

RESEARCH ARTICLE

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Modeling of Overdue Receivables in the City Bank Using Agent-based Simulation (Northwestern provinces of the Country)

Davoud Norouzi ¹, Alireza Bafandeh Zنده ^{2*}, Mortaza Honarmand Azimi ³**Abstract**

The core goal of this study was to simulate the share and predict the current and non-current receivables in Shahr Bank using an agent-based approach. To this end, we employed the data related to the examined features in 11 bank branches aimed at determining the degree of importance of each of the factors affecting the repayment behavior of borrowers using the C5.0 algorithm, the decision tree method, and the simulation process in Net Logo software. We utilized the comparison of the repayment status of a sample of 100 customers over the past year (12 months ago) and at present aimed at assessing the simulated model. The estimation results of the simulation model, as well as the real findings, suggested that the number of type 1 customers (with active repayment status) has decreased during the last 12 months and the number of type 2 customers (with past due repayment status) has enhanced. If the economic recession conditions continue the same way, and considering the low effect of the recession conditions on the businesses of the bank's customers in the next four years, then, the ratio of the bank's current customers will decrease from about 89% to about 81%, while the ratio of the past-due customers of the bank will increase to more than double to about 13%. In the next step, we tried to simulate the future situation of the ratio and the share of the current bank customers' claims in the next 4 years.

Keywords: Deferred receivables, current and non-current receivables, foundation factor simulation

Introduction

The advent of financial crises in the banking system over the past two decades has brought losses to many public and private banks. The outcomes of such crises highlight the significance of the duty of analysts and researchers to more accurately discover and identify the involved factors and how to reduce their intensity and effects (Heidari et al., 2011). Since the volume of Iran's banking system receivables is increasing, it seems essential to examine and evaluate the behavior of bank lending and its relationship with macroeconomic factors and financial variables (Ibrahim and Eskandar Shah, 2012). A developed banking system allows those businesses to compete that can affect interest rates and also have a positive impact on

investment activities and enhance economic growth (Sontake and Tiwari, 2013).

The importance of the banking system in contributing to economic development has been on a rise in recent years, suggesting that the performance of banks and their profitability help the development of countries (Mukoki and Mapfumo, 2015). If the loans are not repaid on time, banks will face a sudden decrease in resources and may even lead to their bankruptcy. Thus, the vulnerability of banks due to overdue receivables needs to be assessed accurately and precisely (Hamdaoui and Makyuf, 2019; Mohammadkhani et al., 2021).

Banks, as leading financial institutions, as well as credits as the driving force of banks are influenced by macroeconomic policies,

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especially in the financial and monetary spheres in developing countries. As a result, the first solution for funding and providing resources is directed to banks (Seyyed Shokri and Garossi, 2015). The increase in non-performing loans or bad debts signals failure (Rahmani et al., 2017). This problem is recognized as one of the main dilemmas of Iran's banking system (Heidari et al., 2011).

Iran's banking industry plays a crucial role in economic activities as one of the influential pillars in the country's economy. Thus, the efficiency and effectiveness of the activities of this industry will play a decisive role in the growth and development of the country's economy (Asgharizadeh and Amin, 2012). Since Iran's financial and monetary market is bank-oriented and about 90% of Iran's liquidity is at disposal of its banks, the issue has turned into a national challenge. If the overdue receivables increase in the banking network, the potential of the bank to lend loans will decrease, which enhances the credit risk of banks. In such a case, the lending power of banks is reduced, putting the country's economic growth in an asymmetric cycle, and thereby, the country will face a slowdown in economic growth (Dermina et al., 2021).

Therefore, we focused in this research on determining the macro and internal factors affecting bank arrears and the sensitivity to the explained factors using the NetLogo software followed by formulating the research function. Then, we will provide the bank with different scenarios through the NetLogo software. By doing so, we try to find the roots of this problem aimed at preventing the growth of overdue receivables in the granted loans and their collection potentially and actually, increasing the facilities of creating new income, and enhancing the bank's planning ability concerning resource consumption and earning higher incomes. Hence, doing applied research on addressing the depth of issues in the banking network appears to be highly important and essential. In fact, this research also relies on such a line of thought regarding making the

banking network more effective (Gholamian et al., 2021; Kian Mehr et al., 2021).

Literature Review

Non-performing receivables indicate the amount of loans that the borrower natural and legal persons are unable or unwilling to repay on their due time. In the Iranian banking system, following the instructions approved by the Monetary and Credit Council, the facilities of banks are classified into 4 categories according to their quality: Current loans, past-due loans, outstanding loans, and doubtful debts (Mehrabi, 2014).

Current loans refer to loans that the payment of the principal and interest of the loans or the repayment of the installments are done at the maturity or at most 2 months after its due date. Past due loans are receivables that it has passed more than 2 months of their due date of the principal and its interest or the date of stopping the repayment of the installments, which has not exceeded 6 months yet. Outstanding or deferred loans include the principal and interest of the loans that time has passed more than 6 months and less than 18 months from their maturity date or from the date of stopping the payment of their installments and the customer has not yet taken any measure to repay them (Seyyed Shokri and Garossi, 2015).

Doubtful loans or debts refer to receivables that are more than 18 months have passed from their due date or the date of cessation of their installments repayment. The sum of past due, deferred, and doubtful receivables, is called non-performing receivables (Abolhassani, 2010). There are two categories of theories on bank receivables. The first group explores the role of macroeconomic conditions in the formation of bank arrears, while the second group focuses on theorizing in the area of bank internal behavior (Vithessonthi et al., 2016).

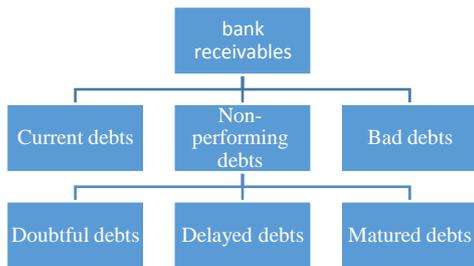


Figure 1. *The fundamental factors of arrears*

According to expert-oriented research and field studies, the most important factors causing arrears and outstanding debts include the decreased economic growth rate, fluctuation in the inflation rate, reduction of information quality, and the weakening of assets and debts management (Taghi Nejat and Najafpour Kurdi 2013).

o The conditions involved in the occurrence of overdue (outstanding) receivables

The theoretical foundations related to macroeconomic conditions mainly rely on the theory of the trading cycle. According to this theory, the economies of countries go through cycles of boom and recession continuously. During the boom periods, the ability to pay bank debts is high due to the appropriate income situation of households, and thereby, fewer overdue receivables are formed; but in times of recession, due to poor production status and low incomes, the households do not have enough capacity to pay their debts, and thus, arrears are created. However, the indulgence in lending loans during the boom period by banks with an approach to gain more profit seems to be one of the major reasons for the formation of overdue receivables and entering the recession period (Rasouli and Majidi, 2015).

Accelerator theory also addresses the relationship between the financial market and the real sector of the economy. According to this theory, the occurrence of recession in the real sector of the economy leads to the creation of overdue debts in financial institutions and banks meanwhile causing some kind of crisis in banking institutions due to the losses resulting from the formation of arrears, making commercial banks unable to lend new facilities

to the manufacturing sector. This situation will deepen the recession in the real sector of the economy and this cycle will lead to the formation of a chronic recession (Kordbacheh, 2011).

A class of theoretical foundations raises the issue of moral hazard. According to this theory, the behavior of the borrower changes negatively before and after receiving the loan. Hence, before receiving a loan and during the process of granting the facility, the borrower tries to present himself as a credible and good pay customer by providing statistics and positive signs. The bank also makes a mistake in the validation process due to incomplete customer information. After taking the loan, the customer's behavior changes and shows unpredictable risky behaviors, which increases the risk of causing overdue debts. This theory, which is more applicable in the insurance industry, suggests employing solutions such as continuous monitoring of the borrower after granting the facilities and apply the conditions and prohibitive clauses in the text of the loan contract to prevent or reduce the effects of moral hazard (Moradi, 2014).

Also, a theory provided by Allen and Gale (2001) believes that the probability of accepting high risk and consequently the formation of arrears is higher in a decentralized banking system due to the increasing competition between different banks. However, there are also opposing theories that see the lowered interest rates and a stronger accreditation system in a decentralized system responsible for the reduced default risk in this system compared to the centralized system.

Poor management seems to be another reason for the formation of non-performing loans. Factors such as screening inability, incorrect validation, inadequate evaluation of collaterals and documents, poor monitoring of borrowers' performance, and the inefficient debt collection process can lead to overdue facilities (Paidar et al., 2021).

Method

Various domestic and foreign studies have been performed in this area. For example, in a study in 2017 entitled “The application of genetic algorithm models to optimize banks' lending decisions”, Metawa et al. suggest that the use of this model in optimizing banking goals provides the banks with building a loan portfolio by maximizing bank profits, and thus, this method appears to be the best tool for banks to reduce loan screening time. Different studies have been also conducted domestically to examine the factors affecting the non-performing receivables of the country's banks. Some of them include studies done by Kordbacheh and Pordel Nooshabadi (2011), Kheirkhah et al. (2016), Mehrabian and Seifipour (2016), and Hakimipour (2015) who have evaluated the reasons for the postponement of bank receivables from the perspective of macroeconomic factors or banking characteristics and features, while they have neglected to examine the characteristics of customers (people using the loans). Akhundi and Mojarad Alaei (2016) suggest that the future of Iran's banking system and preventing the bankruptcy of banks are strongly influenced by the trend of outstanding receivables and the Iranian banking system alone cannot solve this problem due to the involvement of influential external factors, absence of internal motivation, and the force of the economic sphere. Louise et al. (2011) studied the effect of macroeconomic factors and banking-specific factors on the ratio of non-performing receivables among the various types of loans in Greek banks. Their results revealed a negative relationship between the ratio of overdue receivables to the total facilities granted by the bank with the GDP growth. They also found that the GDP has the highest and lowest impacts on the granted commercial loans and mortgages, respectively, while the unemployment rate, real interest rate, and the amount of facilities granted have positive effects on the ratio of non-performing receivables of banks. Castro (2013) assessed the relationship between macroeconomic

developments and bank credit risk and the factors affecting delayed receivables in Greece, Ireland, Portugal, Spain, and Italy. His findings indicated that the poor conditions of macro variables have played a highly decisive role in increasing the overdue receivables of banks during the study period.

This study can be classified as an applied research in terms of objective, while it can be seen as a descriptive research based on the nature of the work. It also belongs to modeling studies in terms of type and is a cross-sectional type in terms of time. It is worth noting that since the study involves different categories of factors or individuals with different traits to identify the reasons for the occurrence of overdue receivables and reduce them, thus, our process in working on these factors will be as follows:

1. Determining the main agent (customer-bank)
2. Determining the type of customer (1-2-3-4-5)
3. The process of determining the type of customer based on the “5 Cs” method

The “5 Cs” method refers to the method used by the lender to estimate the recipient's credit and repayment financial power. In this model, 5 main indices of the borrower are evaluated to estimate the probability of his non-repayment. These 5 indices are as follows:

1. Character: This index is determined depending on the personality of the borrower and depends on factors such as education level, employment status, marital status, the background of his/her repayments on other facilities, and his/her personal credit.
2. Capacity: It refers to a person's capacity for repayment. This validation index depends on several factors such as the amount of income of the borrower, the intervals of receiving the salary, the probability of receiving the salary at a certain time, and the repayment power of a person or entity by considering his other obligations and debts.

3. **Capital:** It refers to the capital invested in a business that the lending institutions expect to repay their loans by making the capital into liquidity at the time of bankruptcy or the deferral of the loan.
4. **Collateral:** It refers to the collateral that the borrower puts in the hands of the lender after receiving a loan.
5. **Condition:** It is related to the economic conditions of the world and the country. Naturally, the likelihood of repayment of facilities will be lower in improper economic conditions or recession.



Figure 2. "5 Cs" method

4. Determining the type of bank customers
5. Determining the agent banks (credit policies, bank management performance, file expert validation, interest rates on facilities, and central bank notified rules)
6. Determining the type of bank branches (type A: strict, type B: moderate, and type C: easy-going)
7. Determining the output of the simulation
8. Defining the system input based on new-comer customers;
 - At this stage, we need to determine that:
 - 8.1 What is the probability of requesting a loan from a new customer?
 - 8.2 What is the probability that the customer is of type 1, 2, 3, 4, and 5?
 - 8.3 The probability rate of the loan is multiplied by the probability rate of the customer.
9. Model simulation (defining the scenarios):
 - 9.1 Continuing the current situation without attracting a new customer;
 - 9.2 Calculating the input to output ratio (input/output);
 - 9.3 Analyzing the sensitivity of the system output to each of the 5 Cs;
 - 9.4 Evaluating the input so that the number of type "B" customers would decrease but the number of loans increases at the same time.

Findings

We used the agent-based modeling (ABM) method in this study due to the complexity and dynamics of the problem. Agent-based modeling is a novel approach to the modeling of systems that are formed of interacting independent agents. The ABM is recognized as one of the most attractive advances in modeling since the emergence of databases; this goes so far as to claim that the ABM has the potential to change our way of thinking about explaining social phenomena (Epstein, 1996). Each customer whose facilities are available is defined as an intelligent agent in this method and interacts with other agents.

- **Modeling and model simulation**

Agent-based modeling (ABM) is one of the novel and highly crucial techniques. The ABM relies on the assumption that the behaviors of agents interacting with each other who are faced with an event or decision can be simulated by a set of rules (Exelrod, 1997). Agent-based modeling is different from conventional approaches in the sciences that are either based on induction or inference. The ABM's goal is to analyze highly unpredictable behaviors aimed at observing the collective behavior models of agents and analyzing the process by affecting or changing them (Adel Azar and Sadeghi, 2012).

- The characteristics of the designed model

- **Model assumptions**

Some assumptions are applied in implementing the agent-based simulation in this research aimed at avoiding unnecessary complexity of the model or due to failure to access detailed data related to the repayment behaviors of the borrowers (non-provided by the bank), which are listed below.

- A. The simulated model in this study has not considered how the bank seizes credit sources. In other words, by ignoring the deposit behavior, the present model assumes that there have been no restrictions on the bank's access to credit resources.
- B. We have considered the impact of the factors and variables affecting them (individual characteristics, bank features, and

macroeconomic conditions of the country) on the repayment behavior of the loan borrowers as a linear function.

C. The agent-based simulation in this study has been performed with the assumption of zero profit due to the inaccessibility of detailed data related to the interest rate and the principal loan received by the borrowers in this bank as well as the uncertainty of the percentage of interest considered in each loan case. Therefore, the share of each of the performing and non-performing claims simulated in this study was calculated based on the ratio of the total principal of the granted loans to avoid a significant impact on the simulation results.

- Designing the Model

Two groups of agents, including banks and applicants for loans, were defined in this study to simplify the model and prevent further complexity. The following features were considered for each of the above agents.

- The characteristics of the loan applicant

The following seven features were considered in the design of the simulation program for the loan applicant agent.

- Gender: (female and male)
- Education level of degree: (under diploma, diploma, bachelor, master, doctorate, and above)
- Job nature: (employment, freelance, retired, and housewife)
- Credit history: (with current facilities, overdue, deferred, doubtful, and bad debt)
- Capital status: (good, moderate, and weak)
- Type of collateral: (legal collateral such as the obligation to deduct from the salary receiving from the organizations and institutions for which the applicant works, and activity collateral or guarantee, which indicates the type of freelance activity of the applicant, such as legal documents of a business, etc.)
- Amount of loans or facilities: (facilities less than or equal to 100 million Rials, facilities between 100 to 300 million Rials, and facilities above 300 million Rials)

- The characteristics of the agent bank

The following three features were considered in the design of the simulation program for the agent bank.

- The existence of an independent unit for monitoring and evaluating the granted facilities in the branch: This feature is regarded in two different states (with and without this independent unit) for the branch granting the facilities.
- The severity of the branch strictness: This feature is regarded in three different modes (strict branches, ordinary branches, and easy-going branches) for the branch granting the facilities.
- Loan interest rate: This feature is regarded in two different states (loans with interest rates lower than the current interest rate on bank deposits, and loans with interest rates higher than the current interest rate on bank deposits) for the branch granting the facilities.

The conceptual model of components and factors affecting the repayment behavior of loan applicants considered in this study is as the following diagram.

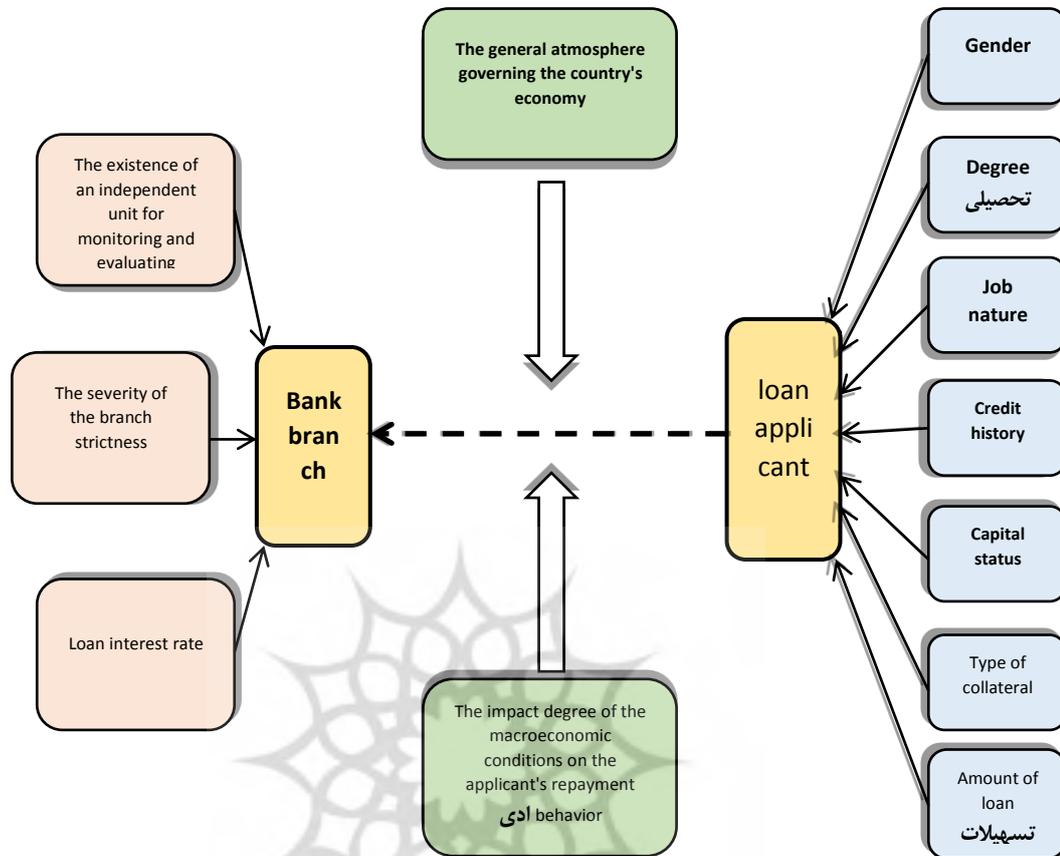


Figure 3. The conceptual model of the research

Therefore, the function of the repayment behavior of the loan applicants was considered as follows:

$$CV_i = \beta_1.sex_i + \beta_2.edu_i + \beta_3.job_i + \beta_4.credit_i + \beta_5.capital_i + \beta_6.coll_i + \beta_7.loansize_i + \alpha_1.assessment_j + \alpha_2.branch_j + \alpha_3.ir_j + \mu_z$$

Equation (1)

In the above equation, *CV* is the value of the risk of granting loans to the *i*th client by the *j*th branch of the bank, and we considered a linear function composed of the following: The gender of the facility applicant (*sex*), the education level of the facility applicant (*edu*), the job nature of the facility applicant (*job*), the credit history applicant of the facility (*credit*), the

capital status of the facility applicant (*capital*), the type of collateral provided by the facility applicant (*coll*), the size of the loan granted to the applicant (*loansize*), the existence of an independent unit for assessing and following up the claims in the branch (*assessment*), the type of branch in terms of strictness (*branch*), and the interest rate of the facilities granted to the customer (*ir*) as well as the impact rate the general economic conditions of the country (μ_z) on the customer's influence. In the above equation, coefficients β indicate the importance degree of the characteristic related to the facility applicant agent in influencing his repayment

behavior, while α coefficients show the importance degree of the agent bank feature in affecting the repayment behavior of the facility applicant.

Table 1.

The value assessment of each of the modes related to the characteristics of the applicant agent and the bank agent in the risk function (objective function)

Bank Agent			Loan applicant agent		
Numerical value of risk	State	Variable	Numerical value of risk	State	Variable
1	Yes	An independent unit for assessment and tracking facilities	1	Male	Gender
2	Female				
2	No	1	Under diploma	Education level	
2	Diploma				
1	Strict	Strictness degree of the branch	3	Bachelor	
4	Master				
2	Moderate	5	Doctorate and higher		
1	Employee of Institutions	Job status			
3	Easy-going	2	Freelance activity		
3	Retired				
2	Lower than interest rates on deposits	Loans interest rates	4	Housewife	
1	Higher than interest rates on deposits	1	Current status	Credit history	
Characteristics of the general economic atmosphere			2	Past due status	
Numerical value of risk	State	Variable	3	Deferred status	
1	Boom	Country's economic situation	4	Doubtful status	
5	Bad debt status				
2	Recession	1	Good	Capital status	
2	Average				
1	Low	The degree of impact of the economic conditions of the country on the applicant business	3	Weak	
1	Legal collateral	Type of collateral			
2	Moderate	2	Activity collateral		
2	Less than 100 million Rials	Loan size			
3	High	1	Between 100 to 300 million Rials		
2	More than 300 million Rials				

Reference (Source): The present study

As seen in the table above, besides the features of the loan applicant agent and the agent bank, the risk function of granting loans to the i th client in this study is a function of the general economic conditions and atmosphere in the country, which may represent itself in two modes of boom and stability and also can be influenced by the degree of impact of the economic conditions of the country on the applicant business.

- The degree of importance of each of the variables included in the model

We used the process of determining the significance of factors in the decision-tree technique with the c5.0 algorithm to determine the relative importance of each of the variables included in the risk function as the objective

function (the β coefficient size). Employing this technique on 110 bank customers from 11 branches chosen by random-cluster sampling method revealed that the relative significance coefficients of the variable of the education level of the loan recipients, the loan size variable, the variable of the type of collateral received by the branch, and the variable of having an independent unit for assessment and tracking facilities in the branch were 1.6, 1/1, 3, and 3 times that of the other variables included in the model, respectively. Thus, the coefficients β_2 , β_6 , and β_7 in the objective function are equal to 1.6, 1.1, and 3, respectively. Also, the coefficient α_1 is equal to 3, and the rest of the coefficients were considered equal to 1.

- The numerical value classification of the risk function by type of customers

The lowest and highest numerical values of the risk function respectively were obtained as 14.7 and 41.2 due to the risk function relationship provided in the previous paragraphs as well as the information given in Table (4-1) and determining the values of the coefficients of the variables studied. It was found by a glance at the numerical value of the risk function in the statistical sample that the customers type I (recipients of loans who had current facilities)

were in the range of numerical value between 14.4 to 27 and the customers type II (recipients of loans with past due installments) occurred in the numerical value range between 27 and 33.9. The customers type III (recipients of loans with deferred installments) fell within the range of numerical value between 33.9 to 38.5 and the customers type IV (recipients of loans with doubtful installments) were in the numerical value range between 38.5 and 41.2. The customers type V (recipients of loans with bad debt installments) have been usually of the customers of type III and IV who have faced unexpected events such as death or bankruptcy. On average, 2% of the recipients of loans in the studied branches had bad debt installments. This ratio seems to have somehow remained unchanged in recent years.

- Model simulation in the NetLogo software

We utilized the risk function calculated for each customer to simulate the repayment behavior of the bank customers. Since the variables included in the examined function are approximately stable for an individual during different intervals (such as variables gender, collateral type, loan size, credit history, an independent loans assessment or tracking unit in the branch, interest rate of the loans, and the degree of strictness of the branch) or some of them with the potential to change (such as variables education level, job, or individual capital status) cannot be monitored by the bank after the granting process, thus, in a general state for the loan borrowers, their repayment behavior and change of status among different types of customers (customers I to V) were considered as a function of economic conditions of society, the conditions of the impact of the economic conditions of the community on the customers' business, and a variable with a normal distribution nature. Therefore, in general, the possibility of changing the type of customers studied in future time intervals was simulated under the following function.

$$\mu_z = \theta \cdot \tau_t + \varepsilon_t \quad \text{Equation (2)}$$

In the above equation, μ_z is the same component affected by the general economic conditions in equation (1-4), which is a function of the period of economic boom and recession of society τ_t and the coefficient (θ) capable of influencing the customer's repayment behavior by affecting his business situation. Also, the phrase expression is included in the equation as a random variable with a mean of zero and a variance of 0.02, which shows the effects of other variables not entered in the model.

It should be noted that we used a positive normal exponential distribution with a mean of

+0.05 to show the recession period and a negative normal exponential distribution with a mean of -0.05 to show the boom period (since the increased numerical value of the risk function implies the rise in the risk of repayment of the loan by the customer).

$$\theta \begin{cases} \text{Low} & = 0.6 \\ \text{Moderate} & = 1 \\ \text{High} & = 1.2 \end{cases}$$

A view of the simulated program in the NetLogo software, Ver. 6.0.2 is displayed in the following figure.

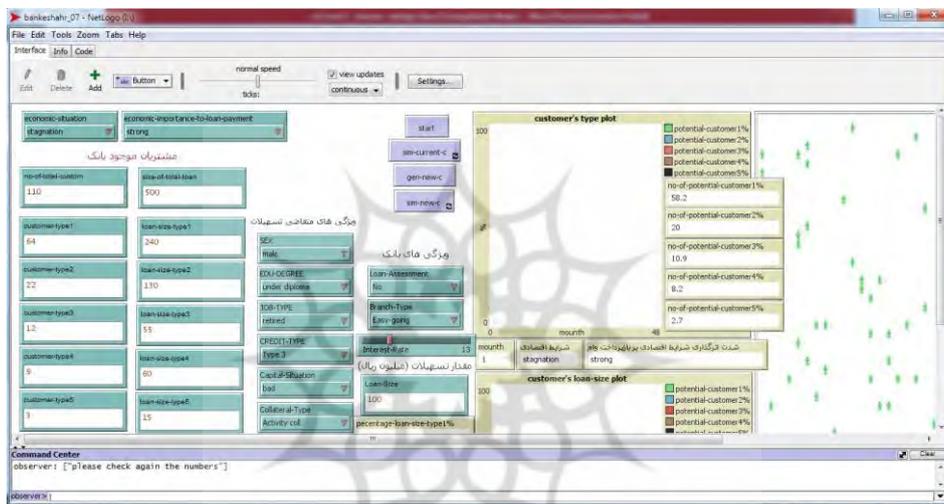


Figure 4. A view of the non-performing receivables simulation program

- Assessing the validity of the designed model

We used the comparison of the repayment status of a 100-customer sample in the past year and now to assess the simulated model. The following tables show the actual combination predicted by the designed model for different types of customers and the share of each of their debts at the present time.

Table 2.

The actual and simulated ratio of different types of customers in a 12-month period (from last year until now) – In percentage

Type of customer	Actual Ratio	12-Month Simulation (Current Conditions)					Simulation	Actual Ratio
	12 months ago	First time	Second time	Third time	Fourth time	Fifth time	An average of 5 times	At Present
Customer Type 1	59	57	55	56	55	57	56	55

Customer Type 2	19	20	22	20	22	20	20.8	21
Customer Type 3	11	11	10	10	8	9	9.6	9
Customer Type 4	10	10	11	12	13	12	11.6	12
Customer Type 5	2	2	2	2	2	2	2	3

Reference: Research findings

Table (3).

The actual and simulated ratio of the share of bank receivables by types of customers over a 12-month period – In percentage

Type of customer	Actual Ratio	12-Month Simulation (Current Conditions)					Simulation	Actual Ratio
	12 months ago	First time	Second time	Third time	Fourth time	Fifth time	An average of 5 times	At Present
Customer Type 1	47.9	46.9	44.7	45.6	44.7	46.4	45.6	45.1
Customer Type 2	26.2	25.7	27.9	26.3	27.9	26.3	26.8	27.1
Customer Type 3	10.7	11.4	10.4	10.4	8.4	9.4	10	9.9
Customer Type 4	12.1	13	14	15	16	15	14.6	14.6
Customer Type 5	3.1	3	3	3	3	3	3	3.3

Reference: Research findings

One can realize due to Table 2 that the study simulation model has managed to achieve high accuracy in predicting the number of types of customers over the past 12 months to bring a very high approximation of the actual (real) results through the average of the simulation results in 5 consecutive times. The estimation results of the simulation model, as well as the actual results, imply that the number of customers type 1 (with current repayment status) has decreased during the last 12 months and the number of customers type 2 (with past due repayment status) has increased. In general, based on comparing the predicted results of the

designed model with the actual results, the designed model appears to have a high level of credibility.

- The evaluation of scenarios

The results predicted by the designed model concerning the ratio of different customers in a 48-month period during the recession conditions under three different scenarios of low, moderate, and high impact of bad economic conditions on the business of the bank's current customers are provided in the following tables. Therefore, the actual situation of the ratio of the number and share of receivables of different types of customers at the beginning of the year has been as follows.

Table 4.

The actual statistics of the ratio and share of receivables at the end of the fiscal year of 2018

	Current Customer	Past Due Customer	Deferred Customer	Doubtful Customer	Bad Debt Customer
The ratio of number of types of customers (%)	89	5.7	2.7	2	0.7
The ratio of the share of receivables (%)	29.6	5.4	44.6	17.21	3.1

Reference: Research findings

Table 5.

Forecasting the ratio and share of customers' debts at the end of the next four years in the recession condition

Types of customers	The ratio of customers in three separate scenarios of the impact rate of recession conditions on customers' business (%)			The share of bank receivables from customers in three separate scenarios of the impact rate of recession conditions on customers' business (%)		
	Low	Moderate	High	Low	Moderate	High
Current customers	81.34	80.5	72.52	27.1	26.8	24.18
Past due customers	13.26	13.94	21.04	7.94	8.06	9.9
Deferred customers	1.9	1.98	2.2	31.26	30.3	19.96
Doubtful customers	2.8	2.88	3.54	30.6	31.74	42.36
Bad debt customers	0.7	0.7	0.7	3.1	3.1	3.1

Reference: Research findings

As the current trend of bank customers continues, one can see that with the continuation of the economic recession, based on the information given in the table above, with a low impact of the recession on the customers' business in the next four years, the current customers ratio will drop from about 89% to about 81%. Whilst the ratio of the past due customers will increase more than double, reaching about 13%.

Table 6.

The forecast of the ratio and share of the customers' debts at the end of the next four years in the boom conditions

Types of customers	The ratio of customers in three separate scenarios of the impact rate of recession conditions on customers' business (%)			The share of bank receivables from customers in three separate scenarios of the impact rate of recession conditions on customers' business (%)		
	Low	Moderate	High	Low	Moderate	High
Current customers	90.24	90.24	91.62	31.13	30.84	32.14
Past due customers	5.28	5.72	4.18	18.8	26.54	21.92
Deferred customers	2.84	2.34	3.52	40.23	30.9	42.86
Doubtful customers	1.6	1.6	0.7	9.76	11.7	3.1
Bad debt customers

Reference: Research findings

However, if the impact rate of the economic situation on the business of customers has been moderate in the same economic boom conditions, then, based on the results of Table 6, one can see that the overall results will not differ from the first scenario and the figures of increase in the ratio of current customers and decrease in the ratio of non-performing customers would be so similar to the first scenario. Hence, under the second scenario, the number of customers with non-performing

The model prediction on the ratio and share of different customers' debts in a 48-month period in the economic boom conditions

If the current trend of customers continues, one can realize from the information given in Table 6 that in the case of continued economic boom conditions in the next four years, with a low impact of the boom on the customers' business, the bank's current customer ratio will rise from about 89% to about 90%. Whilst the proportion of the bank's past due customers will slightly decrease from 5.7% to about 5.2%.

installments will reduce from the current 11% to about 10%.

- Simulating the status of the new loan applicant and the analysis of the model sensitivity to changes in the input of the customer agent

We used a sample with the following customer agent specification to assess the payment status of a new loan applicant. We considered a customer with a diploma in the first case and a customer with a master's degree in the second case aimed at analyzing the model

output sensitivity as well as the model output sensitivity to the new customer repayment behavior.

Table 7.
The feature of the new applicant in the simulation model

Amount of requested loan (Million Rials)	Type of collateral	Capital status assessment	Credit history	Job status	Education degree	Applicant's gender
500	Activity license	Average	Type II	Freelance	Diploma	Male

Reference: Research findings

Table 8.
The characteristics of the bank agent in the simulation model

Loan interest rate (%)	The branch strictness degree	The existence of an independent facility assessment and tracking unit in the branch
18	Moderate	-

Reference: Research findings

- **Input change:** The change of the customer agent degree from diploma to master's degree

In the simulation model, the status of the bank's existing customers is entered as the actual status in the relevant field. Also, the macroeconomic conditions of the country and the impact rate of the recession on the business of the bank's customers are chosen "in the state of recession" and "moderate status", respectively, to be somewhat consistent with the realities of society. The ratio and share of different customers' debts after a 4-year period are provided as following tables:

Table 9.
The ratio (percentage) of different customers by changing the status of the applicant's degree

Status of inputs	Ratio of different customers (percentage)	New customer status
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	Customer Type 1	Customer Type 2	Customer Type 3	Customer Type 4	Customer Type 5	
In the current situation (without a new applicant)	80.5	13.94	1.98	2.88	0.7	-
In the state of the degree: Diploma	79.68	19.94	1.86	2.86	0.7	Blue (in the past due state)
In the status of degree: Master	80.46	13.98	1.72	3.22	0.7	Green (in current status)

Reference: Research findings

Table 10.
The share of bank receivables from different customers by changing the status of the applicant's degree

Status of inputs	Share of different customers' debts (percentage)					New customer status
	Customer Type 1	Customer Type 2	Customer Type 3	Customer Type 4	Customer Type 5	
In the current situation (without a new applicant)	26.8	8.06	30.3	31.74	3.1	-
In the state of the degree: Diploma	26.64	8.38	30.16	31.7	3.1	Blue (in the past due state)
In the status of degree: Master	24.84	8.18	34.62	27.24	3.1	Green (in current status)

Reference: Research findings

Based on the information in the tables and diagrams above, one can realize that, first, the customer's repayment status changes from the past due to the current (performing) state by changing the status of the applicant's degree from a diploma to a master's degree with the stabilized other conditions of the customer and the bank agents. Second, some changes are made in the ratio of customers and the share of bank receivables from different types of customers.

- **Simulating the status of the new loan applicant and analyzing the sensitivity of the**

model to the change of input of agent bank and customer

We used a sample with the following customer agent specification to assess the payment status of a new loan applicant in this section.

Table 11.
The new applicant characteristics in the simulation model

Applicant Gender	Degree	Job status	Credit history	Assessment of capital status	Type of requested collateral	Amount of loan (Million Rials)
Female	Bachelor	Freelance	Type II	Average	Activity License	500

Reference: Research findings

Table 12.
The features of the agent bank (branch) in the simulation model

The existence of an independent facility assessment and tracking unit in the branch	The branch strictness degree	Loan interest rate (%)
No	Moderate	18

Table 13.
The ratio (percentage) of different customers by changing the input variables of agent bank and customer

New customer status	Share of different customers' debts (percentage)					Status of inputs
	Customer Type 5	Customer Type 4	Customer Type 3	Customer Type 2	Customer Type 1	
-	0.7	3.54	2.2	24.04	75.52	In the current situation (without a new applicant)
Red (in deferred status)	0.7	3.4	2.52	21.68	71.62	In the status of the initial characteristics of the agent bank and the customer
Green (in the current status)	0.7	3.38	2.74	20.62	72.64	In the status of changing some features of the agent bank and the customer

Reference: Research findings

Table 14.
The share of bank receivables from different customers by changing the input variables of the agent bank and the customer

New customer status	Share of different customers' debts (percentage)					Status of inputs
	Customer Type 5	Customer Type 4	Customer Type 3	Customer Type 2	Customer Type 1	
-	3.1	42.86	19.96	9.9	24.18	In the current situation (without a new applicant)
Red (in deferred status)	3.1	42.86	20	10.1	23.94	In the status of the initial characteristics of the agent bank and the customer
Green (in the current status)	3.1	40.62	22.5	9.58	24.2	In the status of changing some features of the agent bank and the customer

Reference: Research findings

- Change of the input: Changing the type of collateral of the customer agent from the activity license to the obligation of the employment legal deduction

- Change of the input: Changing the existence of an independent loans assessment and tracking unit in the branch from “No” to “Yes”

- Change of the input: Changing the degree of strictness of the branch from moderate to high

In the simulation model, the status of the bank's existing customers is entered as the actual status in the relevant field. Also, the macroeconomic conditions of the country and the impact rate of the recession on the business of the bank's customers are chosen “in the state of recession” and “high status”, respectively. The ratio and share of different customers' debts after a 4-year period are provided as following tables:

Reference: Research findings

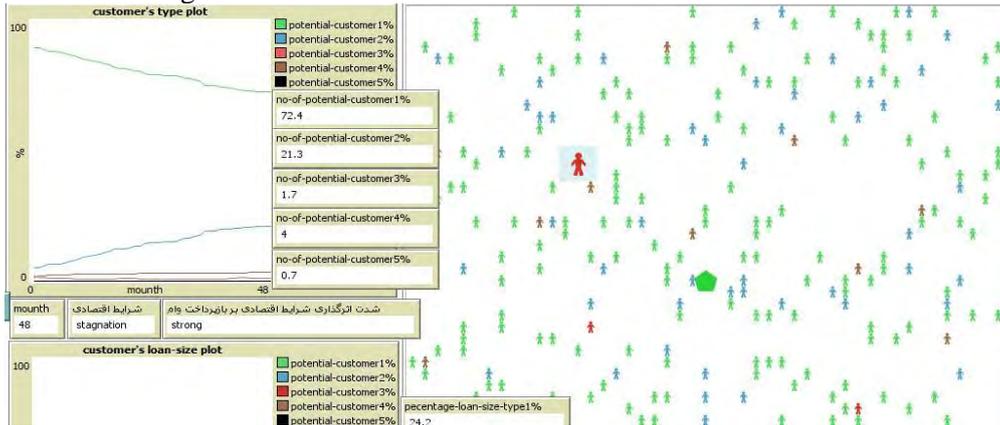


Figure 5.

A view of the output of one of the simulation times before changing the characteristics of the agent bank and the customer and the applicant's deferred repayment status

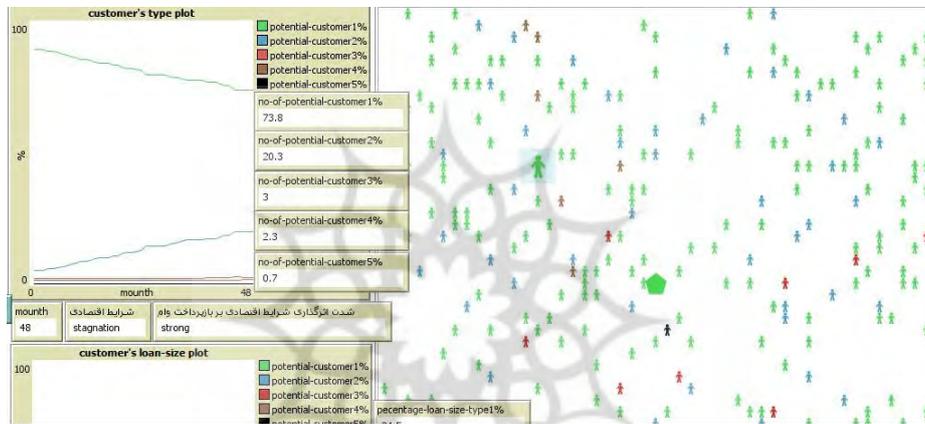


Figure 6.

A view of the output of one of the simulation times before changing the characteristics of the agent bank and the customer and the applicant's current repayment status

Based on the information in the table and diagram above, one can realize that, first, the customer's repayment status changes from deferred (red) to current (green) by changing two features related to the bank agent and one characteristic related to the customer agent with the stability of other conditions. Second, some changes are made in the ratio of customers and the share of bank receivables from different types of customers. However, due to the low weight of the new customer among the bank's current customers (in terms of the number, 1 to 300 customers, and in terms of facilities, about 500 to 17697000), the average results of 5 simulations has similarly managed to lead to the

relative increase in the ratio and share of type 3 customer debts in the initial state and a relative increase in the ratio and share of type 1 customer debts in the second case. Thus, in this case, the ratio and share of current customers' debts have been in the highest situation among the three studied situations.

Conclusion and Suggestion

Due to the results of the simulations made in this study, in which, the averages of figures were reported after 5 times of the simulation process in the previous chapter for the strength of the findings, it was found that the model designed for simulation has revealed a high potential in

predicting the ratio and share of different customers' debts in a 12-month period. Accordingly, comparing the situation at 12 months ago with the current situation of a sample of 100 customers demonstrated that the designed model has successfully predicted the current state of the above sample with high accuracy.

In the next step, we tried to simulate the future status of the ratio and share of the current bank customers' debts in the next 4 years (assuming the stability of current customers in the next 4 years) under two general scenarios, including the continuation of the current economic recession or the change of economic conditions of the society towards economic boom and its continuity for four years. The simulation results indicated that the bank will lose 9 to 18% of its type I customers (customers with the nature of current installments repayment) in the next 4 years with the continual of the current recession condition depending on the impact rate of economic conditions on the business of customers. These customers will often have overdue installments. However, in the same case, some customers with currently overdue installments will fall in the category of doubtful customers as the repayment situation worsens. Thus, depending on the impact rate predicted in the model, the number of doubtful customers of the bank will increase from 0.8% to 1.5%.

Also, if the current recession trend continues, based on the simulation results, 3 to 6% of the bank's current receivables will turn to non-performing status depending on the impact date of the recession on the business conditions so that most of these receivables claims will become natured. The share of the bank's past due receivables is expected to increase to nearly 2 times the starting situation of the simulation.

The simulation results in the economic boom scenario also demonstrated if Iran's economy enters a boom period, which will last for the next 4 years, the ratio of the number of the bank's customers with the current repayment status would increase from about 1.2% to 2.2% depending on the severity of the impact of the

economic situation on the business of customers; i.e., at the highest impact rate of the boom on the business situation of the bank's customers, a 2.2% rise in the ratio of the number of current customers of the bank may be predicted. Also, under the above conditions, the share of the current receivables of the bank will improve from 1.5% to 2.7%. A major part of this improvement will be realized through a reduction in the share of past due receivables.

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