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The Impact of Provisioning Policies on Non-Performing Loans

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The Central Bank has specific regulations, including asset classification guidelines and how to perform loan's loss provisioning to oversee banks and credit institutions. The Central Bank seeks to improve the quality of the loan and reduce the amount of non-performing loans by reducing the revenues of the bank or credit institution through imposing fine on balance of each of the categories of non-performing loans. In this study, the effectiveness of this policy has been investigated using the system dynamics method. The results of the research indicate that the application of the above policy would at least lead to a 17% reduction in the amount of non-performing loans' accumulation. Research suggests that, if the coverage factor of a pledge during the provision of loan, increases the effectiveness of the policy in the fight against the accumulation of non-performing loans will be eliminated. This phenomenon suggests that the Central Bank needs to focus more on preventive regulatory approaches than on a priori methods in monitoring the credit institutions in providing a loan.

Keywords: Monetary Policy, System Dynamics, Non-Performing Loans**.**
JEL Classification*:* E58, G29

1 Introduction

Due to its crucial role, the financial system occupies a significant position in an economic system. This key role can be summarized in two terms: "mobilization" and "allocation of resources." According to the Law for Usury-Free Banking, one of the most important functions of the banking system in Iran is the absorption of deposits (mobilizing resources) and the provision of the loan (allocating resources) for various sectors as well as overseeing the sound circulation of money and credit.

The banking system is subject to some risks in attaining its goals; one of the most important of which is encountering non-performing loans and ultimately write-offs. Policies adopted by the Central Bank are among the factors that have a potential impact on non-performing loans. The evaluation

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of the impact of these policies on the amount of non-performing loans could affect the management of non-performing loans. There is a dependency of the resource allocation process (provision of the loan) on the policies adopted by the Central Bank, such as variations in bank reserve rate, variations in the amount of loan loss provisions, and variations in the interest rates on the loan and deposits.

Currently, one of the supervisory methods employed by the Central Bank for monitoring banks and credit institutions is the provisioning policy, which refers to controlling the accumulation amount of non-performing loans through the imposition of costs on the outstanding balance of all categories of non-performing loans. At the end of the fiscal year, banks are required to maintain a general provision for their claims, equal to 1.5 percent of their credits, as well as a special provision through the transfer of credits from the current category to any of non-performing categories, namely overdue, past due, and bad. On that account, the costs of general and special provisions will be added to the bank expenses by transferring each credit from the current category to the non-performing category. Should the claims become uncollectible, indirect expenses such as the opportunity cost, in addition to the direct expenses mentioned above, will lead to an increase in the investment cost for the bank. In addition to the costs of general and special provisions for non-performing loans, the recovery process of bank claims is associated with a high cost, as well.

Provided that the banking system is regarded as an economic system, mobilization and allocation of resources will be considered as one of the main functions of this system. Given the intricate and complex interactions within the banking system, the nonlinear relationships among the factors influencing the system, and the closed-loop feedback such as the impact of bank profit rates on the process of mobilization and allocation of resources, system dynamics is held to be the proper approach to analyze the behavior of the system.

Accordingly, the complex dynamics of banking operations leads to the question as to whether it would be possible to control the accumulation amount of non-performing loans merely by employing the mechanism of provisioning. The present research addresses the evaluation of the efficiency of provisioning policies in controlling the accumulation of non-performing loans utilizing the system dynamics method. An examination of the previously conducted studies shows that the main focus of researchers, regarding non-performing loans, has been on the influencing factors rather than on the coping strategies. Moreover, concerning the factors affecting non-performing loans,

the focus has been mainly on macroeconomic factors as well as features and characteristics of banks. Consequently, one of the distinctive aspects of the present study is the investigation and evaluation of strategies to cope with the problem of non-performing loans in addition to choosing the best policy in this regard.

Based on the review of the activities performed in the field of financial science, system dynamics tools have been employed to make policy performance consistent with a system. Up to the present, among the investigated studies, not only this tool has not been utilized to analyze strategies of combating non-performing loans, on the contrary, its initial base model has still not been developed. For that reason, another distinctive aspect of the present study is the development of a system dynamics base model and employing it to evaluate the effectiveness of the proposed strategies on non-performing loans.

2 Theoretical Framework

2.1 Types of Bank Claims and Their Classification

Among the variety of bank claims, some may lead to delayed repayment or may not be paid back at all. The Central Bank elaborates on this issue and classifies bank assets in the "Guideline for Asset Classification of Credit Institutions." In this guideline, the loans are classified into four categories based on their quality:

1) **The first category: Current.** The payment of principal and interest of the loan is made in due time, or they are maximum two months overdue.
2) **The second category: Non-performing / overdue.** The repayment of the principal and interest of loan in due time or the repayment of installments has been delayed for more than two months but not exceeded six months.
3) **The third category: Non-performing / past due.** The repayment of the principal and interest of loan in due time or the repayment of installments has been delayed for more than six months but not exceeded eighteen months.
4) **The fourth category: Non-performing / bad.** The repayment of the principal and interest of loan in due time or the repayment of installments has been delayed for more than eighteen months.

The quality of each loan is assessed based on three parameters of time, customer's financial condition, and the relevant industry or field of activity. For the sake of brevity, only the time factor has been addressed in the above statements.

2.2 The Relationship between Provisioning Policies and the Accumulation Amount of Non-Performing Loans

The supervisory authority in the money market, the Central Bank, has other responsibilities including the regulation of credit institutions, in addition to adopting monetary policies. Regulation comprises various features. The four components of regulation are lawmaking, supervision, compliance, and monitoring (Bahador, 2016). The Central Bank supervises and monitors credit institutions through standardizing the techniques used to measure their risk exposure and obliging them to comply with it. The problem of non-performing loans poses some risks to the credit institutions at both macro and micro levels, the most prominent instance of which is a credit risk.

Banks are exposed to several risks, avoiding which is not within the authority of credit institutions. However, credit institutions are exposed to certain risks due to the decisions taken. Correspondingly, credit risk arises from decisions made by the credit institutions as well as involuntary factors. Considering the nature of the risks arising out of credit risk and the tendency of credit institutions toward providing a loan, the Central Bank, as the monetary regulatory authority, has considered costs for credit institutions' exposure to credit risk (Hosseinpour, 2017).

Given that a percentage of credit risk is imposed on a credit institution by its performance and decisions assigning a cost as compensation for undesirable performance can, in some circumstances, lead to the improvement of the institution's performance. The mechanism for the effectiveness of the provisioning policy will be set up through a reduction in the profit of the credit institution and, consequently, a reduction in dividends distributed among shareholders resulting in the dissatisfaction of shareholders. On condition that a proper corporate governance structure is put in place in credit institutions, the dissatisfaction of shareholders will lead to a change in the management or the management styles at credit institution, and thereby the credit risk caused by the credit institution's performance will be reduced. Consequently, modification of special provision rates for non-performing loans is another instrument employed by the Central Bank to monitor the performance of credit institutions. The most basic prerequisite for increasing the efficiency of the monitoring policy is the bank's response to the imposed costs in case of accepting credit risk (Hosseinpour, 2017).

The Central Bank has issued the prudential regulations on this matter under the title of "Guideline for Calculation of Provisions for Claims of Credit Institutions." Based on this regulation, to impose costs on credit institutions in case of generating non-performing loans, penalties are applied to the

outstanding balances of overdue, past due, and bad categories. Thus far, however, no regulations have been issued regarding the establishment of corporate governance in credit institutions, and there have been merely recommendations.

3 Research Background

Although numerous studies have been carried out on claims and factors influencing them, no research has been conducted thus far on the impact of provisioning method on the number of claims through the adoption of the system dynamics approach. Related studies on this topic are briefly presented below:

In his article, "Inside the Bank Lending Channel" (2005), Gambacorta has tested the effect of cross-sectional differences among various banks in Italy on the transmission of monetary policies through bank lending.

To conduct the study, he has employed the model of Kashyap and Stein (1993) and the generalized method of moments (GMM). The results of his research suggest that there is significant heterogeneity in the response of Italian banks to the monetary policies. Banks subject to higher fragility due to their size, liquidity, and capital are more sensitive to monetary policies. Besides, banks with higher liquidity are capable of using their cash balance and securities to prevent a decrease in lending during the tight monetary policies.

Glen and Mondragón (2011) have investigated the effects of business cycles on the performance of commercial bank loan portfolios in developing economies from 1996 to 2008. They indicated that while economic growth is the main driver of loan portfolio performance, interest rates have second-order effects (interest rates have a second-degree relation with the performance of commercial bank loan portfolios in the course of economic growth). Additionally, they realize that there is a highly non-linear relationship between loan loss provisions and economic growth, merely under extreme economic stress.

Macit (2012) has investigated the non-performing loans ratio for the fifteen largest commercial banks in Turkey using quarterly data for 2005 to 2010. According to him, both bank-specific and macroeconomic variables cause fluctuations in the non-performing loans ratio.

Buncic and Melecky (2012) have studied the influencing factors on the non-performing loans ratio using the generalized method of moments using panel data of 45 high- and middle-income countries for 1994 to 2004. The explanatory variables comprise the lagged non-performing loans ratio, GDP,

the consumer price index, the real interest rate, and the changes in the US dollar exchange rate for each country; and the control variables consist of logarithm of GDP per capita, the credit to GDP ratio, and the share of foreign currency loans in total loans. The results of the study indicate that changes in the US dollar exchange rate and the control variables do not have significant effects on the non-performing loans ratio.

Beck et al. (2013) have investigated the role of macroeconomic determinants across 75 developed and developing countries in the period 2000 to 2010. According to the results of the study, GDP, the nominal exchange rate, and the real lending interest rate significantly affect the non-performing loans ratio.

Perera et al. (2014) have studied the impact of off-balance-sheet banking on the bank lending channel in monetary policy transmission using a panel data set for 114 South Asian commercial banks. They realized that banks with unbalanced balance sheets reduce the efficiency of the bank lending channel in monetary policy transmission. Banks with exposure to off-balance sheet activities can insulate their loan supply against the fluctuations above during monetary policy shocks, and, thus, create a buffering effect on monetary policy transmission.

Ghosh (2015) has examined the role of banking-industry specific and regional economic determinants on the amount of banks' non-performing loans. To this end, a total number of 50 savings institutions and commercial banks in the US were investigated for 1984 to 2013. Using the GMM model, he demonstrated that greater capitalization, liquidity risks, poor credit quality, cost inefficiency, and banking industry size lead to an increase in non-performing loans, while greater bank profitability decreases the non-performing loans. His study is indicative of the fact that higher level of GDP, personal income growth, and changes in housing price levels cause a reduction in non-performing loans, whereas inflation, unemployment rate, and the state public debt cause a rise in them.

The following cases are studies conducted in the field of financial science using system dynamics.

Blanc and Peterson (2012) have adopted system dynamics to demonstrate that internal parameters of the banking system have an impact on the process of money creation. That is to say, the fluctuation in the process of bank deposits declines as a result of increasing the lifetime of deposits, decreasing the lifetime of loans, and increasing the reserve rate, hence a decline in the probability of banking crises.

Booz Allen Hamilton (2011) has investigated the dynamics degree of bank-based financial systems through system dynamics. They have developed a system dynamics model able to represent a bank's behavior in mobilization and allocation of resources and expanded the functions of this tool in the financial sector.

Among domestic researches, Hashemi Nodehi (1998) has explored the causes of past due to receivables and overdue claims of Maskan Bank for 1986 to 1997. His research confirmed that the amount of claims is affected by the market interest rate variables, the interest rate variations on the loan, the penalty rate, and the interest rate of the unorganized money market.

In a study under the title of "Analyzing the Impacts of Monetary Policy Shock on Banking Network Loan," Mirhashemi (2011) has investigated the impacts of monetary policy shock on banking network loan in Iran through testing the bank lending channel. To this end, she has assumed that banks' lending is affected by the characteristics of banks' balance sheets, namely the liquidity ratio, the capital adequacy ratio, and the relative size of banks. To evaluate this impact, two different models are employed, both of which complement each other and are estimated by the generalized method of moments. The results of the study are indicative of a significant impact of the liquidity ratio, the capital adequacy ratio, and the relative size of banks on bank lending in Iran, which is intensified through the implementation of the monetary policy. Even though the existence of a bank lending channel in Iran is confirmed due to the significant changes in these variables, i.e., the liquidity ratio, the capital adequacy ratio, and the relative size of banks, this impact is negligible.

Mousavi Haghighi et al. (2014) have employed system dynamics to investigate money multiplier dynamics and liquidity cycles in the banking system of Iran. They demonstrated that financial crises could be exacerbated by internal determinants in addition to determinants outside the banking system such as non-repayment of bank claims. As represented by them, the level of deposit fluctuations in a banking system will increase as a result of increasing the lifetime of loans and reducing the time of converting liquidity to loans. Besides, according to their research, banks are required to reduce the lifetime of loans, increase the reserve rate, and increase the lifetime of deposits to reduce the probability of bank crises and the risk of non-repayment of bank debts.

Noroozi (2014) has studied the effect of macroeconomic variables on credit risk of banks in Iran for 2007 to 2013 using the generalized method of moments. Findings of his research indicated that the credit risk of banks is

affected by macroeconomic variables. To be specific, the credit risk of banks has a positive relationship with the real interest rates on loan, the inflation rate, public debt, and the unemployment rate and a negative relationship with the gross domestic product growth. Besides, bank characteristics, including size and profitability, have a negative impact, and credit risk of the previous term has a positive impact on the credit risk of banks.

Hosseinpour and Aghababaei (2017) have investigated the impact of monetary policies on the amount of non-performing loans of banks through the system dynamics approach. In this research, they have concluded that changing the interest rates on loan and deposits does not have a significant effect on the amount of non-performing loans. Meanwhile, adopting provisioning mechanisms will lead to more efficiency in reducing the balance of non-performing loans.

Mohammadi et al. (2017) have studied the influential factors in shaping the non-performing loans in the banking system of Iran. This research has been conducted using a descriptive survey method. The statistical population comprises branches of one of the banks throughout the country. The results indicate the most significant factors influencing the increase of non-performing loans in the banking system of the country. They are as followed: The discrepancy between the collaterals and guarantees and the bank's internal regulations and policies, technical and specialized credit restrictions, unsuitable supervisory process for the use of loan and recovery of claims, inadequate interest rate and penalty policies, legal obligations and restrictions, economic sanctions, and inappropriate business environment and credit assessment are considered as infrastructural factors and causes of non-performing loans. These seven factors compose 46 percent of the variance in the dependent variable, i.e., non-performing loans in the banking system.

Hakimipour (2018) has evaluated the effective factors on non-performing loans in Iranian banks using the generalized method of moments. According to the findings of this research, the last interruption in non-performing loans, the equity turnover rate, the ratio of granted loan to assets, the ratio of equity to assets, and the rate of granted loan have a significant impact on the generation of non-performing loans in the banks across the country.

4 Research Methodology

Banks act as a financial intermediary, which they receive funds from owners of excess resources and distribute them among those who need resources. It is a general description of a bank's function. A more meticulous look into banks' operations, however, reveals that a bank is composed of particular units with

different duties, fulfilling the main function of the bank as a financial intermediary. In other words, a bank is composed of different divisions in the same way that a system comprises several components. Different approaches are adopted to study systems. The simulation method is one of the common methods in system analysis. In the present study, the system dynamics approach will be taken to investigate the impact of loan loss provisioning policy, made from the outstanding balance of different categories of non-performing loans, on the scope of changes occurring in them. Accordingly, when there are negative feedback loops in a system, adopting the system dynamics approach can well represent the model's behavior. In the process of resource absorption and allocation by the bank, multiple negative and positive loops interact with each other in one variable, which makes the adoption of system dynamics approach more justifiable.

4.1 Research Questions

The present study is specifically seeking responses to the following questions.

1) Will a change in the rate of special provisions for non-performing loans lead to a change in the accumulation amount of non-performing loans?
2) Is the mechanism for provisioning against non-performing loans effective?

4.2 Base Model Design

Previously conducted studies show that no base model has been presented thus far, about deposit absorption and provision of loan, hence it is necessary to analyze a base model in this regard, and, subsequently, make necessary modifications to investigate the efficiency of the provisioning policy on the accumulation amount of non-performing loans.

To design the base model, it is essential to draw a cause-and-effect diagram for the bank. A cause-and-effect diagram for a bank is presented in Figure 1. The relationship among the variables is illustrated using positive signs, indicating a direct relationship between two given variables, and a negative sign, indicating an indirect relationship between two given variables. The cause-and-effect diagram consists of four sections, namely deposit absorption, resource allocation to a variety of assets, provision of loan, and recognition of profit and loss resulting from the loan granted.

Section one: Deposit absorption. Under The Law of Usury-Free Banking, banks are permitted to absorb Qarz-al-Hasaneh current deposits, Qarz-al-Hasaneh savings deposits, short-term investment deposits, and long-term investment deposits in Iranian Rial or foreign currency. Probing into the

financial statements of banks manifests two more types of deposits in liabilities: advance receipts for guarantees and opened letters of credit. Only the first category of deposits, as a whole, is presented in the proposed model.

According to the law, banks are obliged to deposit a percentage of their customer deposits in the Central Bank, the percentage of which is referred to as bank reserve rate and the deposit held in an account with the Central Bank is referred to as bank reserve. This deposit is among banks' claims on the Central Bank. The first section of the cause-and-effect diagram is demonstrated in Figure 2. Considering that the aggregate amount of attracted deposits is used in this model, the bank reserve rate is computed using the weighted average.

Section two: Resource allocation to a variety of assets. According to The Law of Usury-Free Banking, banks are authorized to hold a part of their resources in the form of shares, fixed assets, and cash. Every fiscal year, banks make decisions about their approaches to allocating their resources among different assets, owning which is within the authority of a bank. The present study does not address the management approaches for bank assets and suffices to a limiting assumption that every single bank is going to allocate its assets every 12 months. Concerning methods of decision-making, it is assumed that the behavior of a bank will be similar to that seen in the past.

Section three: The provision of a loan. After the determination of the share of credit resources in banking resources, banks will grant a loan to the applicants. In the case of the availability of resources, the provision of a loan to applicants will be subject to the bank's evaluation of their creditworthiness. In the event of repayment in the current category, the principal will be added to the bank's resources, and the profit will be added to the bank's joint income. In the event of non-repayment, it will be transferred to the non-performing categories. As presented in Figure 3, regardless of the positive dynamics in the cause-and-effect diagram of the third section, no negative dynamics can be found in it. There is an obvious reason for it: After explaining about all the four sections of the cause-and-effect diagram, the relationship among them will be discussed, as a result of which the negative dynamics will be developed.

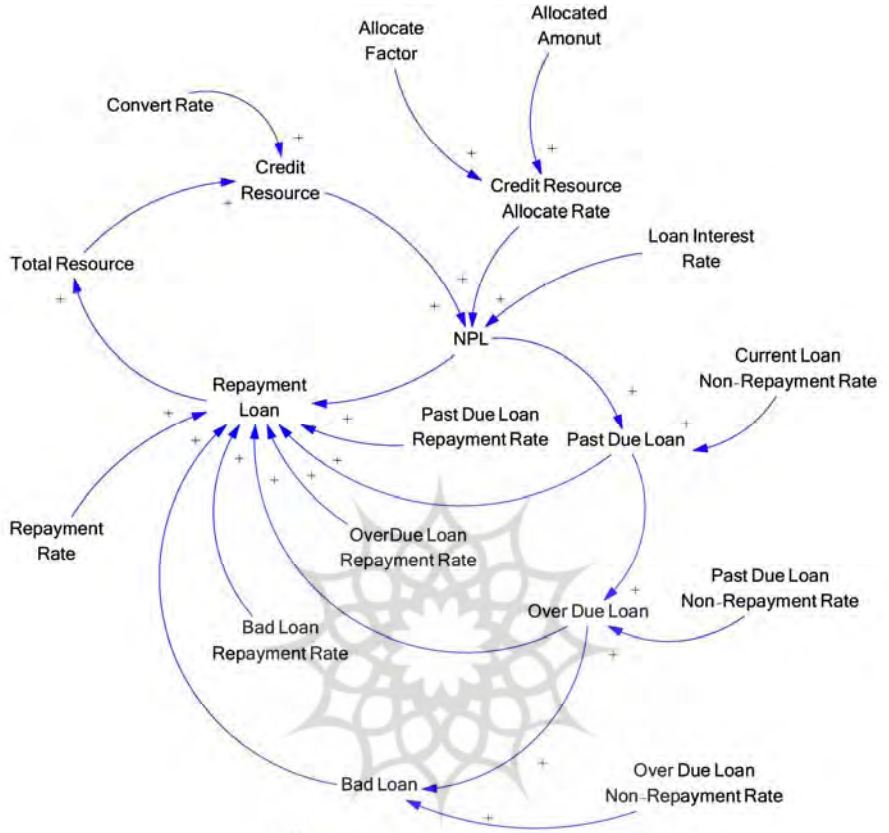


Figure 1. The Cause-And-Effect Diagram. Section Three: The Provision of a Loan.

Section four: Recognition of profit and loss resulting from the loan granted. As the supervisory authority in the money market and to control the provision of loan, the Central Bank charges banks for the loan that become non-performing, which is done based on the "Guideline for Asset Classification of Credit Institutions" and the guideline for the calculation of special provisions for non-performing loans. In other words, the Central Bank holds the bank responsible for creating non-performing loans, hence the need for it to endure costs as compensation for providing a loan without adequate attention. Due to the imposition of the charges above, the distribution of dividends among shareholders will be reduced, resulting in changes in the bank management system, and, thus, more attention in the allocation of credit

resources. As can be seen, the fourth section causes negative dynamics to emerge in the cause-and-effect diagram for the provision of a loan.

After drawing a cause-and-effect diagram and ensuring the availability of negative dynamics in the system using a state-flow diagram and differential equations, the mathematical modeling of the system will be carried out. Differential equations in the state-flow diagram are written using three variables of level, rate, and auxiliary to illustrate the states of the model. For the sake of brevity, the equations are not presented in this article.

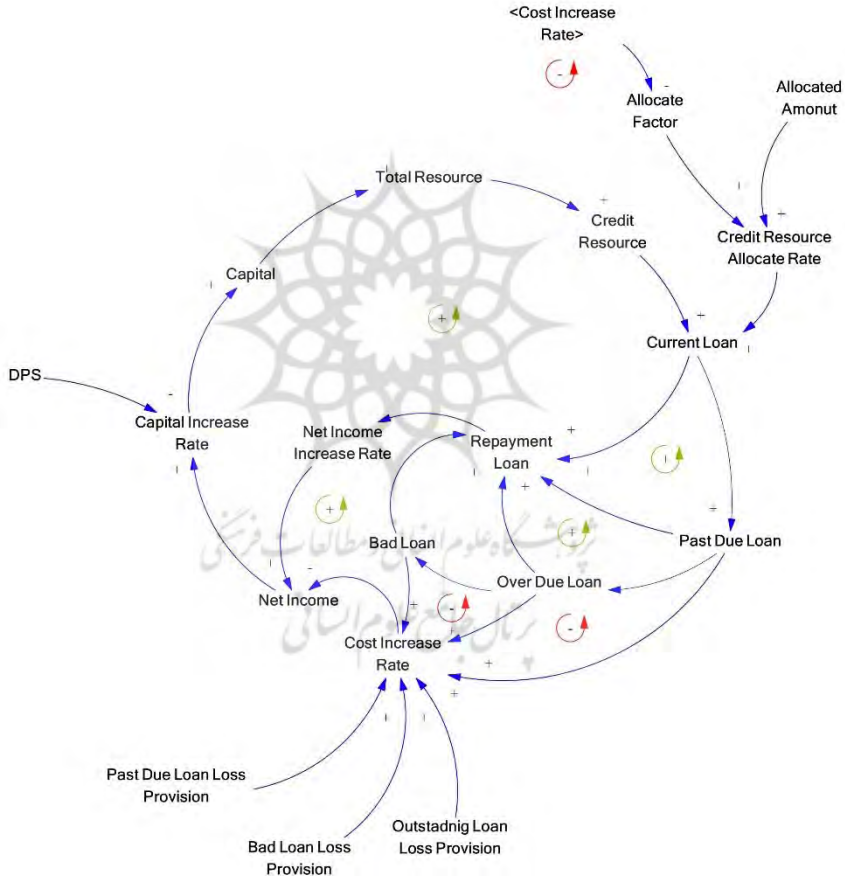


Figure 2. The Cause-and-Effect Diagram. Section Four: Recognition of Profit and Loss Resulting from the Loan Granted.

4.3 Base Model Validation

The validity of system dynamics models can be assessed and evaluated from different aspects. The present research merely concentrates on the assessment of structure validity, model behavior validity at limit points, and the ability of the base model to reproduce the historical behavior.

A. Assessment of the structure validity of the base model

In the majority of system dynamics models with no structures in the real world, the assessment of the model structure is of importance. However, banks' operations for resource mobilization and allocation in the banking network are well structured by supervisory and legal authorities and, thus, it merely suffices to make certain that the model has been designed based on the existing structures. The base model has been designed in accordance with the Money & Credit Council ratifications concerning the provision of loan, receipt of deposits, resource allocation, and other existing stages in the model. Bank accounting and how information is reflected in the financial statements have been considered in the model design. Another approach to assessing the structure validity of system dynamics models is expert evaluation and remark on the accuracy of validity. Apart from being in the researcher's field of specialty, and the fact that he has studied its details in the banking network for a considerable amount of time, the base model in this study has been evaluated and revised by three bank experts in addition to a system dynamics expert. The final structure was approved after several changes.

B. Assessment of the model behavior validity at limit points

One of the principles of validity for a model in the production of proper behavior at limit points. To evaluate the model behavior at limit points in the proposed model, it is important for level variables, except for the "net income," not to take negative values. As for other variables of rate, auxiliary, and constant, given their ability to take both positive and negative values, there is no need for a specific condition to be considered.

To investigate the state of level variables in the model, a flow of the provision of loan and flow of deposit absorption are introduced to the system for a particular time frame and the initial value of all the level variables, except for the "capital," is considered zero. The flow of deposit absorption has been introduced to the model in the first month in the quantity of 10,000 units for one time, and the flow of the provision of loan has been introduced to the model from the second month in the quantity of 100 units for eight times (once a month). The above observations show that variables of absorbed deposits, claims on the Central Bank, credit resources, current claims, bad claims,

current claims profit, bad claims profit, bad claims penalty, provisions for claims, and the capital have not taken negative values. Other variables, however, demonstrate negative values in different time frames. Consequently, it is necessary to make some amendments in these variables.

C. Assessment of the ability of the base model to reproduce the historical behavior

In system dynamics literature, there are a variety of base models presented for a larger part of social and economic systems. Findings of the researcher's investigation are indicative of the fact that no base models have been presented concerning the modeling of banking operations (resource mobilization and allocation in banks). Therefore, what will be of significance is to initially design a base model with some fundamental features of the real world, and then to develop the model towards what happens in reality.

The information provided for the researcher is obtained from the real world in a detailed and accurate manner. Nevertheless, the base model has been designed with limiting assumptions, and data extraction consistent with the assumptions of the base model from among the available information was either infeasible or achieved with a reasonable error. For that reason, estimates are calculated using simulation and approximation. Cases with information available from the real world include various states that are beyond the limits of the model assumptions.

It is not logical to have a matching value between the base model behavior and the information available from the real world. Based on the model assumptions mentioned in the previous sections, it would be impossible to have conformity, except in the circumstance where only the model assumptions occur in the real world, which is infeasible. Moreover, the purpose of matching the base model with the real world is to assess the ability of the model to produce a similar behavior to ensure the accuracy and adequacy of the model assumptions and structure. On that account, the base model will have adequate validity as long as it can produce behavior similar to the real world.

The results of the model indicate that the behavior produced by the model related to the absorbed deposits, the claims on the Central Bank, the credit resources, the current, overdue, past due, and bad loans, the special provisions, and the net profit is remarkably similar to the historical behavior. Generally speaking, the overall time frame of the behavior produced by the model, about the said variables, has satisfactory conformity with the historical behavior.

Finally, for the sake of brevity, only the modified model will be presented, and the explanations on how it was modified will not be provided. The

diagram of the modified process of the model is illustrated in Figures 3 to 7. The green color presents modifying variables for limit behavior; the red dashed lines present the relationships introduced to the model merely for the sake of modification, and the red lines present the relationships introduced to the model for both modification and the process of granting a loan. The variable illustrating the condition of banking resources is shown using the label "Banking Resources" in Figure 3. The rate variable labeled "bank resource increase rate" is determined by four circumstances: Initially, by the absorbed deposits; secondly, by the cash investment of the shareholders; thirdly, by the retained profit not distributed among shareholders at the end of the year; and lastly, by the repayment of the principals of current and non-performing loans which is shown using the label "total loan repayment". Ultimately, a part of the banking resources is assigned to the provision of loan, which is labeled as "Credit Resources," and a part of them is converted into other assets. The bases of credit resource allocation and its conversion into current loans are the two parameters of the applicant's creditworthiness and the amount of loan demanded, which are determined by the two auxiliary variables of "Loan Demand" and "Creditworthiness Factor."

As illustrated in Figures 4 to 6, due to the necessity of considering the profit and penalty in the model, it must include each one of current, past due, overdue, and bad categories for the profit, overdue, past due, and bad categories for the penalty. The basic equations for Figures 4 to 6 are as follows:

$$Delay\ In\ Current\ Loan(t) = DELAY\ FIXED\big(CurrentLoanIncreaseRate(t), 3, CurrentLoanIncreaseRate(t)\big) \quad (1)$$

$$Current\ Loan\ Non\ Repayment\ Rate(t) = Delay\ In\ Current\ Loan(t) * Probability\ Of\ Non\ Repayment\ In\ Current\ Loan \quad (2)$$

$$Current\ Loan\ Repayment\ Rate(t) = Delay\ In\ Current\ Loan(t) * (1 - Probability\ Of\ Non\ Repayment\ In\ Current\ Loan) \quad (3)$$

$$Current\ Loan\ (t) = \int (Current\ Loan\ Increase\ Rate(t) - Current\ Loan\ Non\ Repayment\ Rate(t) - Current\ Loan\ Repayment\ Rate(t)) * dt \quad (4)$$

$$Total\ Repayment\ (t) = Current\ Loan\ Repayment\ Rate(t) + Past\ Due\ Loan\ Repayment\ Rate(t) + Outstanding\ Loan\ Repayment\ Rate(t) + Bad\ Loan\ Repayment\ Rate(t) \quad (5)$$

$$P = \int (Outstanding\ Loan\ Non\ Repayment\ Rate(t) - Bad\ Loan\ Repayment\ Rate(t)) * dt$$

$$A = P \frac{\frac{r}{12}(1+\frac{r}{12})^N}{(1+\frac{r}{12})^N - 1} \quad (6)$$

$$Loan\ Interest = NA - P = NP \frac{\frac{r}{12}\left(1+\frac{r}{12}\right)^N}{\left(1+\frac{r}{12}\right)^N - 1} - P = P \frac{1+\left(1+\frac{r}{12}\right)^N * \left(\frac{Nr}{12} - 1\right)}{\left(1+\frac{r}{12}\right)^N - 1} \quad (7)$$

$$Loan\ Interest\ Factor(t) = \frac{1+\left(1+\frac{r(t)}{12}\right)^{N(t)} * \left(\frac{N(t)*r(t)}{12} - 1\right)}{\left(1+\frac{r(t)}{12}\right)^{N(t)} - 1} \quad (8)$$

Following the "Guideline for Asset Classification of Credit Institutions," banks are required to assign a part of the loan income, equal to the number of collaterals not covering the loan, to special provisioning of a loan after granting them at the end of each year. The collateral coverage value is calculated based on the type of collateral and the weights provided by the Central Bank in the guideline.

To estimate the collateral coverage value, the ratio of the outstanding basis of calculation for the special provision in each category to the outstanding balance of each category will be employed.

The rates of the special provisions for overdue and past due categories are stable and, respectively, equivalent to 10 and 20 percent of the outstanding basis of calculation for the provisions. About the claims having remained in the bad category for more than five years, 100 percent of the outstanding base is considered as the reserve rate. It is worth mentioning that the provisions are calculated at the end of each year and will be deducted from the bank incomes.

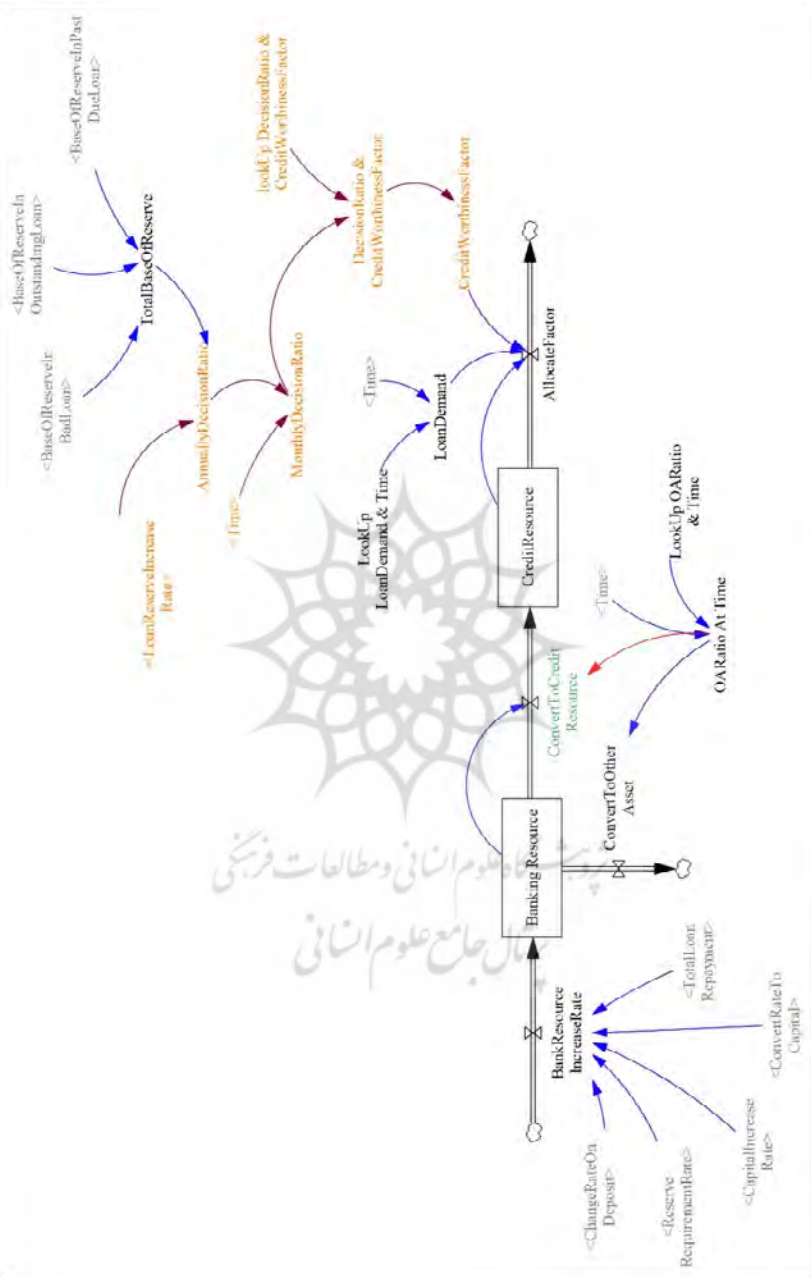


Figure 3. State-flow diagram: Section of resource allocation to credit resources.

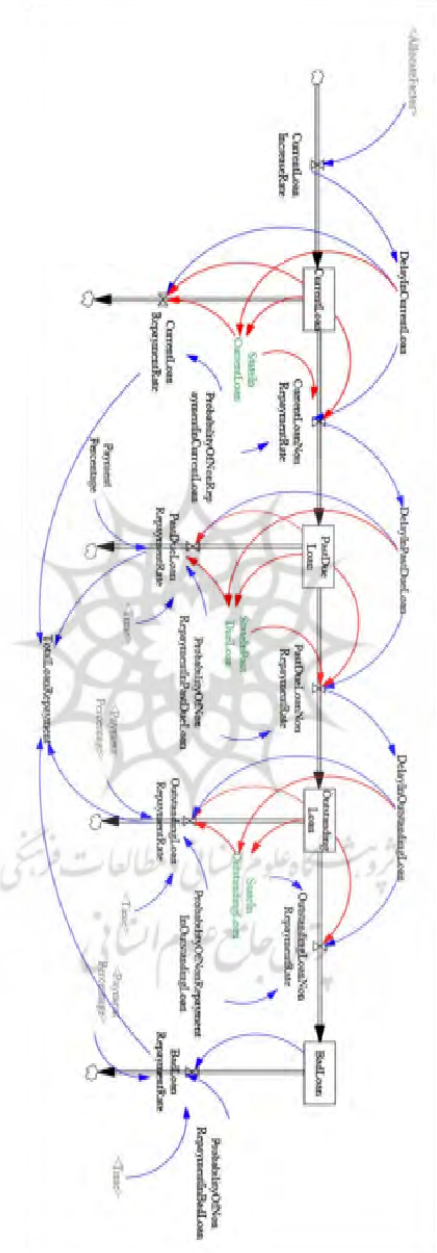


Figure 4. State-Flow Diagram: Section of the Provision of Loan / Division of the Principal of Loans.

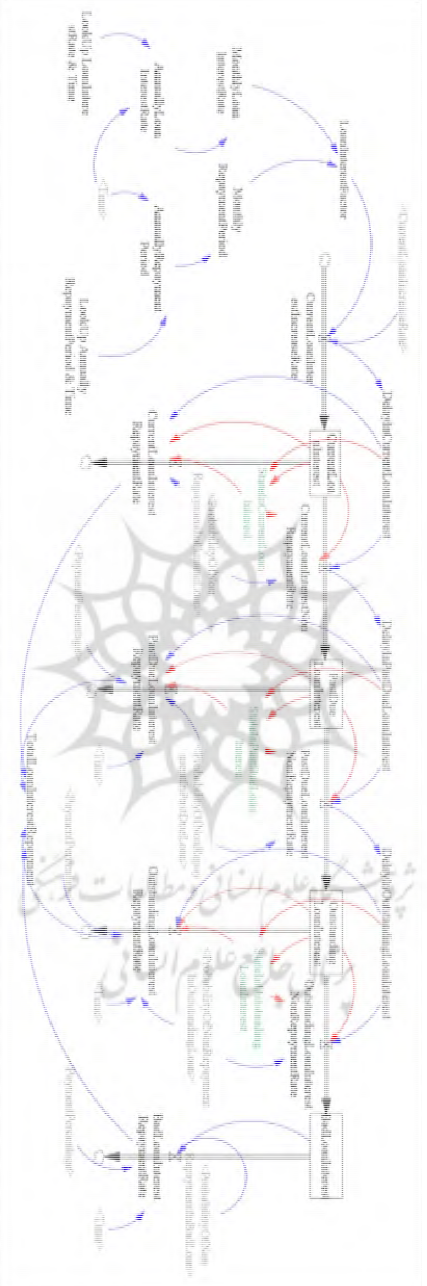


Figure 5. State-Flow Diagram: Section of the Provision of Loan / Division of the Profit of Loans.

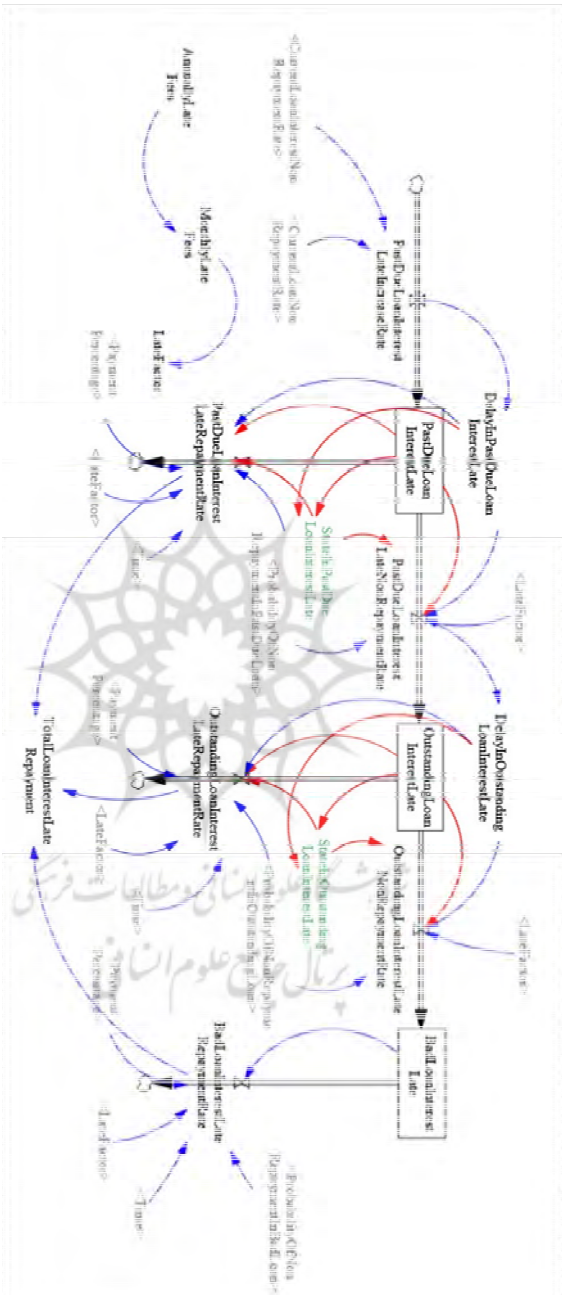


Figure 6. State-flow diagram: Section of the provision of loan / Division of the delay penalty of loans.

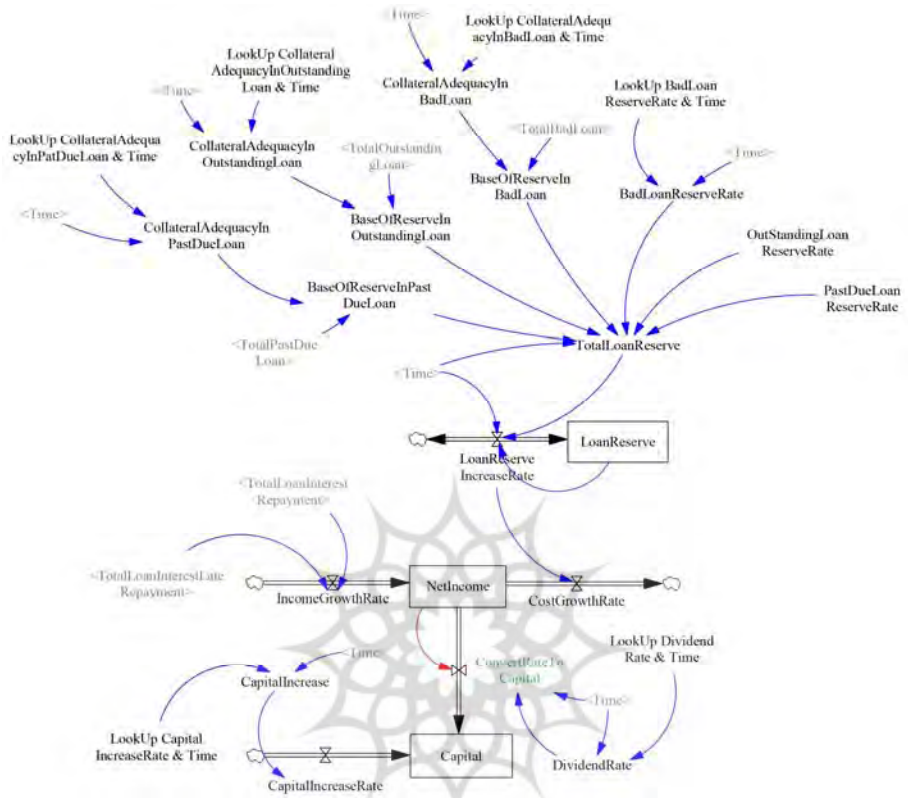


Figure 7. State-Flow Diagram: Section of the Recognition of Profit and Loss Resulting from the Provision of a Loan.

Changes in loan loss provisions are subject to netting. To be more precise, a bank is going to add 15 units to its special provisions for loans at the end of the year. Provided that the aggregated amount of loan loss provisions is 20 units and the value of the loan loss provisions variable in the previous year was 5 (i.e., at least 5 units of loan loss provisions had been set aside in the previous year, and the bank is authorized to utilize that as a kind of asset in the current year).

Bank expenses will be equal to the loan loss provisions. Operational incomes will be generated by the profit or delay of the claims, as well. The retained profit or loss will be calculated at the end of each fiscal year. A proportion of it will be distributed among shareholders, and the remainder will be added to the capital. The net income of the bank is shown with the state

variable of "net income" and is influenced by two variables of "income growth rate" and "cost growth rate" causing its increase or decrease, respectively. The net income growth increases as a result of profit or penalty payments and decreases as a consequence of receiving the loan loss provision. The residual net income variable will be added to the state variable of capital after its distribution among shareholders at the end of the year. The value of the variable "rate of conversion into capital" is generated by multiplying the auxiliary variable of "dividend ratio" into the state variable of "net income" at the end of each year. Figure 7 shows the state-flow diagram of this part of the model. The basic equations for Figure 7 are as follows:

$$Loan\ Reserve(t) = \int Loan\ Reserve\ Increase\ Rate(t) * dt \quad (9)$$

$$Income\ Growth\ Rate(t) = TotalLoanInterestLateRepayment(t) + TotalLoanInterestRepayment(t) \quad (10)$$

$$Income\ Growth\ Rate(t) = LoanReserveIncreaseRate(t) \quad (11)$$

$$NetIncome(t) = \int (Income\ Growth\ Rate(t) - Income\ Growth\ Rate(t) - ConvertRateToCapital(t)) * dt \quad (12)$$

4.4 Data and Information

Information of the base model is derived from the bank's financial statements for 2009 to 2015. The requested information was obtained from the department of research and development and the department of information technology in Mellat Bank. The simulation time frame was from the beginning of 2008 (the information of which was in the financial statement of 2009) until the end of 2015.

The information has been extracted from the annual financial statements and, in some cases, they were required to be changed to monthly financial statements. Linear interpolation search and random changes with the process were employed to convert the annual information to monthly ones, in a way that the data from late February to mid-March (which is equal to Esfand, the final month of the year in the Solar calendar) would show matching values of the financial statement.

The information required in the model has been collected with two objectives; first, to estimate some parameters, relations, and initial values in the base model, and, secondly, to evaluate and validate the base model behavior through its conformity with the historical information. Given the variety of information required in the model, not all their names and sources are indicated, and only some are presented below.

5 Experimental Results and Answers to the Research Questions

In the course of evaluating the process of loan loss provisioning, it is possible to analyze the changes in the variables of the rate of special provisions for overdue, past due, and bad claims, the collateral coverage factor, and the bank management's response to the expenses imposed due to the creation of non-performing loans. The collateral coverage weight is determined through the division of the outstanding basis of calculation for special provisions of non-performing loan categories by the outstanding balance of the same category at the end of the year.

$$Collateral\ Adequacy = \frac{Base\ Of\ Reserve}{NPL}$$

The results of changes in every one of the items above have been evaluated using the concept of elasticity. The following formula is used to calculate the elasticity.

$$The\ ratio\ of\ x\ to\ y\ = \frac{\frac{\Delta x}{x}}{\frac{\Delta y}{y}}$$

The elasticity of non-performing loans, concerning the changes in any of the rates mentioned before, is the benchmark for comparison between the changes in the variables of special provision rates for overdue, past due, and bad claims and the collateral coverage factor. Concerning the bank management's response to the expenses imposed as a result of creating non-performing loans, only the percentage of changes are employed.

Findings of the evaluation of the changes in every special provision rate for each category of non-performing loans are presented in Table 1. For the value of elasticity for each variable, it is noteworthy that every rate mentioned has an indirect and inverse relationship with the amount of non-performing loans. A diagram corresponding to the comparison of the sensitivity analysis results of the changes in special provisions is illustrated in Figure 10. As it is shown by the diagram and the elasticity results, changes in the special provision rates have no significant impact on the accumulation amount of non-performing loans. As a consequence, there is an inverse relationship between the accumulation amount of non-performing loans with the changes in the special provision rates for non-performing loans (overdue, past due, and bad categories). Furthermore, it is indicated that the accumulation amount of non-performing loans is more affected by the changes in special provision rates for

the bad category than the changes in special provision rates for the past due category, which affects the accumulation amount of non-performing loans more than the changes in the special provision rates for the overdue category. However, changes in the special provision rate of every one of overdue, past due, and bad categories have no significant impact on controlling the accumulation amount of non-performing loans.

Table 1
The Elasticity Value of Every Special Provision Rate and the Collateral Coverage Weight

Variable Name	Elasticity Value
Special Provision Rate for the Overdue Category	-0.8%
Special Provision Rate for the Past-Due Category	-1.61%
Special Provision Rate for the Bad Category	-1.84%
Collateral Coverage Weight	-22.38%

Source: Research calculations

In view of the importance of the collateral coverage weight in the effectiveness of the provisioning process on the amount of non-performing loans, the collateral coverage weight for the overdue category has been increased for 20%, and decreased for 20%, 50%, and 70%, in the given order, and the results have been compared. Increasing the collateral coverage weight indicates a rise in the outstanding basis of calculation for the provisions. Decreasing it (which is feasible by reducing the risk weight for every single type of collaterals or the minimum value of collateral accepted by the bank for covering the risks of the received loan) is indicative of a reduction in the outstanding basis of calculation for the provisions. It is worth mentioning that the topic of investigation in this article has been the collateral coverage weight in the process of provisioning, and not collateralization. In other words, according to the "Guideline for Calculation of Provisions for Claims of Credit Institutions" ratified by the Money & Credit Council, the basis of calculation for provisions will be determined after the deduction of the values of adjusted collaterals from the outstanding balance of non-performing loans. Subsequently, provisions will be defined based on their weights. The collateral coverage weight refers to the ratio between the value of secured collaterals and the value of the received loan. In this study, efforts have been made to adopt a statistical and procedural approach to addressing the issue as to whether or not this policy would have the adequate effectiveness provided that the collateral coverage weight were more than the typical limit. Consequently,

the topic of investigation is the collateralization method and how bank management can get away with the results of this policy.

The elasticity of the overall non-performing loans to the collateral coverage weight is calculated -0.2238 indicating that for each unit being reduced from the collateral coverage weight, 0.22 units will be added to the amount of non-performing loans. In the event that the bank provided loan subject to collateralization with the value of 1.7 times more than the amount of received loan, there would be no need to pay the provision in the calculation of the outstanding basis for these loan due to the complete coverage of the collateral even after its adjustment announced by the Central Bank. Thus the effect of the provisioning process in the course of providing loan on the reduction of non-performing loans will be eliminated. This issue will be exacerbated in case there is a likelihood of receiving over-declared collaterals in the banking system. Consequently, this mechanism will not be effective if the collateral coverage weight is more than adequate.

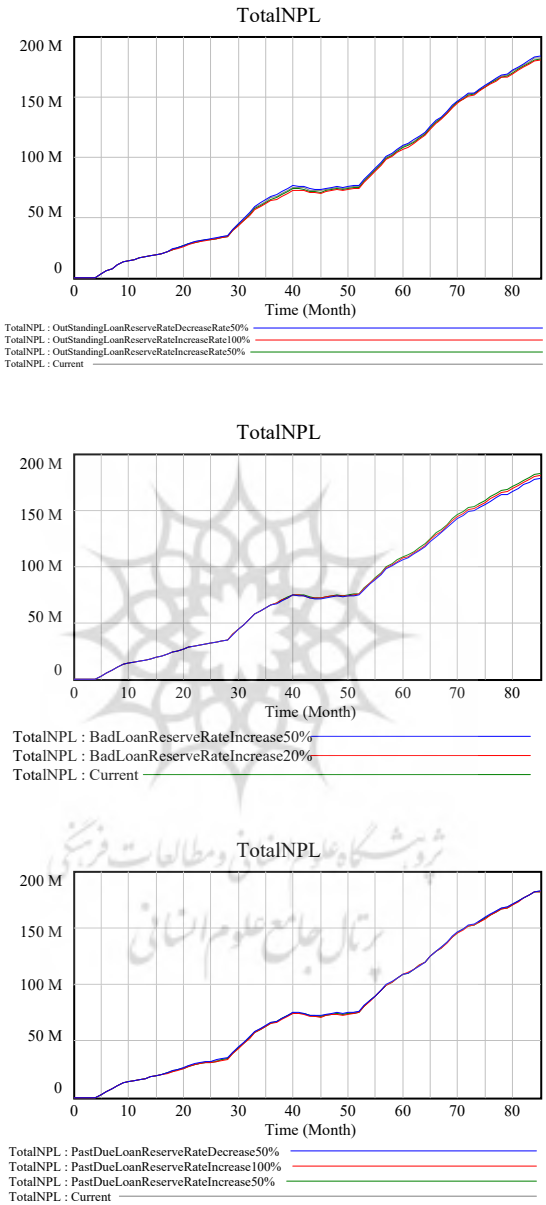


Figure 8. The Sensitivity Analysis Results for the Effect of Changes in Special Provision Rates on Non-Performing Loans.

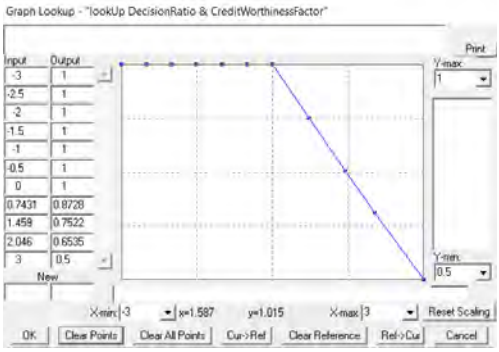
Findings indicate that there will be at least 17 percent of reduction in the number of claims provided that merely the bank management responds to the imposed expenses caused by the creation of non-performing loans and, subsequently, to the profit decline resulting from it, is done by taking notice of the applicant's credit health prior to granting loan.

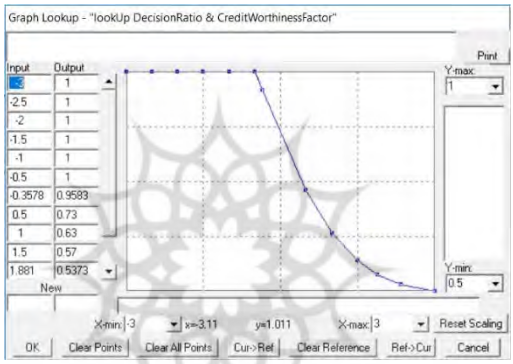
Orange parts in Figure 3 are modeled based on this issue. Under normal circumstances, taking the data received from Mellat Bank into consideration, the CreditWorhinessFactor variable is constant not influenced by the bank's operation. The mechanism of employing a bank's feedback in the provision of loan is designed by adding the orange parts. The basics of this mechanism are as follow:

- The bank management refers to the group of decision-makers at different levels of credit bodies.
- The bank management's decision-making approach has a direct correlation with the value of expenses imposed on the bank due to special provisioning.

On that account, decisions can be made concerning adopting strict or permissive policies in respect of the applicant's credit status. It can be done through dividing the net amount of changes in the basis of special provisions in a term by the aggregate amount of the basis for special provisions in the previous term (the decision-making ratio). It indicates that the more the decision-making ratio increases, the more attention should be given to the provision of the loan (for instance, the applicant should be required to have higher creditworthiness) and the less the value of this ratio, the more possibility is to reduce the severity of strictness in the provision of a loan. The LookUp function in Venism has been utilized for modeling this type of response. To apply this function, it is assumed that the more the decision-making ratio increases, the more severe the bank will respond; and the exponential model has been used.

In the first scenario, the bank management has responded to the reduction of benefits due to the creation of non-performing loans as normal; indicating a linear relationship between the severity of response and the cost value. In the second scenario, there has been a non-linear relationship between the severity of response and the cost value with the severity being significantly more than the linear mode for increasing amounts of expenses. This issue is illustrated in Figure 9.


Graph Lookup - "lookUp DecisionRatio & CreditWorthinessFactor"
Input
Output
-3
-2.5
-2
-1.5
-1
-0.5
0
0.7431
1.459
2.046
3
1
0.8728
0.7522
0.6535
0.5
New
Print
Y-max
Y-min
X-min -3
x=1.587
y=1.015
X-max 3
Reset Scaling
OK
Clear Points
Clear All Points
Cur->Ref
Clear Reference
Ref->Cur
Cancel


Graph Lookup - "lookUp DecisionRatio & CreditWorthinessFactor"
Input
Output
-2.5
-2
-1.5
-1
-0.5
-0.3578
0.5
1
1.5
1.881
1
0.9583
0.73
0.63
0.57
0.5373
New
Print
Y-max
Y-min
X-min -3
x=-3.11
y=1.011
X-max 3
Reset Scaling
OK
Clear Points
Clear All Points
Cur->Ref
Clear Reference
Ref->Cur
Cancel

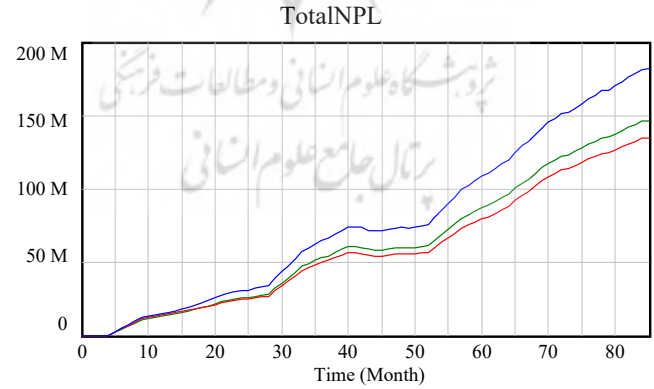

TotalNPL
200 M
150 M
100 M
50 M
0
0
10
20
30
40
50
60
70
80
Time (Month)
TotalNPL : BasicModelWithoutDecisionRatio
TotalNPL : BasicModelWithDecisionRatio-Senario B
TotalNPL : BasicModelWithDecisionRatio-Senario A

Figure 9. The comparison between different modes of bank management response to the imposed expenses caused by the creation of non-performing loans along with the function of bank management response.

Consequently, another requirement for having efficiency in the mechanism above is the bank management response to the imposed expenses under the influence of providing the possibility of making changes in the accumulation amount of non-performing loans in a significant manner. The way that the bank management responds to the imposed expenses reduces the accumulation amount of non-performing loans by 17%.

6 Overview and Conclusion

Policymaking for implementing comprehensive supervision as well as controlling and leading the money market, has been a constant concern for the monetary supervisory authority, followed by putting the economy on the right track to achieve its goal. One of the key issues in this area is choosing the implementation method of supervision as well as the controlling process for the players in the money market, namely the banks. One of the factors able to prevent the economy from achieving its goals is the excessive accumulation of non-performing loans in banks. Consequences of this phenomenon are exemplified by the freezing of bank assets, credit dilemmas, and encountering financing difficulties for production processes in the economy. The Central Bank, as the monetary supervisory authority, constantly aims at controlling this issue through different approaches. Reviewing the supervisory actions of the Central Bank over the past decade clarifies that the majority of supervisory actions of the Central Bank has been related to policy implementation aiming at generating costs in exchange for an increase in the outstanding balance of non-performing loans in banks, which has been conducted through the process of provisioning against non-performing loans.

In this study, modeling of this issue has been performed using the system dynamics approach. The most important limitation of the present research is the availability of information. Due to this limitation, several issues were not being modeled. These cases are presented below:

- The impact of inflation on the amount of repayment by individuals.
- The creditworthiness of applicants to receive a loan is not considered as a variable.
- The repayment method in the model has been implemented at the time of transferring from one category to another category. Besides, a percentage of the outstanding balances in overdue and past due categories are repaid

every six months. The repayment in the bad category is made every eight months as a percentage of its outstanding balance.

- Forgiveness of penalty, installment, and grace period are not included in the model.

The present research is indicative of the fact that the decision-making approach of the managers about the provision of the loan according to the number of acquired provisions has a significant impact on the accumulation amount of non-performing loans. Nonetheless, the effectiveness of this process will be eliminated provided that it would be possible for the managers to disregard this rule; an issue that is consistent with the findings of Komijani and Fallahi (2016). Ultimately, taking all investigations of the present study into account, it is suggested that:

1) The Central Bank needs to verify the observation of the necessities in the process of provisioning against the outstanding balance of non-performing loans, in a manner that the adoption of specific behaviors by the bank manager would be infeasible. To exemplify, obtaining adequate collateral and not excessive collateral need be verified. To this end, it can be helpful to prepare regulations concerning obtaining large-scale provisioning from the customers and providing collateral valuation mechanisms in collaboration with the Judiciary Official Experts Organization, so that the possibility of over-declaration in valuations would be minimized. That being the case, through the implementation of provisioning policies depending on the bank management response, it would be possible to observe between 17 to 22 percent of the reduction in the accumulation amount of non-performing loans in a bank.
2) The Central Bank is required to make certain of the bank management response to the imposed expenses caused by the accumulation of non-performing loans so that the provisioning process against the outstanding balance of non-performing loans would not lose its effect on the reduction of the accumulation amount. For instance, setting up internal control systems and establishing corporate governance in banks can be among the Central Bank's strategies in this regard. To the exclusion of other factors, the managers' response to the imposed expenses, to lead to increased accuracy of investigation of the applicants' credit standing, would result in 17 percent of improvement in the amount of non-performing loans.
3) The Central Bank can reduce the accumulation amount of non-performing loans through increasing the rates of special provisions for non-performing loans, particularly for bad loans. However, this approach does not have a significant effectiveness, owing to the fact that we can observe

minimum 8 percent and maximum 2 percent of changes in the accumulation amount of non-performing loans per one percent of changes in the rates of provisions, and an increase in the special provision rates has specific consequences of its own for the bank management.

Undoubtedly, reducing the accumulation amount of non-performing loans through the adoption of monetary policies would not be feasible. Thus, it is essential to provide an opportunity for the implementation of monetary and financial policies utilizing technology-based supervisory techniques and information systems, for the banks to be obliged to set up an internal control system and establish the corporate governance.

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