greater economic development (Coleman, 2010).

From a macroeconomic point of view, financial inclusion could contribute to the stability and development of the financial system. Expanding access to formal financial services promotes the inclusion of the population in the regulated financial system and reduces dependence on informal and risky services (Allen *et al.*, 2014). Greater formality in financial services could promote better channeling of savings into productive investments, facilitate greater financial regulation and supervision, as well as adequate tax collection, increasing the resources available to the State for the provision of basic services.

This is facilitated by regulation. More efficient regulation stimulates the supply of financial instruments tailored to the needs of the population and the process of financial democratization.

In contrast, we cannot ignore the well-founded criticism of the processes generated by the deepening of financial inclusion, one of which is financialization. Authors such as Correa and Girón (2019) and Gronbach (2023) point out that, in countries such as Mexico and South Africa, financial inclusion has promoted financial dynamics that have deepened financialization. This is facilitated by biased regulations that promote excessive behavior by financial institutions, such as high fees, excessive interest rates and their role as judge and jury in resolving conflicts between customers and financial institutions (Lavinas *et al.*, 2023).

In order to analyze the differentiated impact of greater financial inclusion in different strata of society, it is extremely important to understand the sociodemographic and economic determinants of access to financial services since, based on this information, both banking institutions and governments can design specific products aimed at certain sectors of the population and include them in the financial system, thus facilitating their access to other products, promoting savings and, through credit, generating access to certain products and services, extending their long-term consumption and investment possibilities, and alleviating short-term shocks that may arise from unforeseen events.

Thus, the objective of this research is to analyze the determinants of the level of financial inclusion in Mexico, differentiating social strata according to their income level. Microdata from the 2021 National Financial Inclusion Survey (ENIF) was analyzed. A financial inclusion index was constructed as the dependent variable, which considers the number of financial products to which agents have access and socioeconomic variables from the ENIF, such as sex, age, education, marital status, occupation and income level, were used as explanatory variables.

The hypothesis to be tested is that certain sociodemographic and economic determinants influence access to financial services which vary depending on income level. Thus, the research question is: What are the sociodemographic determinants of the level of financial inclusion in Mexico?

The methodology used is that of artificial neural networks in the form of multi-layer perceptron with analysis of the importance of the variable. The originality of the research lies in the estimation of a weighted index of financial inclusion and segmentation by income level, which makes it possible to draw differentiated conclusions regarding the determinants of financial inclusion at different income levels.

The research for the presentation was structured as follows: the second section reviews the most recent works that apply quantitative methodologies to identify the factors that influence the development of financial inclusion. The third section describes preliminarily analyzed data. The fourth section develops the methodology. The fifth section analyzes the results and finally, the last section presents the conclusions of the research.

2. FINANCIAL INCLUSION FACTORS

Expanding on the presence of factors that affect financial inclusion, it is worth noting that, besides descriptive and qualitative references from previous decades, a recent line of research adopts quantitative methods to identify its variables and determining factors, among which the works of Park and Mercado Jr. (2018), Roa and Carvallo (2018), Céspedes T. *et al.* (2018) and Demir *et al.* (2022) stand out.

Park and Mercado Jr. (2018) analyze the factors that influence financial inclusion and their impact on poverty and inequality using an index and regression analysis across 176 countries. These authors find that per capita income, Rule of Lawfff and demographic factors significantly affect financial inclusion globally and in Asia.

For their part, Roa and Carvallo (2018) identify factors that limit financial inclusion in Latin America and the Caribbean. On the demand side, they highlight low income, distrust, lack of financial education and cultural and social influences. On the supply side, they point to high transaction costs and information asymmetries.

In turn, Céspedes *et al.* (2018) analyze how financial inclusion affects poverty in Bolivia. Using panel data models, they conclude that lower inequality, economic growth and financial deepening have reduced poverty, thanks to inclusive and redistributive financial policies.

Meanwhile, Demir *et al.* (2022) analyze how financial inclusion driven by FinTech affects income inequality in 140 countries, using WB (2017)-Global Findex survey data (2011, 2014, and 2017) and quantile regression. They conclude that financial inclusion reduces inequality, especially in high-income countries.

Recently, Balliester Reis (2022), Zhang *et al.* (2023), Pacheco-Ortiz (2023), González Sierra *et al.* (2023) and Quispe Mamani *et al.* (2024) have published studies on the factors affecting financial inclusion, which will be analyzed in detail below.

Balliester Reis (2022) constructs an alternative index of inclusion using the World Bank's Findex (set of 451,372 microdata). The empirical evidence did not reveal the presence of a gender gap between low- and middle-income countries. Similarly, the evidence suggests that financial inclusion is more closely related to income and employment status than to gender disparity.

Considering that financial inclusion is affected by information technologies, Zhang *et al.* (2023) applied an exploratory spatial data analysis and a geographic detector to elucidate the spatiotemporal characteristics and factors influencing digital financial inclusion at the county level in China (data does not include Hong Kong, Macau, and Taiwan of China) from 2014 to 2020. The results indicate that at the county level in China, digital financial inclusion generally increases and displays high spatial autocorrelation.

Meanwhile, Pacheco-Ortiz (2023) studies how socioeconomic and bankarization variables influence savings, using Global Findex data, binary logistic regression and neural networks. The results show that financial inclusion is related to savings, while education and income favor them and credit limits them.

Meanwhile, González Sierra *et al.* (2023) investigate the relationship between financial inclusion and economic complexity in Mexico. They develop the economic complexity index and the financial inclusion index (access and usage) for 2018. They conduct a descriptive correlational and exploratory descriptive analysis of spatial data. The evidence reveals that financial inclusion has a direct, strong and significant correlation. This in turn indicates that the poles of high complexity are in turn of financial inclusion.

Finally, Quispe Mamani *et al.* (2024) apply a non-experimental quantitative approach with a descriptive and correlational design that includes binomial logistic regression. Using data from the Peruvian National Household Survey, the results revealed that the determinants of financial inclusion are related to area of residence, level of education, age, financial income, gender, marital status, social status and legalized ownership.

In summary, recent studies identify several factors that affect financial inclusion, its magnitude and direction, such as socioeconomic level, the year and the instrument used. What all the studies agree on is the importance of analyzing and identifying these determinants for the design of financial strategies and economic and monetary policies to increase the levels of financial inclusion and its impact on the population's wellbeing.

3. DATA

Financial Inclusion Survey

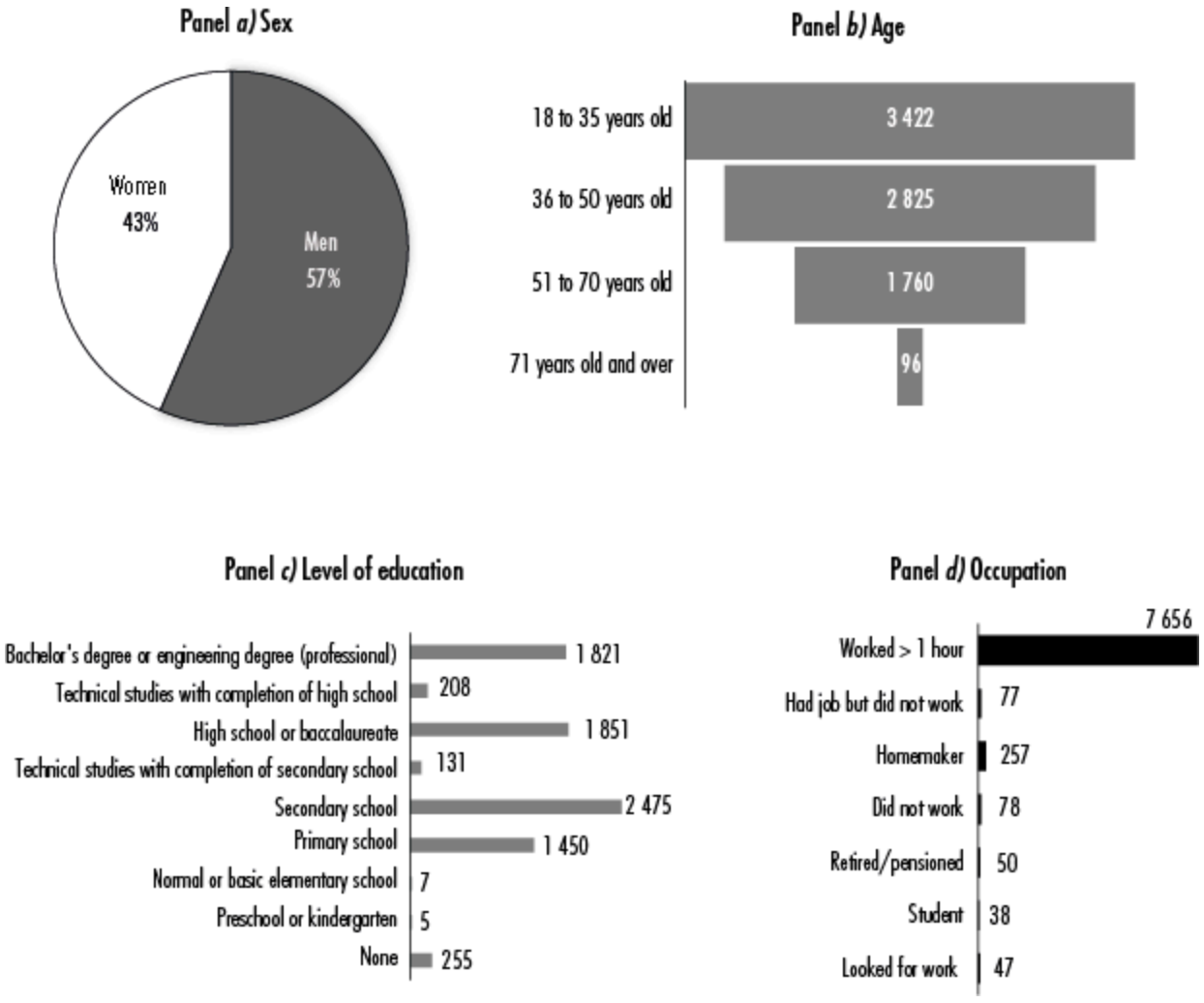
Based on the National Institute of Statistics and Geography (INEGI) (2021), the 2021 ENIF is the source of national measurement of financial inclusion. The ENIF provides statistical data and analysis that help authorities, financial institutions and other participants to design policies and strategies to promote financial inclusion and reduce existing gaps.

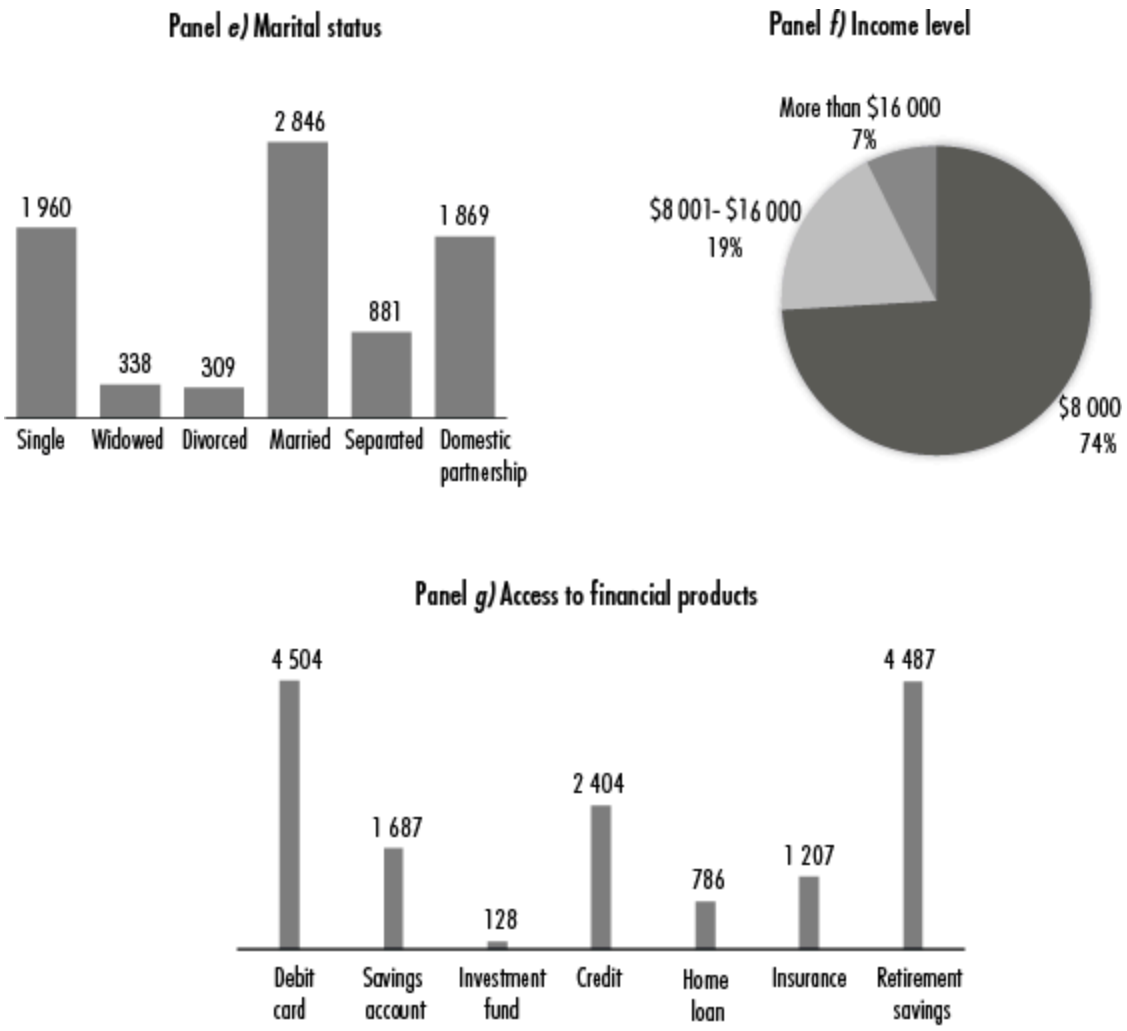
The survey was conducted from June 28 to August 13, 2021. The effective sample size was 13,352 households and 13,554 people over the age of 18. For this research, the base was limited to include only those persons who reported their income level, leaving a total sample of 8,203 records.

Size and characteristics of the sample used

Of the 8,203 records, Figure 1 shows the following information: panel a) 43% are women and 57% men. The population trend in Mexico represents an inverted pyramid due to the demographic bonus: 42% of the sample is between 18 and 35 years old, 34% between 36 and 50 years old, 21% between 51 and 70 years old and 2% 71 years old and older.

Figure 1. Preliminary analysis of the sample





Source: prepared by the authors with data from ENIF (2021).

Panel c) shows that the majority of the people in the sample have secondary school as their highest level of education (30%), the second group is those who have a high school diploma or baccalaureate (23%), followed by those who have a bachelor's degree or engineering degree (22%). It is worth noting that a large number of people have only a primary school education (18%), which implies that their level of mathematics may be insufficient to understand concepts related to financial products, constituting a barrier to accessing the financial system.

Regarding occupation, panel *d)* shows that 93% of the respondents worked at least one hour during the month prior to the survey, 3% were homemakers and some minorities studied were pensioners or did not work. Panel *e)* shows that the predominant marital status is married, followed by single and non-married couples. Panel *f)* shows that 74% of the population earns between MXN$0 and 8,000 per month, 19% earn between MXN$8,001 and 16,000 and only 7% have an income greater than MXN$16,000.

Finally, panel *g)* of Figure 1 shows that the debit card (DC) is the product to which the individuals in the sample have most access, followed by retirement savings, credit, savings account, some type of insurance, housing credit and, finally, an investment fund (it should be noted that in the figure the total number of records is added together because some of them may have more than one product).

Construction of the financial inclusion index [2]

Given that the objective of this research was to find the factors that determine financial inclusion in Mexico, a Financial Inclusion Index (IIF for its acronym in Spanish) was estimated, which is a simple measure of the number of banking and financial instruments to which a person has access. This was carried out in order to make the information captured in the ENIF operational.

The IFF is calculated as follows, with the variables being binary:

$$IIF = \sum(X_1 + X_2 + \cdots + X_3 + X_4 + X_5 + X_6 + X_7)/X_n \qquad (1)$$

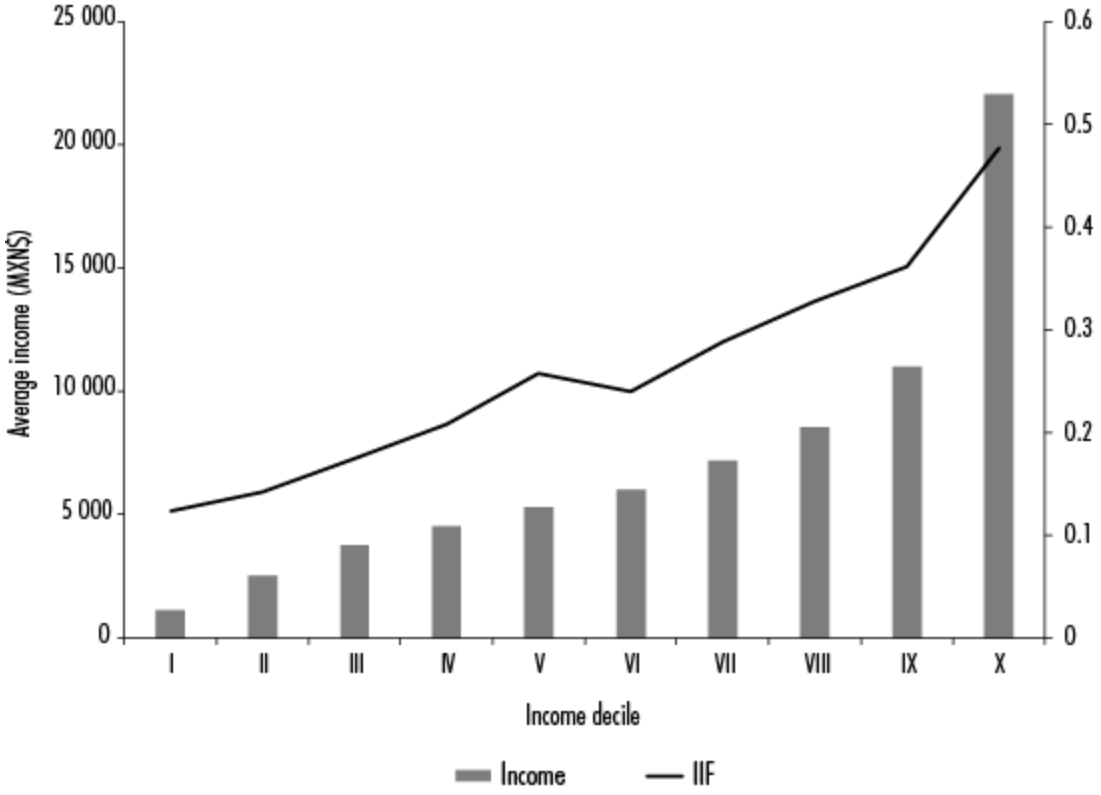
Where:

IIF = Financial Inclusion Index
X_1 = If they have a debit card
X_2 = If they have a savings account
X_3 = If they have an investment fund
X_4 = If they have a credit card
X_5 = If they have a home loan
X_6 = If they have any insurance policies
X_7 = If they have a savings account for retirement

Thus, we have an index that takes values between 0 and 1 and constitutes a proxy variable for financial inclusion, allowing us to analyze some socio-economic and demographic variables in relation to the level of financial inclusion; an index close to 1 indicates a higher level of inclusion, while an index close to 0 indicates a lower level of inclusion.

Once the index has been created, a significant relationship is observed between income level and level of financial inclusion. This is particularly apparent when the ENIF sample is divided by income level. Figure 2 shows all the observations in the sample, grouped by deciles. Decile I corresponds to the 10% of observations with the lowest average income, while decile X shows the 10% of ENIF respondents with the highest income. A pattern is observed that relates income level to the value of the estimated IIF. The higher the income level, the higher the IIF tends to be. In principle, this could be an indicator of a relationship in which, as the income level increases, some socioeconomic and demographic factors such as, for example, level of education, age, or marital status, begin to affect the financial decisions of the agents, in the same way that the level of risk perceived by the financial institutions decreases, due to an increased ability to pay.

Figure 2. Income Level and Financial Inclusion Rate



Source: prepared by the authors with data from ENIF, INEGI (2021).

Based on the graphic evidence, in which a positive relationship between income level and inclusion is observed, and by taking into consideration the experience of other authors such as Li (2018) and Demir *et al.* (2022), the income level of the agents is differentiated and divided into three panels: the first, which for the purposes of this paper will hereinafter be referred to as "Income level 1" and which ranges from MXN$0 to 8,000 monthly income; the second, "Income level 2", which ranges from MXN$8,001 to 16,000; and the third, "Income level 3", which groups together agents with incomes greater than MXN$16,000.

The group of ENIF respondents whose income is less than MXN$8,000 is the largest in terms of the number of survey observations, as shown in Figure 1 panel f), accumulating 74% of the data (6,076 observations), with an average income of MXN$4,632 per month.

The group with incomes ranging from MXN$8,001 to 16,000 represents 18.57% of the sample (1,524 observations) and has an average monthly income of MXN$11,572. Finally, the group with incomes above MXN$16,000 per month represents 7.35% of the total number of ENIF respondents, with an average monthly income of MXN$26,705.

Subsequently, three artificial neural network models were run, one for each income panel. The objective is to analyze whether the results in terms of the importance of the variable differ significantly between each panel when determining the level of financial inclusion.

The estimated model for each panel allows us to link socioeconomic and demographic variables contained in the ENIF, as follows:

$$IIF = f(Sex, Age, Level\ of\ Education,\ Marital\ Status, Occupation,\ Income) \quad (2)$$

Where:

Sex = Whether the respondent is male or female

Age = Age in years of the respondent

Level of education = Level of studies of the respondent, ranging from *1)* None; *2)* Preschool or kindergarten; *3)* Primary school; *4)* Secondary school; *5)* Technical studies with completed secondary school; *6)* Normal basic education; *7)* High school; *8)* Technical studies with completed high school; *9)* Bachelor's degree or engineering degree (professional), *10)* Master's degree or PhD.

Marital_status = Whether the respondent: *1)* Lives with a partner in a common-law relationship; *2)* Is separated; *3)* Is divorced; *4)* Is a widow; *5)* Is married; *6)* Is single. *Occupation*[3] = the occupation performed by the respondent, which is coded as follows: *1)* Worked for at least one hour; *2)* Had a job, but did not work; *3)* Was looking for work; *4)* Student; *5)* Doing housework or caring for children; *6)* Retired or pensioned; *7)* Is permanently unable to work; *8)* Did not work.

Income = monthly income in pesos of the respondent.

4. METHODOLOGY

Multi-layer perceptron

Multilayer perceptron neural networks are a type of artificial neural network (RNA in Spanish) consisting of multiple layers of processing units called neurons, organized in a layered architecture (Ruelas *et al.*, 2020). These networks are capable of learning and performing classification and regression tasks.

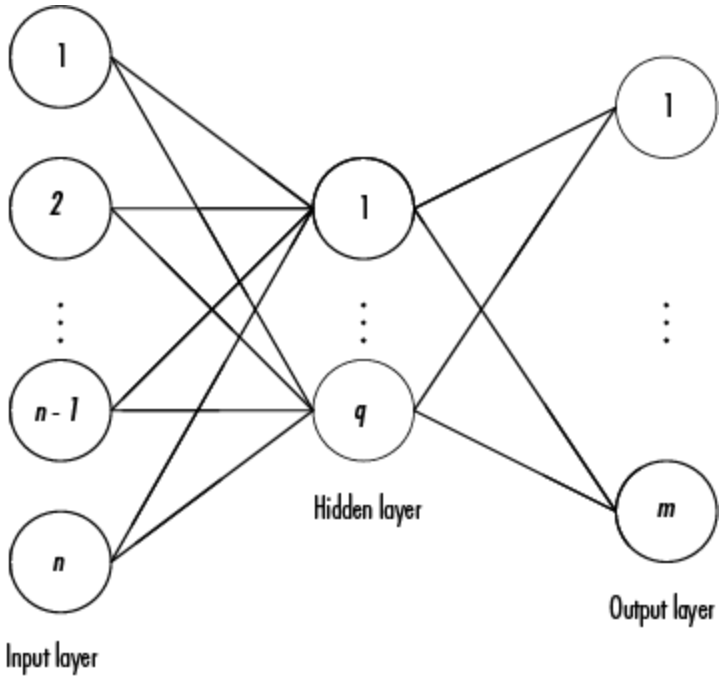
As can be seen in Figure 1, the basic structure of a multi-layer perceptron consists of three types of layers.

Input layer: This is the initial layer of the network composed of input units that represent the characteristics or variables of the problem being addressed. In this case, the input variables or *inputs* are the economic and sociodemographic data of each individual interviewed: sex, age, level of education, marital status, income and occupation. Each input unit is connected with all the units of the next layer.

Hidden layers: these layers are located between the input layer and the output layer. Each unit in a hidden layer receives inputs from all units in the previous layer and sends outputs to all units in the next layer. The number of hidden layers and the number of neurons in each layer can vary depending on the problem and the network architecture.

Output layer: This is the final layer of the network and produces the estimate. Each unit in the output layer is connected to all units in the last hidden layer. The number of output units will depend on the type of problem being solved. What is expected to be obtained in the output layer is the prediction of the level of financial inclusion, based on the input variables and the learning process developed in the hidden layers.

Diagram 1. Multilayer perceptron neural network structure



Source: Vivas et al. (2018).

The operation of a multilayer perceptron is based on the forward propagation process and the backpropagation process of the error. In forward propagation, inputs propagate through the network from the input layer to the output layer, generating a predicted output. Then, during backpropagation of the error, the difference between the predicted output and the observed variable is calculated, and this error is propagated backward through the network to adjust the connection weights and minimize the error (Bishop, 2006).

5. RESULTS

The presented neural network is the one with the best results in terms of error minimization. Previously, several networks were run with different specific characteristics, e.g., different types of training of the neuron (online, batch, mini-batch), with different optimization algorithms (gradient descent, conjugated gradient scaling), as well as different activation functions of the hidden layers (hyperbolic tangent and sigmoid) and output (identity, softmax, hyperbolic tangent and sigmoid).

The results of the network estimation are shown below:

Table 1 summarizes the processing of three neural networks. All used scaled conjugated gradient as a stopping rule, with initial values of lambda and sigma of 0.0000005 and 0.00005, respectively. In the group with income less than MXN$8,000, more than 70% of the observations were allocated to training, a percentage similar to that of groups 2 and 3 (70.7% and 68.9%). In all three networks, the error validation process was performed with approximately 10% of the observations.

Table 1. Comparison of case processing of estimated RNAs

Case processing summary							
		Income less than MXN$8,000 (Level 1)		*Income between MXN$8,001 and MXN$16,000 (Level 2)*		*Income greater than MXN$16,000 (Level 3)*	
		N	*Percentage*	*N*	*Percentage*	*N*	*Percentage*
Sample	Training	4 261	70.4	1 062	70.7	405	68.9
	Tests	1 202	19.9	299	19.9	121	20.6
	Validation	592	9.8	141	9.4	62	10.5
Valid		6 055	100.0	1 502	100.0	588	100.0
Excluded		21		22		15	
Total		6 076		1 524		603	

Source: prepared by the authors with data from ENIF (2021).

Table 2. Layer information for estimated networks

Network information		*Income less than MXN$8,000 (Income level 1)*	*Income between MXN$8,001 and 16,000 (Income level 2)*	*Income over MXN$16,000 (Income level 3)*
Input layer	Factors	Sex	Sex	Sex
		Age	Age	Age
		Level of education	Level of education	Level of education
		Marital status	Marital status	Marital status
		Occupation	Occupation	Occupation
		Income	Income	Income
	Number of units[a]	220	121	110
Hidden layer	Number of hidden layers	1	1	1
	Number of units in the hidden layer 1a	17	7	3
	Activation function	Hyperbolic tangent	Sigmoid	Hyperbolic tangent
Output layer	Dependent variables	Standardized inclusion index	Standardized inclusion index	Standardized inclusion index
	Number of units	1	1	1
	Rescaling Method for Scale Dependents	Standardized	Normalized	Standardized
	Activation function	Identity	Identity	Identity
	Error function	Sum of Squares	Sum of Squares	Sum of Squares

Note: [a] bias unit is excluded.

Source: prepared by the authors with data from ENIF (2021).

The three networks included the same factors in the input layer (see equation 2). In the hidden layer, different activation functions were used according to error minimization: hyperbolic tangent for input levels 1 and 3, and sigmoid function for level 2.

In terms of error minimization and calculation of the errors in the training, testing and reserve segments, Table 3 shows the estimated errors for each income level group.

Table 3. Summary of errors

Criterion		*Income less than MXN$8,000 (Level 1)*	*Income between MXN$8,001 and 16,000 (Level 2)*	*Income greater than MXN$16,000 (Level 3)*
Training	Sum of squared errors	1734.335	451.961	189.667
	Relative error	.814	.852	.939
	Stopping rule used	1 consecutive step without decreasing error [a]	1 consecutive step without decreasing error [a]	1 consecutive step without decreasing error [a]
	Training time	0:00:07.12	0:00:01.62	0:00:00.39
	Sum of squared errors	514.515	134.547	61.392
	Relative error	.814	.901	.892
Tests	Relative error	.841	.883	1.045
Reserve	Relative error	.841	.883	1.045

Notes: dependent variable: Standardized Inclusion Index; [a] computed errors are based on the test sample.

Source: prepared by the authors with data from ENIF (2021).

One of the most relevant elements of analysis of the research is to be able to describe whether the variables of the input layer have a different order of impact depending on the income level of the interviewed ENIF agents. This can be observed through the analysis of variable importance, a technique within artificial neural networks that is based on the importance of synaptic weight values. Its objective is to obtain information on the impact or influence that the input variables have on the output variables of the neural network. Thus, the following function is used to measure the synaptic weights of the variables and their effect on the output variable:

$$Q_{ik} = \frac{\sum_{j=1}^{L}\left(\frac{w_{ij}v_{jk}}{\sum_{r=1}^{N} w_{rj}}\right)}{\sum_{i=1}^{N}\left(\sum_{i=1}^{L}\left(\frac{w_{ij}v_{jk}}{\sum_{r=1}^{N} w_{rj}}\right)\right)} \quad (3)$$

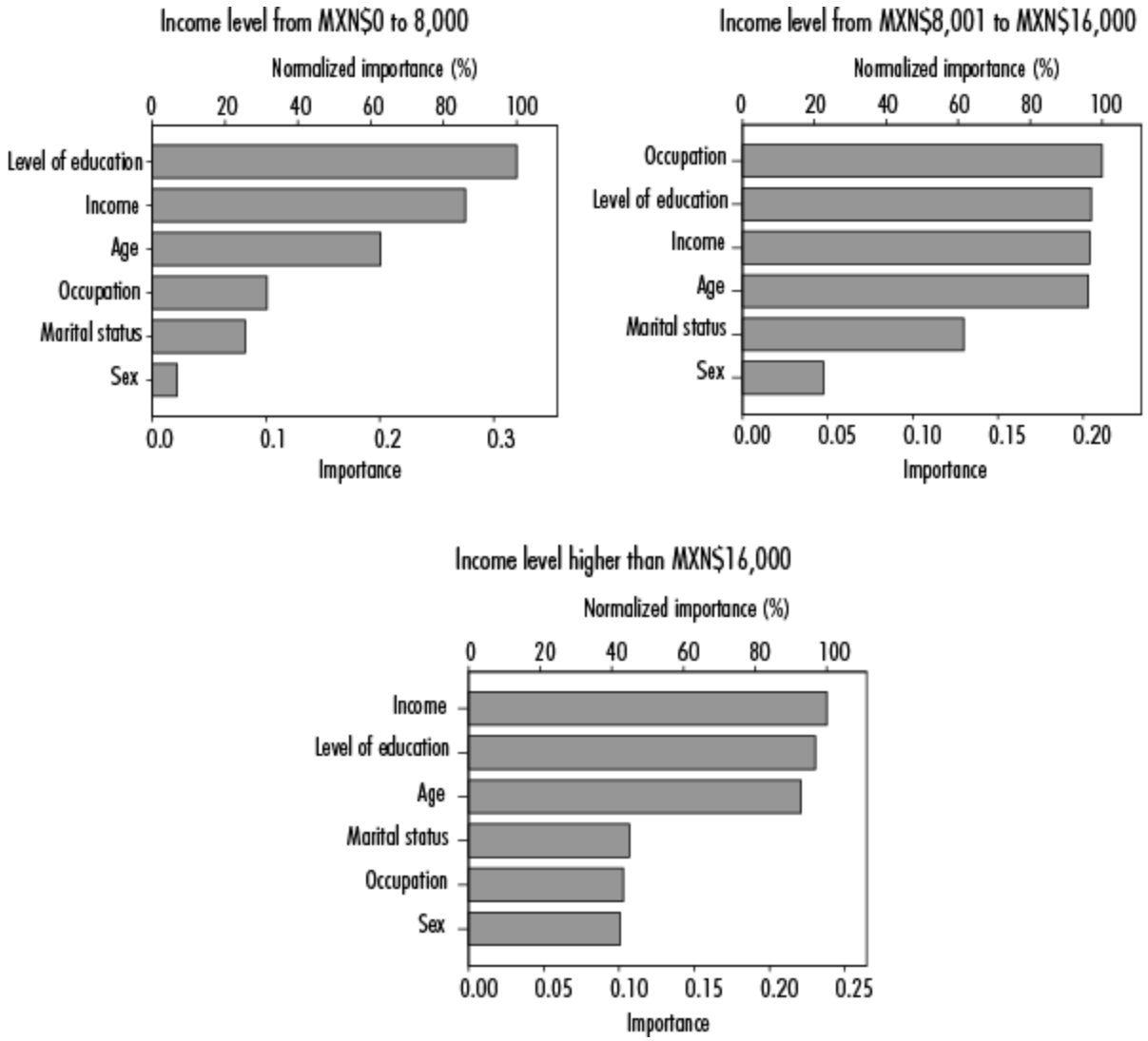
Where:

Q = normalized importance of the independent variables
W = synaptic weights
V = independent variable

Thus, the analysis of the importance of the variable yields the following results for each of the three income groups.

Figure 3 shows the importance of the factors that determine the level of financial inclusion divided by income level.

Figure 3. Results of the analysis of the importance of the variable



Source: prepared by the authors with data from the ENIF (2021) and model results.

The variables considered as elements of financial inclusion by the ENIF include a set of banking and financial instruments that, although with different characteristics, are related to income level. For example, no minimum income is required for a person to have a debit card, but a minimum income is required to access a mortgage loan; therefore, the universe of individuals who can potentially access these banking instruments is reduced as income requirements increase.

Some others are related to the type of employment and its level of formality and informality. For example, someone dedicated exclusively to household activities and childcare has a different probability of having retirement savings than someone who works in the formal sector and who, by law, must have savings in a retirement fund management institution.

Table 4 shows how, for each and every one of the instruments considered in the ENIF as elements of financial inclusion, the percentage of people who have these instruments increases as the level of income increases.

Table 4. Percentage of use of banking instruments by income level

Percentage of people by income group that have banking instruments								
Level of income	*Debit %*	*Savings account %*	*Investment fund %*	*Credit %*	*Housing loans %*	*Insurance %*	*Retirement savings %*	*N total*
1	46	16	1	24	7	8	48	6 076
2	76	28	2	41	16	28	75	1 524
3	87	45	10	56	21	53	73	603
Total	55	21	2	29	10	15	55	8 203

Source: prepared by the authors with data from ENIF (2021).

The explanation for this is related to several factors, including the following:

1) Income level: As it increases, basic needs can be covered and progress can be made towards more complex needs. Although all banking instruments can contribute to meeting primary needs, such as housing (mortgage loans) or future income (investment funds), credit approval depends on disposable income. Households with lower incomes spend more on food and clothing, which explains why only 7% of those earning less than MXN$8,000 have access to mortgage loans.

In addition, some other banking instruments, such as the purchase of insurance, tend to occur more frequently as basic needs are satisfied and other types of concerns arise. This is evident in Table 4, which shows that, as the level of income increases, the percentage of people who take out insurance rises from 8% for group 1 to 53% for group 3.

Something similar occurs with the percentages of the different banking instruments, which tend to grow as level of income increases.

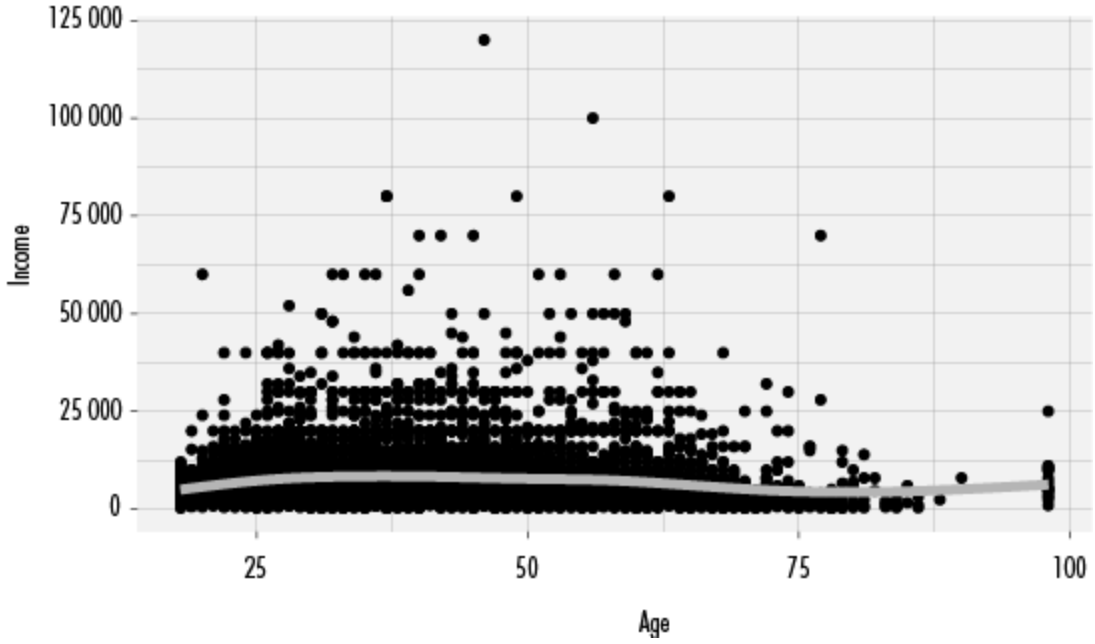
2) The second factor that appears among the three most important in the estimated networks is level of education. Financial inclusion and level of education are related in a circular fashion since, on the one hand, a higher level of education provides people with the knowledge and skills necessary to understand and use financial services effectively. Through education, basic personal finance concepts such as saving, budgeting and debt management can be taught, in addition to learning about the different types of financial products available, such as bank accounts, credit cards, loans, etc., as well as understanding the risks and benefits associated with the use of these services and making more informed financial decisions.

Several studies (Lusardi and Mitchell, 2014; Collins, 2009) show how a lack of formal education limits access to various types of financial services and can affect the demand for financial services, mainly because formal education provides people with the knowledge and skills to understand basic financial concepts, such as budgeting, saving, investing and making informed financial decisions, in addition to increasing their capacity to process information. Generally speaking, people with higher levels of education tend to have greater capacity to process and understand complex information, including that related to financial services.

3) Meanwhile, age is a variable that appears in two of the estimated networks as one of the three most relevant factors in explaining the level of financial inclusion. Age is related (although not strictly) to the income level of individuals. Some theories, such as the life-cycle theory, postulate that the level of income varies throughout a person's life cycle. In general, income is expected to increase as individuals gain experience and advance in their careers during early and middle adulthood. However, as retirement approaches, income may decline due to reduced labor participation and reliance on pensions or retirement funds.

It seems that, in the case of Mexico, the life cycle theory provides a weak explanation for the determination of income levels (see Figure 4).

Figure 4. Level of income by age in the ENIF



Source: prepared by the authors with data from the ENIF (2021).

The possibility of falling into poverty traps, where the socioeconomic characteristics of low-income levels tend to perpetuate themselves through pernicious feedback loops, is one of the explanations that attenuate behaviors such as those explained in the life cycle theory (Deaton, 2005). However, it is a fact that, although the life cycle theory may provide some explanation for understanding the link between age and level of financial inclusion, attention needs to be paid to the relationship between age and different socioeconomic factors.

4) Another relevant factor according to the models estimated to understand the level of financial inclusion is marital status. There are many mechanisms whereby marital status can affect the level of financial inclusion, e.g., access to shared resources. Married couples often combine their income and assets, which can increase their ability to access financial services and engage in joint financial activities, such as opening joint bank accounts, purchasing assets or joint financial planning. Another mechanism is through greater financial stability, as couples who are married or living together may have greater stability in terms of shared income and expenses, which can help build a solid financial foundation (Dew, 2008). This can also facilitate participation in financial services and the ability to save and invest

more consistently, in addition (and not least) to the legal protection and inheritance rights that marital status can confer on couples and their children.

5) Meanwhile, sex in the three estimated neural networks appears as the least relevant factor in explaining the level of financial inclusion for each of the groups. This seems to be a counterintuitive result, given the wide gaps between men and women in many of the socioeconomic variables analyzed here, such as income, which for men surveyed in the ENIF is MXN$8,671 per month on average, and for women is MXN$6,078, i.e., a gap of almost 30%. However, when the estimated IIF is analyzed by sex, the difference is less significant, amounting to a little more than 5%.

In this case, in particular for the survey analyzed, the study gathers evidence that gender is the least important variable in explaining the level of financial inclusion. However, this does not imply that financial instruments (credit, insurance, savings funds, etc.) do not have a positive impact on improving gender equity, as was argued. What the result indicates is that there are variables, such as schooling, occupation or income, which are more important in explaining level of financial inclusion, and that the order of these variables changes according to socioeconomic level. This does not imply that sex does not impact the level of financial inclusion, but rather that it has less impact than variables such as income or education.

In aggregate terms, inclusion is greater in favor of men, partly because the percentage of men surveyed (who reported being heads of household) is higher (56.5%) compared to women (43.5% women).

6. CONCLUSIONS

This research contributes to the understanding of the importance of the factors that affect the level of financial inclusion in Mexico through the analysis of microdata with statistical and neural network methodologies.

The statistical analysis reveals the most relevant aspects for understanding the way in which financial inclusion occurs in Mexico. The average income of 70% of the population in Mexico is less than MXN$5,000 per month, i.e., most of the population does not have an income that allows them to cover all their basic needs given that the living wage for Mexico is MXN$13,117 per month and the wage that some authors (Andersen *et al.*, 2022) call "decent" for a standard family should be MXN$18,571. This is partly related to lack of education since 51% of the population has a level of education lower than secondary school.

Given the wide variety of financial instruments and products available in the Mexican market, it is not possible to directly measure the level of inclusion by contracting products. This implies that, for the very concept of financial inclusion, having a debit card is not necessarily the same as investing in fixed-term promissory notes or having a mortgage since each of these products implies a different level of financial depth. In this respect, one of the main contributions of this study is the creation of a financial inclusion index, which shows a direct and positive relationship between income level and the degree and depth of financial inclusion.

Based on this relationship, we sought to test the hypothesis that income level is a determinant of the factors that affect the degree of financial inclusion, dividing the ENIF into three income groups. In this way, neural network analysis made it possible to analyze the hierarchical importance of the factors that determine the level of financial inclusion for each income level.

For the lowest income bracket of the population (MXN$0 to 8,000), the most important variable in explaining the level of financial inclusion is level of education. For the lowest income bracket, an increase in the level of education

significantly improves the understanding of the benefits of using available financial products and services, as well as the risks and benefits associated with them, which can lead to a greater willingness and ability to participate in the financial system in an informed manner.

For people earning between MXN$8,001 and 16,000, the most relevant variable to explain their level of financial inclusion is occupation, understood not as the exercise of a specific professional activity, but as a generic activity and the level of formality of the activity to which their time is dedicated (studying, working, retirement, household chores, etc.). This is based on both life cycle theory and the inherent characteristics of each type of occupation. At this income level, a student is less likely to worry about taking out insurance or have the resources to make fixed-term investments. This result suggests that a strategy that seeks to increase the level of financial inclusion of the population should differentiate financial needs by type of occupation.

For people with incomes above MXN$16,000, the main determinant of the level of financial inclusion is income level. One of the various explanations for this finding is related to Maslow's pyramid, which shows the order of satisfaction of needs according to their hierarchy. From an economic point of view, this result explains why, as income levels increase and get further away from satisfying basic needs, the concern for satisfying higher-order needs increases, such as purchasing a home, taking out different types of insurance (life, employment, medical, etc.) or increasing savings for retirement.

In the case of the three income levels, sex is the least relevant factor.

Based on the above, two public policy recommendations emerge. It is necessary to promote policies focused on increasing the level of household income and promoting financial education and information. If families have the income to satisfy their primary needs and understand the basic concepts associated with the financial system, they will be able to access financial products that will improve the quality of life of Mexicans, making it possible to acquire capital goods, real estate and assets, as well as contract services that protect them from contingencies or allow them to overcome short-term situations, without having to risk or lose their assets.

Furthermore, in terms of financial policy, clear and direct information must be made available to the population, so that they can make better consumption and investment decisions and choose the products that best suit their needs. This will allow the promotion of a process of democratization of finance and a better functioning of the financial system and a greater contribution of the latter in terms of economic development and growth.

Parallel to the process of democratization of finance, work must be done on the regulatory issue, moderating commissions, interest rates, conditions and guarantees associated with financial products. Likewise, the role of development banking and the design of products that adapt to the needs of low-income economic groups should be strengthened, for example: products where people can make weekly payments since in informal jobs, income is received at this frequency, start-up loans, housing or for the purchase of capital goods, with low amounts and comfortable interest rates that allow people to improve their living conditions.

Future lines of research should include further analysis considering relevant classifications, such as level of education, sex, age, among others, and include other factors contained in the survey, e.g., those associated with the attitude of individuals. Likewise, innovation can be achieved through the proposal of an alternative index that measures financial inclusion, giving greater weight to products that represent a higher degree of financial inclusion.

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[1] SDG 1. Eliminate poverty by facilitating a consumption profile over time that is less vulnerable to shocks. SDG 2. Zero hunger. SDG 3. Health and well-being through greater investment in education and health. SDG 5. Gender equality through better attention to women's financial needs. SDG 8. Decent work and economic growth through the allocation of available resources. SDG 9. Industry, innovation, and infrastructure. SDG 10. Reduction of inequalities through greater financial inclusion of disadvantaged and marginalized groups, as well as a reduction in the cost of public transfers (UNCDF, 2018).

[2] There are other indexes that measure financial inclusion, but they do so in a different way; for example, the Dirceo-Palacios and Citibanamex indexes focus on measuring financial inclusion by municipalities and states. In this case, we use the microdata, the answers per individual surveyed, provided by INEGI's ENIF 2021.

[3] Neural networks employ a technique called *one-hot encoding*, which converts each category into a binary representation. This allows the neural network to learn specific relationships and patterns between categories, without imposing an artificial order between them.