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The importance of Social Networks in the savings decision of Mexican households: An agent-based model

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Abstract

Saving is important for economic growth because it is one of the determinants of investment and productivity. However, at the micro level, the decision of individuals on the use of their remaining income after consumption expenditures is affected by various issues, both social and economic. In Mexico, there are millions of people who prefer to borrow from relatives or friends rather than from any banking institution. The objective of this work is to study the impact of family networks on private savings in Mexico. Given the socio-cultural context behind the saving decisions of individuals, we conduct the study from the perspective of Agent-Based Models (MBA). The analysis is done through a model that is built and simulated on the NetLogo platform. The parameters and target values correspond to the Mexican economy in 2012 and 2014. The results suggest that family relationships have an effect on savings in Mexico.

Agent Based Models, Family networks, Formal savings, Informal savings, NetLogo

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Introduction

From very old times humans know and practice the concepts of saving and credit. While saving refers to the difference between the disposable income of people and the consumption they make, the credit refers to those loans between people for a given period. At the national level, saving is an important variable for economic growth because it is one of the determinants of investment and productivity.

However, at the microeconomic level, individuals' decision about what to do with the remaining income from their consumption expenditures is affected by various social and economic issues. The customs, traditions, habits, economic and geographical characteristics of each region and country have been determinants of the savings mechanism chosen by households, which may be formal or informal. In Mexico, for example, both saving and personal credit are influenced by existing social relationships, so that millions of people prefer to apply for loans to relatives, friends, neighbors or acquaintances rather than to a banking institution (CONDUSEF, 2014).

Given the macroeconomic relevance of these variables, the objective of this study is to study the impact that family networks have on private savings in Mexico. Due to the socio-cultural context behind the saving decisions of individuals, it is considered opportune to carry out the study from the perspective of Agent-Based Modeling (MBA, onwards).

The MBA is a form of computer simulation that allows to create, analyze and experiment with models composed by agents that interact in an environment. Although simulation is an important research technique in the natural sciences, in areas such as biology, chemistry, physics, zoology, to mention a few, it has only been used in the social sciences (Wilensky & Rand, 2015).

This is largely due to the fact that with this approach it is possible to address real-world problems under a wide variety of possible circumstances. In addition, the simplified representation of social reality that can be created allows us to express in the simplest way possible the way in which reality is thought to be directed. However, the greatest advantage of the MBA is that it enables virtual social experiments without incurring the difficulties and ethical problems that would arise from carrying them out in reality (Gilbert, 2008).

In economics, there are several recent examples of the use of this model with favorable results (Fagiolo and Dosi, 2003, Deissenberg et al., 2008, Dosi et al., 2010, Martínez, Quintero and Viianto, 2015, among others). The present work is in addition to this aspect by developing an MBA that allows the evaluation of the impact of income and consumption levels of the country, and especially the family ties (friendship, neighborhood, etc.), personal savings decisions and the national savings.

The rest of this paper is organized as follows. Section 2 presents a brief review of previous work on the determinants of savings, in order to emphasize the added value of the present analysis. Section 3 deduces the concept of household savings. Section 4 presents the savings and credit landscape in Mexico in 2012 and 2014. Section 5 analyzes the determinants of saving. Section 6 presents the MBA approach. Section 7 develops and simulates a model for saving households in Mexico. Section 8 presents and discusses the results. Section 9 summarizes the conclusions of the present study

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Review of related literature

Emphasizing the socio-cultural issues behind individual savings decisions, the present analysis distances itself from a number of previous work on the determinants of saving in Mexico using more conventional tools and approaches and which, among other things, do not take Taking into account the interactions of individuals with the environment.

This is the case, to mention a few: Villagómez (1993), Attanasio and Székely (1999) and Montes and Villagómez (2002), who use, among other tools, the Life Cycle hypothesis with favorable results. However, Villagomez (1993) points out the need to "deepen work that analyzes the problem of saving from a microeconomic perspective, as well as those that study the behavior of this variable in informal markets." On the other hand, Attanasio and Székely (1999) conclude that:

"[...] When households are less likely to save during some phases of their life cycle, strong family ties may often replace the lack of savings at more advanced ages ... Policies to promote savings Must take into account that in Mexico the different sectors of the population may respond in a totally different way in the face of savings incentives ... "p. 334 and 335.

On the other hand, some recent econometric studies study a great variety of variables that determine saving. For example, Rodriguez (2015) uses partial equilibrium, general equilibrium, and econometric multinomial logit models and to explain the savings using macroeconomic variables.

The results highlight that the unemployment rate, annual general inflation and fiscal reform have a negative effect on the savings possibilities of Mexican consumers.

While the real ex-post interest rate and labor reform contribute positively to these possibilities. For their part, Bosch, Melguizo, Peña and Tuesta (2015) use a cluster analysis and a probit econometric model, and evaluate variables such as gender, educational level, self-confidence, motivation and employment in the formal and informal sector. One of its results is that informal work adversely affects savings decisions.

Therefore, the present study complements those mentioned above when taking into account the informal savings market and the influence of family and social ties in the decision making of heterogeneous agents.

From national saving to household saving

When talking about saving, there is a natural allusion to consumption since these concepts are the two possible destinations of the income of a person, household or society. On the other hand, the credit allows to extend the possibilities of consumption of the individuals. In sum, savings, credit and income have a close relationship capable of affecting the microeconomic decisions of current and future consumption of people. Moreover, viewed from a macroeconomic perspective, when saving is channeled as investment, it becomes a key element for long-term economic growth in the country.

According to conventional economic theory, a measure of the total income that the set of people obtains in the economy is given by the Gross Domestic Product (GDP), which is defined as:

'The market value of all final goods and services produced (legally in the market, including tangible and intangible goods) within a country in a given period".

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However, in an economy money flows continuously from households to businesses and then back to homes. While a significant part of this flow of money is measured by GDP, there are other sources of monetary income that are received by households, but by definition are not accounted for in GDP. For example, diverse incomes, dividends, interests, transfers, et cetera. As will be discussed below, these other sources of income induce a gap between savings, according to the National Accounts, and household savings, understood as the difference between the amount of all their monetary incomes (including or not in GDP) And its consumption.

Private savings according to National Accounts

According to the expenditure approach, GDP (denominated Y) is composed of the sum of the following elements: private consumption (C), private investment (I), government purchases (G) and net exports (XN). That is to say:

$$Y=C+I+G+NX \quad (1)$$

However, given the very small proportion of net exports in most countries, the simplified assumption is often made that it is a closed economy. This fact simplifies the identity of GDP, which can be rewritten as:

$$Y-C-G=I \quad (2)$$

The left side of the last expression represents national saving (or simply saving), since it is the remnant of total income in the economy that results from paying for consumption and government purchases. This equation reveals that, for the economy as a whole, savings must equal investment.

Therefore, according to conventional theory, saving has a key role in the development of countries as it constitutes the main source of funds for the financing of investment projects that promote economic and social development. It is important to emphasize that savings, channeled through an efficient and secure intermediation system, drive productivity and lay the foundations for sustained long-term growth (Rivera, 2014).

So, saving is the main constraint on investment spending and, therefore, plays a crucial role in the Mexican economy. Because investment provides a key link that leads to productivity and real income growth, an adequate supply of savings is required for the economy to progress at an acceptable pace (Huidobro, 1995). Thus, a greater effort is required to understand the determination and behavior of savings if the public policies are to be designed to achieve this objective (Villagómez, 2011).

The haushold saving

Denoting by A the savings and by T the net amount that the government collects from households in taxes, national savings can be broken down between private savings and public savings:

$$A = (Y – T – C) + (T– G) \quad (3)$$

Thus, public saving is the amount of tax revenue left to the government after covering its expenses, while private saving is the amount of income left to households after taxes and consumption. Although private saving results from household decision-making, it does not constitute all of its real or actual savings.

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The gap between private saving and real household saving is due, on the one hand, a part of the latter comes from unaccounted income in GDP and, on the other hand, that households use both formal and informal saving methods (CNBV and INEGI, 2016).

According to the above, the National Institute of Statistics and Geography (INEGI) defines savings simply as:

"Separate a part of the income or the money that is received to use it in the future. Saving can be achieved by saving a portion of income or by spending less. There are two forms of savings: formal and informal "(INEGI, 2016).

In turn, the income referred to by this definition is personal income or average current income. This indicator is made up of monetary and non-monetary inflows, divided into the following five categories: labor income, property income, transfers, housing rent estimation, and other current income (INEGI, 2016).

In other words, the effective saving of households depends on the total income they receive, which, by its composition, is greater than that recorded in GDP, that is, private saving according to the National Accounts. In sum, as Huidobro (1995) points out:

"[...] Most definitions consider savings as a residual concept, that is, income minus consumption, or in an international context, such as the demand for investments minus the net inflow of capital. Consequently, savings measures can vary significantly due to differences in both definitions and measurement of concepts difficult to quantify [...] "(p.1).

Such savings can also be made in a formal way (supported by the financial legislation system) or informal, which makes their quantification even more difficult.

These types of savings are defined by INEGI (2016) as follows:

Formal savings: "Money that is saved in some financial institution (bank or non-bank), through certain products such as savings accounts, investment accounts, among others, which may or may not, give a profit or performance depending on the conditions Of opening or characteristics of the product, with the advantage of providing security, because the money is protected by the IPAB (Institute for Protection of Bank Savings) and offers greater facility to obtain a credit. This type of savings does not have any risk, only in certain options like term deposits or promissory notes there is no immediate availability of money. "

Informal saving: "When money is stored in the house, with a relative or through mechanisms such as bundles, piggy banks or unauthorized institutions. You can dispose of the money immediately, but it has the risk of being stolen, there is the temptation to spend it by having it handy and make improper use of it. "

As a complement to savings, INEGI defines the loan as:

"Act through which a person (creditor) entrusts money to another (called debtor) for a certain period. After the deadline, the person who received the money returns it to the creditor. Usually the credits are not free, so the debtor, when returning the money to the creditor or before, must add an additional payment, which is called "interest" and is expressed or disclosed through the interest rate".

From the above, it follows that, like savings, credit can be channeled through formal or informal mechanisms. The definitions of formal and informal credit described by INEGI (2016) are as follows:

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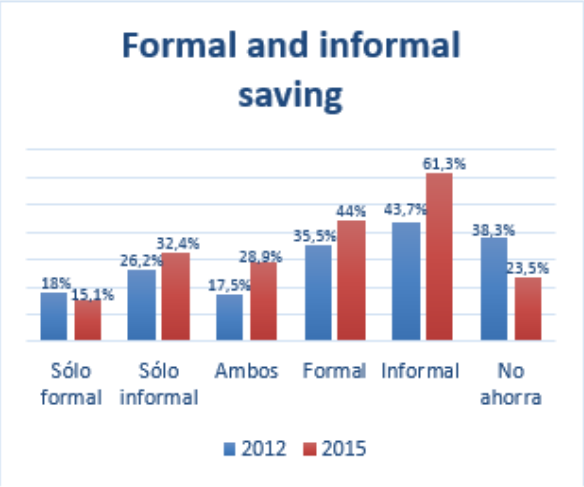
Crédito formal: "Préstamo solicitado a una institución financiera que se dedica, como parte de su actividad principal, a intermediar recursos económicos".

Formal credit: "Loan requested from a financial institution that is engaged, as part of its main activity, to intermediate economic resources".

Saving and credit in Mexico

In Mexico, the percentage of adults who save has increased in recent years. In 2012, 61.7% (43.4 million) declared savings, while in 2015 the percentage rose to 76.5% (58 million) (CNBV and INEGI, 2012 and 2016, page 35). However, as shown in Figure 1, the weight of informal savings has been greater than that of the formal one in both years and was also the one that experienced the greatest increase from 2012 to 2015.

The preference of Mexican households for informal savings mechanisms is mainly due to insufficient or variable national income (CNBV and INEGI, 2016), which makes it difficult to enter the formal financial market (Hoyo, Peña and Tuesta, 2013, Allen, Demirgüç-Kunt, Klapper and Martinez Pería, 2012, Djankov, Miranda, Seria and Sharma, 2008, and Cano, Esguerra, García, Rueda and Velasco, 2013). .



Graphic 1 Formal and informal saving
The sum of the percentages is greater than 100% since the informant could mention more than one option.

The situation of credit or loans in Mexico, as well as savings, has shown an increase in the percentages of use. The percentage of adults who applied for loans in 2015 was 54.4% (41.5 million), surpassing the 2012 credit of 51.4% (36 million) (CNBV and INEGI, 2012 and 2016). Similarly, Figure 2 shows that, like savings, the preferred mechanism for credit is the informal mechanism. The main barriers to not requesting formal credit products are: dissatisfaction with debts (39.5%), non-compliance (32.9%), lack of interest (19.3%), and high commissions and interest involved in a loan with some authorized institution (14.2%) (CNBV and INEGI, 2016, p. 92).

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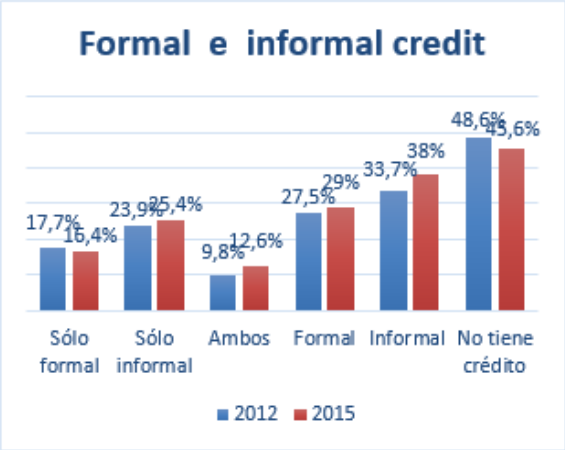

Graphic 2 Formal and informal credit
The sum of the percentages is greater than 100% since the informant could mention more than one option
Source: Own elaboration with information of the ENIF 2012 and 2015

From the above, it is concluded that in both cases the users of only formal mechanisms decreased while the users of only informal systems and those using both increased. For Peña, Hoyo and Tuesta (2014) this suggests that Mexico lags behind and with savings figures lower than what would correspond to its level of development.

The fact that at the national level there is a greater number of users of informal savings than formal savings reduces the efficiency of the formal market of loanable funds, the channeling of resources towards formal markets is less. This translates into fewer resources available in banks for the financing of investment projects, causing the increase of credit. This in turn limits the financing of capital creation projects that accelerate the country's economic growth (Rivera, 2014).

On the other hand, households deprive themselves of the various benefits derived from participating in formal financial systems, such as: access to credit on terms more favorable than those provided by the informal market.

Ssecurity offered by formal savings and The possibility of managing or mitigating risks through insurance (Peña, Hoyo and Tuesta, 2014).

Given this picture of savings and credit in Mexico, the following section will explore the factors that influence and determine people's savings and loan decisions.

Determinants of household savings and credit

Two crucial variables for decision making on saving and credit are personal income and consumption, since saving is a residual income variable after spending on consumption of goods and services.

In a country as Mexico, where there is a high poverty rate and a widespread informality, the main factor that determines the possibilities and decisions of savings and loans is income. According to Hoyo et al. (2013), the main barrier to saving and obtaining formal credit financing in Mexico is the insufficiency or the instability of income.

A relevant feature of loans at the national level is that they are mostly not solicited from authorized financial institutions, but rather from relatives, friends or acquaintances (see Figure 3). This suggests that another determinant of savings and credit is membership in family networks. That is, savers have part of their disposable income stored in the hands of one or more family members, friends or acquaintances who have applied for loans. For this to be possible, people create multiple types of links or ties based on mutual trust and at the same time this gives rise to social networks or "family networks". By maintaining expectations in these relationships with multiple interpersonal links, in addition to financial services, favors, information, goods, and others are exchanged (Vélez-Ibáñez, 2010).

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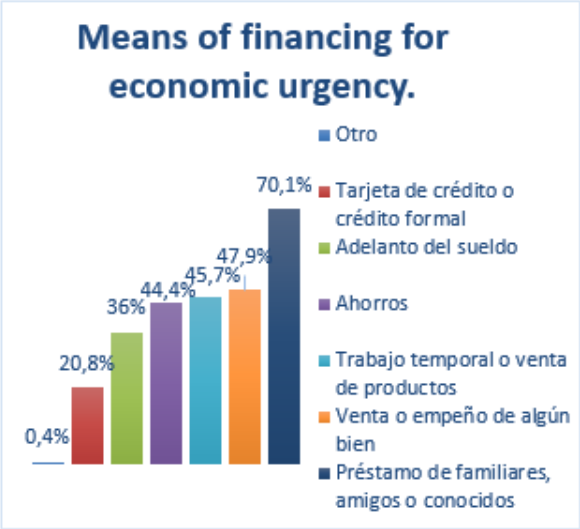
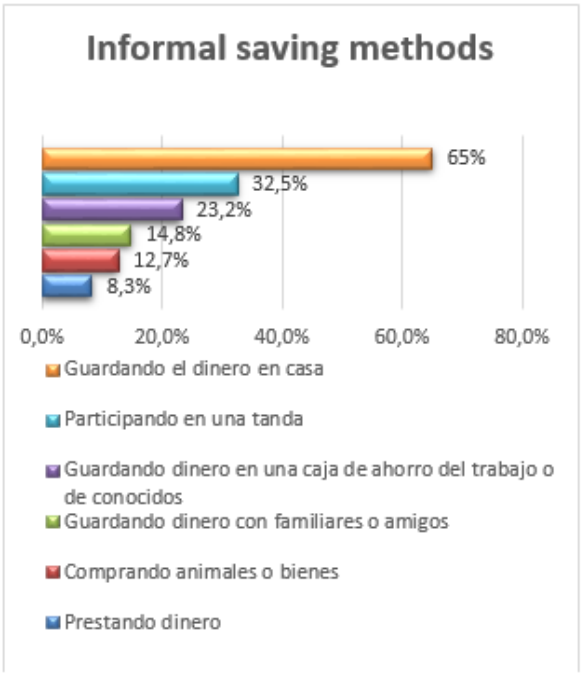


Graphic 3 Means of financing for economic urgency
The sum of the percentages is greater than 100% since the informant could mention more than one option.
Source: Own elaboration with information of the ENIF 2012 and 2015.

Thus, loans in the informal market are financed by the savings of other people who are part of their family networks, as shown in Figure 4. Note that all illustrated savings means money flows between members of family networks, being saving money at home the preferred saving mechanism.



Graphic 4 Informal saving methods
The sum of the percentages is greater than 100% since the informant could mention more than one option.
Source: Own elaboration with information of the ENIF 2012 and 2015.

Tamaño de la familia y el desempleo (Allen et al., 2012; Demirgüç-Kunt y Klapper, 2012); las regiones geográficas y nivel de desarrollo de los países (Demirgüç-Kunt y Klapper, 2012); la autoexclusión (Hoyo et al., 2013); el género, la educación, la ocupación, el tamaño de la comunidad donde habita el individuo, la preferencia por el mercado financiero informal (Peña et al., 2014); el empleo informal (Bosch et al., 2015), etcétera.

However, in this paper, the following factors will be retained, given their relevance in the savings and credit decisions of Mexicans: personal income, consumption and membership in a family network. In turn, as a determinant of income will be considered the employment status (employed or unemployed) of individuals.

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In other words, the effects of economic variables (income, consumption and labor status) on family savings will be analyzed in a social context where membership in a network may be the most important factor in savings and credit decisions of households. Households. Given the socio-economic nature of this study, we will resort to Agent-Based Modeling.

Agent-Based Modeling (MBA)

According to Ballot, Mandel and Vignes (2014), traditional economics is based on a reductionist approach in which, if one knows the basic elements of a system, it is possible to predict its behavior and properties. Thus, the tendency has been to consider as homogeneous the agents of the population of economic systems, with equal skills and rationality to process information. However, the markets and their dynamics are rather heterogeneous. Neither this feature nor the impact of institutions or social phenomena such as beliefs, imitation or loyalty has been incorporated into most microeconomic models.
In contrast, the MBA correspond to a view of socioeconomic dynamics driven by interactions between heterogeneous actors, so that individual knowledge is not sufficient to describe the overall behavior of the system. Unlike analytical models where it is not possible to differentiate individual behavior from agents, MBAs allow each agent to operate according to their own preferences or rules of individual action (even agents can learn from their past experiences in making Decisions), that is, it is heterogeneously modeled for individuals (Wilensky and Rand, 2015).

This is why the MBA plays a central role in the search for alternative economic models. In sum, it can be said that it is a valuable approach to economics for the following reasons (Gilbert, 2008; Ballot et al., 2014): (i) the importance of interaction in the economy can be addressed through the use of networks as a means to better understand and analyze economic dynamics. (Ii) It is possible to represent intangible but relevant factors such as family and social ties. (Iii) The inclusion of individual heterogeneity even allows agents to learn from their past experiences and use that information in future decision making. (Iv) Analysis can be performed at various scales. For example, from the results of the individual interactions it is possible to generate structures at the macro level. (V) It allows to understand the process and not only the final deductions. (Vi) It is possible to take into account imperfect information and limited rationality. (Vii) Provides a dynamic adjustment framework for public policy analysis and thereby facilitates the collection of predictions about the impact they may have on society. (Viii) Ensures that the mathematical and computational construction of the model is accurate, complete, consistent and unambiguous, as this is a necessary step in order to be properly programmed and executed.

Given the characteristics of the socioeconomic phenomenon of household savings, this paper will use the MBA in the analysis of the impact of family networks on the savings of Mexican households. In particular, the following section will develop and simulate an agent-based computational model.

MBA General Characteristics

A model is intended to facilitate understanding of the real world. Its main advantages are that they succinctly express the relationship between the explanatory variables and the phenomenon represented in the model, while at the same time making it possible to know better if it is possible to reproduce properly its characteristic pattern, or reference pattern. In the context of the MBA, this translates into finding a set of agents that, by providing them with certain rules, generate the underlying reference pattern of the phenomenon (Wilensky and Rand, 2015), which in this case is household savings.

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The following describes elements of the basic structure of an agent-based model.

Models under this approach are composed of agents endowed with four fundamental attributes: autonomy, social ability to interact, reaction to stimuli and pro-activation (goals to be established by the agents themselves). In addition to these attributes, we have the following: perception of the environment, memory to store perceptions and experiences, movement, execution of actions and rules or strategies that determine their behavior (Gilbert, 2008). In addition, agents have limited rationality (as a consequence of the complexity that heterogeneity and interactions) and their rules of the game are precisely modeled.

On the other hand, models incorporate randomness, since decisions can be made on the basis of probabilities (Wilensky and Rand, 2015). It is also possible to represent multiple scales of analysis, such as the emergence of structures at the macro level from individual actions. This global behavior or macro is revealed as a society, since in isolation, the facts (in the virtual and real world) would be completely different in the absence of the scenario of trust, communication and exchange of physical or intangible goods between the people. That is, the individual values are incorporated by mere summation to obtain aggregate values (Ballot et al., 2014).

The NetLogo simulation platform

The most popular agent-based simulation tool is the NetLogo free computing platform (Garcia-Valdecasas, 2016). According to Tisue and Wilensky (2004), NetLogo is a programming language environment where multiple agents and characteristics coexist that is useful to simulate natural and social phenomena.

It particularly adapts to models with complex systems that evolve over time and allows to give instructions to hundreds or thousands of independent agents, all operating simultaneously. This makes it possible to explore the connections and influence that exist between the behaviors of individuals at the micro level and the patterns at the macro level that arise from interactions. Even this program facilitates experimentation because experiments can be repeated to identify variations in dynamics and outcomes (Wilenksy and Rand, 2015).

In this computational platform, agents follow certain predetermined rules of behavior, both when isolated, and when they coexist and interact with other agents. The results of these interactions can be very diverse depending on how they are programmed both the environment and the rules of behavior of the agents (Fioretti, 2013).

The programs in NetLogo have three parts. First is the section that indicates the types of agents that will be there (called turtles) and the name of the variables that will be available for all the agents (global variables). Next, there is the so-called configuration procedure, which initiates the computational simulation. Finally the tracking procedure is found, which is repeatedly executed by the system in the order in which the simulation is executed (Gilbert, 2008). The following section presents the agent-based model for saving households in Mexico, based on the NetLogo language.

An agent-based model for household saving

Agents

The agents in this model of savings are the households, because it is within the same that give the fundamental decisions of work and consumption.

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The home is also a core of important social linkage, since the more links are with other households, the greater the sources of financing for tied agents. These ties will be called family networks.

Thus, unlike models where the location of agents plays a crucial role in the simulation of the program, in this model what is important is the representation of connections between agents.

The rules of household behavior on savings and savings are related to various explanatory variables such as employment status, income, consumption and the degree of solidity the connections between households, among others, described below.

Variables

The independent or explanatory variables that define the behavior of the agents in the system are the following:

- Members: average number of household members nationwide.
- Economically active members: number of household members who are able to work, regardless of whether they are employed or not.
- Members with work: number of household members with employment.
- Unemployment: difference between economically active members and members with work.
- Status: indicates the decile of income and expense to which each household belongs. This variable randomly distributes agents in deciles. Depending on the decile, the level of income and expenditure are then assigned.
- Income: constituted by ten deciles that represent the income of households..
- Expenditure: it represents the part of the income that is destined to the consumption of the households, which also is divided into ten deciles.
- Excess: remnant of income that has not been consumed by households. That is, it is obtained as the difference between income and expenditure, so that its value can be positive or negative. A positive value means that the household has savings, while a negative value means that you have incurred debt.
- Savings: collects the excess in each iteration. If such excess is greater than a certain number (called a limit), the household will decide whether to save it formally at the bank, or informally in the form of a loan to a member of its network that requires it. If the excess is less, use the informal mechanism to keep it at home.
- Limit: it is the reference value from which the household makes its saving decisions.
- Savings at home: the excess of income accumulated at home.
- Savings in the bank: it is the excess of income of the homes formally saved.
- Family loans: records all household savings that have been kept in the hands of some other agent who needed loans. Some agents borrow what they need to meet their spending needs, while others lend according to their savings situation available.

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- Extended family: counts the bonds that each household has with other households. These links form family networks and are so strong that, if an agent needs a loan, any member of your network can provide the loan, if your savings allow it.

- n: represents the number of agents or households in the environment, ready to interact. This variable can take values between 0 and 1000.

- gm: coefficient that indicates the strength of the family and social connections or connections in the environment. Their value is between 0 and 10. The smaller this value, the smaller the links between households, reducing the possibility of loans between relatives, friends or acquaintances. On the contrary, a high value translates into a great trust between the population and therefore a large amount of loans, links and networks in the environment.

Pseudo-codigo

This part presents the pseudo-code of programming of the household savings model, in order to facilitate their understanding. It consists of an informal blend of natural language and programming that clearly and simply shows the structure and flow of the developed program.
The programming pseudo-code has two parts, initialization (called setup in NetLogo) and execution (go in NetLogo). Initialization indicates the types of agents and global variable variables. In the execution, the simulation starts (configuration procedure) and the tracking procedure, which is everything that allows the interactions between the agents and the system to be repeated in the order of the simulation.
Initialization:

- Global variables that count the total income, the different types of savings and the deciles in which the income is divided are created.

- The class of agents "families", as well as their categories called "family" is created.

- Families are characterized: number of members, being economically active, having employment, income, expenditure, remaining income, saving, status of informal, formal savings, saving at home, saving at a bank, lending money to relatives or Friends, have family ties in addition to nuclear, review, belong to some decile of income and add.

Ejecution:

- The enviroment is cleaned.

- A grafic circle representation is asigned to family.

- Families are created and dstributed randomly in the enviroment.

- Families' size is adjusted and are distinguished by colors.

- Families' bounds are created and colors are asigned to them.

- Families with links are considered as extended family.

- Member number is randomly asigned to each amily.

- Those who are economically active are specified.

- Those who are employed are specified.

- Starts the status of the income deciles.
- Savings in banks and family loans are started at zero.
- Every tenth of the families are assigned a decile.
- Links are created between families, determined by the value of gm.
- The family income is added to the total income.
- Income is distributed by deciles.
- In each decile the income and expenditure are assigned according to the gamma distribution.
- Families with excess income are identified.
- Agents with excess income are given the ability to lend.
- Those who have excessive negative income are given the ability to borrow.
- If families have savings greater than a pre-set value, they will save it at a bank or lend it to a member of their network. If not, they will keep it at home.
- If the excess income is negative, borrow money from someone in your network with excess positive income.
- The formal savings are accounted for with the proceeds in banks, and the informal savings with the money borrowed and kept at home.
- The proportions of those who used both mechanisms, from those who only used formal savings and those who only used informal savings, are presented.
- Finish the simulation.

Parametrization

The model was simulated using the most recent official data published by INEGI in the National Household Income and Expenditure Survey (ENIGH) and in the National Financial Inclusion Survey (ENIF). Thus, the model is first simulated for 2012 and then for 2014-2015. This is because the ENIGH reports socio-economic data for 2012 and 2014, while the ENIF reports saving and credit data for 2012 and 2015.

The average value of the variable members was 3.7 members per household in 2012 and in 2014 3.8. Then in the program agents are initially provided with 2 members plus a random integer between 0 and 4 to generate households with an approximate amount to the national average.

The average value of the variable economically active members was 1.7 in 2012 and 2014, so the program is assigned a value close to 1 plus an integer random number between 0 and 3.

The average value of the variable members with work was 1.7 in 2012 and 1.6 in 2014. In the program it is assigned a random decimal number between 0 and 1.7 plus an inferred number of a Poisson distribution.

The variable unemployment is deduced from the previous two.

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The income variable is made up of ten deciles, as is its real counterpart reported by INEGI (2015): Average quarterly total current income per household (in millions of Mexican pesos and at constant prices in 2014). The INEGI data are quarterly, so they were divided between three to approximate them to monthly data. To divide the income by deciles was used the fact that income in Mexico had a Gini coefficient of 0.44 in 2012 and 0.438 in 2014. This translates into a positive asymmetry, so that the monthly values were adjusted a Distribution function Gamma: $\Gamma(k, \lambda)$, from which the distribution of income per deciles.

As income in Mexico reflects a great deal of inequality (CONEVAL, 2013), we chose k = 2. This generates a greater variance in the income distribution of the country's households. From this value and the average of the income we derive $\lambda = k /$ average. Finally, the variance is obtained as: variance $= k\lambda \wedge 2$. The values per decile of the mean of the income and of the parameter λ are shown in Table 3 (Annex).

For the estimation of expenditure per decile, the same procedure was used as for income, since it is also divided into ten deciles according to INEGI (2015): Quarterly average monetary expenditure per household. That is, quarterly data on household expenditure on final goods and services (variable in millions of pesos at constant 2014 prices) approximate monthly data. From these, a Gamma distribution function, with parameter k = 4, is estimated. This in order to reproduce a relatively soft household consumption. The values per decile of the expenditure average and the parameter λ are shown in Table 4 (Annex).

The excess variable is obtained as the difference between the income and the expenditure previously obtained. These values accumulate in the savings variable.

Depending on its value in each iteration, the household decides whether to save it using formal or informal mechanisms. For this he compares it with the limit. The rule is that if the excess of an agent is greater than that amount (which is set at 2200 pesos), you can choose to save it in the bank or informally in the form of a loan to an agent that requires it. If the excess is less, it will keep at home (variable savings at home).

Savings in banks is the variable where all the excess of income of the households is formally saved in the bank. Similarly, the family loans variable records the household surplus that has been kept in the hands of some other agent who needed loans.

The variable n of number of households living in the environment is assigned the value of 800.

The variable gm average grade for 2012 was assigned a value of 3.0 and 4.7 for 2014-2015, was assigned a higher value because in the two years that passed in this period of time increased the participation of Mexican households in saving Informal with loans between them, that is to say, the strength of the social bonds that allow the financing of loans grew.

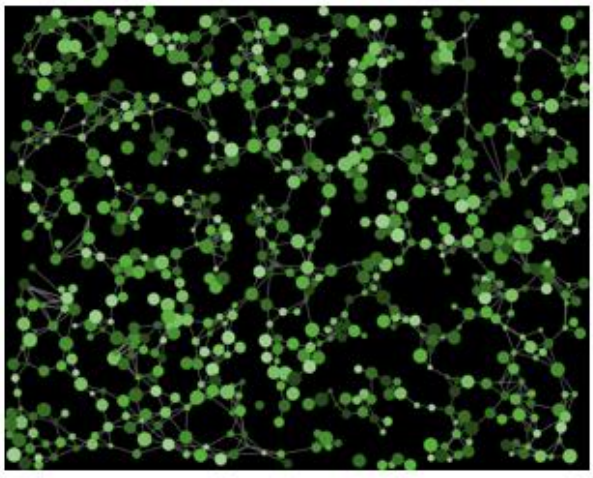
With these values, you can proceed with the simulation of the model for 2012 and 2014-2015. The results are presented in the following section.

Simulations results

The differences between the simulations for 2012 and 2014 are derived from the differences between the levels of income and expenditure of households in each year, as well as the random elements included to approximate the values of the model variables.

This randomness makes each simulation for a given year yield slightly different results, albeit with minimal variations. To reduce the effect of the random component, 100 simulations were performed for each year and the averages of the estimated variables were obtained.

The family networks created in one of the simulations for 2014 can be seen in Figure 5. The green circles represent the families and differ in size according to the members of each. Families belonging to the same network are linked with lines that reflect the various links.



Graphic 5 Family networks formed in a simulation for 2014-2015. Source: own elaboration through the simulation of the model

Table 1 reports the average values of the simulations along with the observed values. Three key parameters are also added in the definition of family networks (number of families and average grade) and savings decisions (limit), in order to facilitate the evaluation of the model.

Variable	Simulated values	Simulated values	Observed values	Observed values
	2012	2014	2012	2015
Informal savings only	28.7%	33.9%	26.2%	32.4%
Formal savings only	16.2%	16.1%	18%	15.1%
Both of them	14.1%	15.3%	17.5%	28.9%
Informal savings	42.8%	49.2%	43.7%	61.3%
Formal savings	30.3%	31.4%	35.5%	44%
Limit to decide to save on banks	*$2,200*	*$2,200*	--	--
Number of families	*800*	*800*	--	--
Average grade	*3.0*	*4.7*	--	--

Table 1 Simulated values and observed values for 2012 and 2014-2015. Source: Own elaboration based on the simulations of the INEGI model and data

Model evaluation

To determine if the implemented model explains the phenomenon of household savings in Mexico, it is necessary, among other things, that the individual and aggregate patterns deduced from the simulations correspond to the pairs reflected in the data. This comparison between the observed values and the values generated by the model is part of the validation process of the model (Wilensky and Rand, 2015).

The data in Table 1 show that the model is capable of reproducing the trends observed in both years in saving in Mexico. That is, from 2012 to 2014, in both simulated and observed data, the following is observed regarding savings preferences:

- The proportion of savers using only informal saving mechanisms increased (see first row).

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- On the contrary, the proportion of savers users only formal mechanisms decreased (see second row).

- The proportion of users of both mechanisms increased (see third row).

- The proportion of total users of informal savings increased (see fourth row).

- The proportion of total users of formal savings increased (see fifth row).

As in the data, there is an increase in the number of savers, both formal and informal. However, this increase is explained by the higher percentage of users of only informal mechanisms, at the cost of the reduction of users of formal mechanisms. In other words, savings increased, but their composition changed in favor of the informal sector.

On the other hand, most of the values generated by the model are very close to the observed values. This is best seen in Table 2, which shows a measure of the explanatory power of the model, given by the percentage proportion that represents the simulated value in the estimated value.

This table shows a better adjustment for 2012 than for 2015. This may be due to the fact that for that year the model was parameterized with both values of 2014 and 2015, due to the limitation in the data. Thus, in 2012 the explanatory power of the model is higher than 80% in the five categories of savings, although slightly overestimates the first. Its performance decreases in 2014, as it slightly overestimates the proportions of users of the first two mechanisms (only informal and only formal) and widely underestimates the proportion of users of both. However, its explanatory power is greater than 50% in all cases.

Variable	Simulated values Simulated values	Simulated values Simulated values
	2012	**2014**
Informal savings only	109.5%	104.6%
Only formal savings	90%	106.6%
Both of them	80.6%	52.9%
Informal savings	97.9%	80.3%
Formal savings	85.4%	71.4%

Tabla 2 Explanatory power of the model. Source: Made by myself

In sum, the previous results point to the validity of the model, since it succeeds in reproducing the underlying pattern of household saving in Mexico and its operation resembles that of the real world. This is, as in reality, in our virtual society, households have as main means of financing the informal sector, granting and borrowing from the members of the social networks to which they belong.

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Conclusions

In the present work, an agent-based model was constructed to study the effect of social networks on saving in Mexican households in 2012 and 2014. The simulations of the model allow us to conclude that the family networks stimulate the increase of informal savings, preferring to meet the needs of financing within them rather than using formal mechanisms.

Although the model can reproduce qualitatively the trends observed in the different types of savings, it is necessary to extend its scope to other years and variables to validate it satisfactorily also in a quantitative way. This would allow their use in the analysis and design of policies to stimulate savings, for example. However, it is a good starting point for a better understanding of saving in Mexico.

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