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Modelling Liquidity Risk Management in Banking Using System Dynamics Approach

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ABSTRACT

Banks as one of the most important and crucial economic sectors in each country play a significant role in economic growth and development and they face various risks one of which is liquidity risk. Managing liquidity risk is of great importance and identifying its effective factors is more vital. The present study aims to present a dynamic model to manage liquidity risk. System dynamics is used to find a risk making structure and present the most effective solution to manage it. In this method, by providing a mathematical model, simulating the results of various scenarios is possible. The results of implementing four scenarios on the model were simulated and analysed. The results revealed that reducing legal deposits and nonperforming loans and increasing attraction of deposits is influential in banks liquidity risk.

1 Introduction

Today`s increasing and widespread developments and increase in economic competition have put people and organizations in an uncertain environment that has confronted with numerous risks and hazards. Risk means more uncertainty means more risk [19]. Banks and financial institutions due to their nature are more subject to risk since they are responsible for people`s investments and try to operate economic operations. As banks plays a crucial role in domestic development, their success is greatly depending on their risk management [43, 46]. Literature reveals that risk management is a complex system consisting of various components that includes different beneficiaries with a variety of goals [51].
Overcoming this complexity by the traditional management approach based on mental models, intuition, experience and judgment make managers encounter some difficulties. Therefore, through information selection and structuring tools, it is required to shape knowledge of a manger, visualize it and provide the obtained results and consequences using formal models so that the manger can understand the function of the system and improve its policies [55]. One of the most common and highest risks that a bank faces due to its nature is liquidity risk which is defined as the risk of lack of liquidity to supply current expenses as well as depositors` demands. Saunders and Cornett [45] define liquidity risk as an unexpected increase in depositors` withdraws causing banks to face difficulty in meeting their short-term obligations. Liquidity risk occurs when a large number of investors decide to withdraw a large

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amount of deposits or when borrowers can`t meet their financial obligations. Increase in liquidity risk decreases a bank`s ability to grant more loans, particularly the long-term lines. Since banks are greatly responsible for financing manufacturing sectors, increase in liquidity risk can have an alarming effect on the economy. Liquidity risk also contributes to various risks including, market risk, interest rate risk, credit risk, bankruptcy risk, and strategic risk [7, 47, 14, 53]. Managing or not managing this risk as one of the key principles of banking determines the success or failure in this industry; as lack of management can even cause a bank to go bankrupt. Hence, systematic attitude is applied to understand and create a casual chain among practical risk liquidity management policies and its components. Thus, regarding the importance of liquidity risk, the present study aims to design a risk management model through identifying the effective factors in liquidity risk and the structured relations among them using system dynamics approach.

2 Theoretical Literature and Background

Banks, as one of the major financial institutions, have a prominent role in establishing a relationship between the real and monetary sectors of the economy since they facilitate commercial transactions by organizing and guiding payments and repayments which as a result contribute to development of the markets and economic enhancement and prosperity [42]. This role leads banks to liquidity risk [6, 32]. Liquidity risk is the risk of lack of liquidity to pay the obligations. This risk is one of the most common but the most hazardous risks that a bank is faced with due to its nature and it is defined as the probability of lack of liquidity to meet regular expenses and the demands of depositors. In other words, liquidity risk means is defined as when a bank is unable to meet its short term obligations. Liquidity risk occurs when a large number of depositors decide to withdraw a large amount of their deposits from a bank or when the loan takers are not able to meet their financial debt obligations. In other words, with decrease in liquidity, banks are subject to liquidity risk and reputation risk making a bank more probable to go bankrupt [20].

Since liquidity risk of banks is due to financing of the bank's assets through short term debts, deposits should be continuously renewed or debts need to be financed. Liquidity risk in each bank normally has a unique nature but sometimes it may be synchronized with liquidity problems of financial system. Considering the unique feature of each financial institution, accurate definition of liquidity policy in terms of the way it works is the first responsibility of management of each bank. Liquidity management policies should comprise a risk management structure, a liquidity management and funding strategy, a set of limits to liquidity risk exposures, and a set of procedures for liquidity planning under alternative and crisis scenarios [57]. Deposits at banks usually have shorter maturity date compared to loans and liquidity management should, in addition to covering the maturity gap between assets and banking debts, provide a margin of safety for the risk of withdrawing from deposits. Liquidity risk is not only related to management of assets and debts but also to other aspects of the financial structure such as interest rate risk, market risk, Profitability, and financial health of a bank [56]. Being exposed to liquidity risk in the short run can result in a serious liquidity gap. Although with a serious lack of liquidity a bank is unable to meet its obligations and, in turn, it goes bankrupt maintaining surplus is a specific kind of misallocating the resources in which banks do not use productive assets and existing opportunities which leads to lower profitability and to lose the market. Managing and controlling liquidity risk is vital and inevitable for efficiency and profitability of a banking system [37]. So it can be concluded that liquidity risk and profitability are inversely correlated [34]. Unfortunately, some managers, when

facing liquidity risk, with a superficial attitude, make some decisions that not only manage the risks properly but worsen the situation so that beneficiaries are more subject to risk. For a bank to work effectively in order to achieve the determined goals of managing risk, a comprehensive governing attitude is required to provide a more general, comprehensive, and systematic understanding which is called systems thinking. Systems thinking is a new and powerful perspective, a special language and a collection of tools which can be utilized to devise smart and sustainable solutions to solve the problems. Systems thinking is a method for understanding facts that focuses on details more than general points and it highlights roles.

This approach is based on strong theoretical fundamentals and presents a more detailed and accurate image of the reality with a comprehensive and long term perspective so that the desirable results can be obtained using the internal forces of a system. Systems thinking approach allows us to refine our perceptions about the systems and to acquire abilities to understand the components, observe the interactions, and know different future behaviors of the systems and creativity and courage to redesign the systems [5]. Hence, for effective risk management, a deep understanding of liquidity risk management methods and comprehensive understanding of factors influencing this risk should be acquired using systems thinking [48]. Risk management systems like other systems have their own regulations and effective factors that are necessary to be identified and understood and then they should be used to manage liquidity risk efficiently. Without such knowledge, making policies about or managing risks and designing a comprehensive risk management model seems farfetched. Thus, managers are able to enhance the system and protect the beneficiaries by taking advantage of this in-depth knowledge about different components of liquidity risk and its governing rules.

3 Literature Review

All research studies carried out on liquidity risk can be divided into three general groups. Group 1 identifies the determining factors and variables related to liquidity risk. These studies, for example Dolgun and Ng [11], El-Massah et al. [13], Mazreku et al. [35], Negash and Veni [41], Galletta and Mazzù [16], Shamas et al. [49], Kafayi and Rahzani [26], Ismailpour [23],Yaacob et al. [60], Mehrara and Bouhloulvand [37], Hanifi and Rahmanipour [20], Ahmad et al. [2], Vodova [59] and Yazdanpanah and Shakib Haji Agha [62], aim to identify the nature of this relationship (positive or negative) and its effect (significant or insignificant). Group 2 assess liquidity risk (quantification techniques).

These studies utilized some techniques such as Multivariate portfolio optimization algorithms [3], Option-pricing approach [63], Stress Test [61, 28], Structural equations [54, 21], Dynamic panel regression [26, 31], Neural network and Bayesian network model [54], ARIMA Model [24], Fuzzy measurement [10, 25], Focal analysis [20, 4], and Bayesian Econometrics [37]. Group 3 also examines the performance of liquidity risk management. Most of the studies centered on determining the effect of creating a risk management structure on bank performance in terms of profitability. Some of these studies include liquidity risk management and financial performance of conventional commercial banks [58], bank liquidity risk and performance [9], liquidity risk and financial performance of commercial banks [39, 40, 33], examining the effect liquidity risk and credit risk on bank stability index and bank performance [50], the relationship between liquidity risk and credit risk and its effect on financial stability in Iran banking industry [8], the impact of credit, operational and liquidity risks on the efficiency of the banking system [29], Effects of credit risk and liquidity risk on banks' performance [15].

4 Research Methodology

This research is to offer a model for managing liquidity risk in Iranian banks using system dynamics approach. Since risk management systems due to their numerous components, interconnected relationships and dependencies are too complex, system dynamics is a useful tool to analyze them by introducing the structure of the problematic behavior based on systems thinking and it also makes them easier to understand [17]. One of the salient features of this approach is that it allows evaluating different policies in scenario format. In addition, by quantitative simulation of results from implementation of the policy in small scale, learning from the system and as a consequence improving the problematic behavior and presenting effective solutions based on systematic approach would be possible [1]. The process of building the model in system dynamics includes:

1. Identifying and defining the problem
2. Checking the reference mode
3. Formulating the dynamic hypothesis
4. Mapping causal loop diagrams
5. Mapping the Stock and flow structure and devising the mathematical formulation of the model
6. Model validation and sensitivity analysis
7. Identifying pivotal points of the model and making scenarios
8. Simulating the scenarios, then selecting and implementing the most appropriate solution.

After designing the model, different policies were implemented in the form of decision scenarios and the simulation results were analyzed and then a suitable solution is offered for managing liquidity risk. The present study highlights risk management in banking and, regarding the nature of systems thinking approach, sampling is not carried out, rather the system is investigated [38]. To build a mathematical model, the data from an Iranian bank between 2014 and 2018 was used. The bank was chosen based on financial health index (provided by international observer authorities) from the listed banks in Iran Stock Exchange. Since the dynamic model of the present research was designed in the framework of design science, to ensure accuracy of designing and development of the model, the opinions of exerts in this field were used. Hence, two populations were selected:

1. The population of academic experts in the field of designing and using system dynamics to validate the proposed model according to principles of system dynamics
2. The population of experts in Banking risk management to test the behavior and the structure of the proposed model and to evaluate the results of simulation.

The sampling method used for these populations is targeted sampling. Based on this method, people who were effective and had key roles in understanding designing issues and the process of interpreting the model were selected. Therefore, 4 researchers and experts in system dynamics were selected from the first population and 9 managers and veterans of banking risk management with more than 10 years of experience were chosen and they were interviewed repetitively in order to achieve theoretical saturation.

5 Building the Simulation Model

5.1 Identifying and Defining the Problem

After the financial crisis in 2007, most of professional and academic institutions have been seeking for a comprehensive and holistic approach to risk management [27, 18]. Currently, achieving such an approach without systems thinking appears impossible [30]. A risk management system can be considered

as an entity whose existence is maintained though interaction among its components. This system is beyond a group, that is, the interaction among its components shape the characteristics of a risk management system, and not the mere components. The key to understand the system is to understand these relationships. Since risk management system is complex in nature, understanding various factors causing this complexity including, the large number of these components and their interactions, nonlinear and dynamic interactions, causal relationships, endogenous factors, and their *c*ounterintuitive nature is highly significant [5]. These systems, like other management and social systems, may indicate some unexpected behaviours over time, so making decisions about these systems solely based on intuition and management understanding may lead to some unexpected results. To avoid numerous challenges in today`s uncertain conditions, managers need to quit their "linear thinking" and adopt a "systems thinking", keeping in mind that today`s business environment and its governing system is nonlinear. Trying to linearize to facilitate the decision making process, if possible, doesn't seem suitable since nonlinear relationships and existing delays in processes may create surprising and unexpected conditions for managers. Systems thinking approach and modelling liquidity risk management try to provide a new insight into liquidity risk and offer effective solutions for managing this kind of risk. Devising strategic plans, defining the organization`s plans based on universal concepts and standards, employing the newest and most advanced risk management systems etc., despite their relative effect on banks, are all, without systematic approach, worse than useless.

5.2 Reference Model

Liquidity management is one the most important duties of bank managers by which they tend to maintain the inflow and outflow of their liquidity system at an appropriate level so that they can hold effective liquidity ratios at a standard level to achieve maximum efficiency and minimum liquidity risk. Investigating the process of deposit attraction and granting loans in the given bank (Fig. 1) indicates an increase in attracting resources and, consequently, the number of granted loans over the past five years.

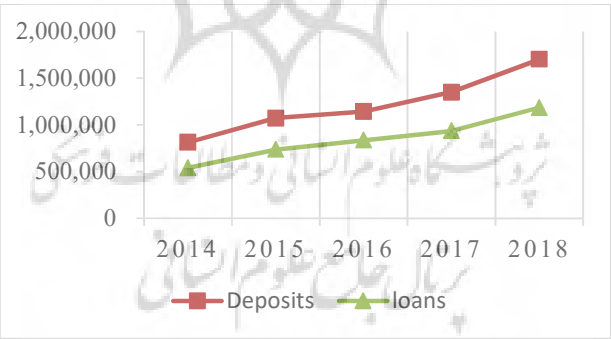

Fig. 1: The Attracted Deposits and Lending in the Period of Study

The bank has been able to keep its liquidity risk at a reasonable level and, as Fig.2 shows, during the given period, the liquidity risk of this bank has been lower than liquidity risk of the Iranian banking industry, implying that the mangers have adopted cautious steps and created a liquidity shield to tackle probable liquidity crises.

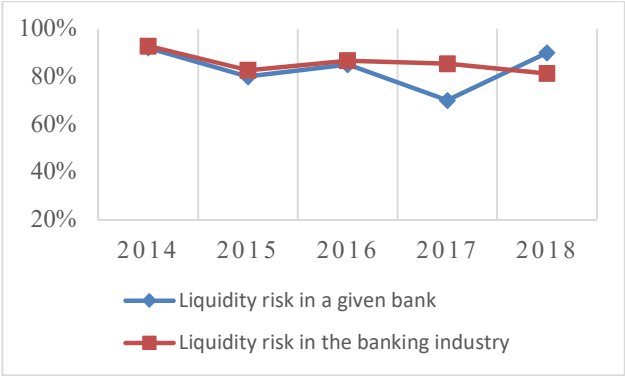

Fig. 2: Comparison of Liquidity Risk of Given Bank and Banking Industry

5.3 Dynamic Hypothesis

The major source of banks for granting loans is either from investments of their investors or from their customers` deposits. The latter consists of two main groups including, benevolent lending, a form of interest-free loan, which is considered a cheap source and short and long term deposits that are hugely expensive due to their obligation in paying interest. Since most of these resources are given to customers, any problems in loan payments make a bank unable to pay back the deposits and as a consequence it raises liquidity risk. However, conversely, the more loans are paid, the lower liquidity risk is and customers trust banks more and this increases their ability to attract more deposits. Moreover, as interest from the granted loans is the major income of a bank, mangers try to offer quality loans to their customers to avoid higher liquidity risk. The quality of a loan depends on the bank`s policies on customer's evaluation when granting the loan, monitoring and control systems [12]. Low quality loans are more likely to turn into non-performing loans that increase liquidity risk due to inability in funding the deposits. Loan -to-deposit ratio is used as the variable of liquidity risk management in this study.

5.4 Causal Loop Model

Regarding the presented dynamic hypothesis of the problem, to document the behaviour of liquidity risk management system in the given bank, this hypothesis is presented as a causal loop diagram and feedback chains in Figure (3) which indicates the casual structure of the elements and the system components along with the feedback relationship among them. The diagram, on the one hand, aims to help understand the real function of the liquidity risk management system and on the other to document the influencing factors on the system and the relationship among them. The diagram in Fig.3, made based on the research carried out by other researches and collecting experts` opinions, indicates that liquidity risk is affected by at least 37 feedback loops including, 23 Reinforcing feedback loops and 14 balancing feedback loops. Increase in liquidity risk, on the one hand, raises the customers` demands to withdraw their money creating a negative feedback loop which reduces the lending power of the bank as well as repaying the deposits, and, on the other hand, it decreases deposit attraction by creating a balancing feedback loop. The attracted resources by banks should be allocated effectively and optimally to increase profitability and to reduce risks. Managers shouldn`t ignore this point that, despite a negative relationship between the volume of deposits and liquidity risk, sometimes with an increase in deposits, widespread and unexpected withdraw of money by depositors due to reasons, such as releasing bad news, may go up, so growth in deposits may lead to higher liquidity risk. Since most part of resources

from deposits are given to customers as loans, validating them before granting the loans can ensure the banks from realizing the expected income since more lending can expose banks to credit risk and non-performing loans. Nonperforming loans and inability to reclaim loans reduces income of a bank which, in turn, it decreases the net profit. Accumulation of nonperforming loans removes some assets of the bank from credit management which weaken the time balance between assets and liabilities and faces liquidity risk and reduces the lending power of the bank [36]. To compensate the probable loss resulting from failure in fulfilling the customers' obligations banks need to provide general or specific reserves.

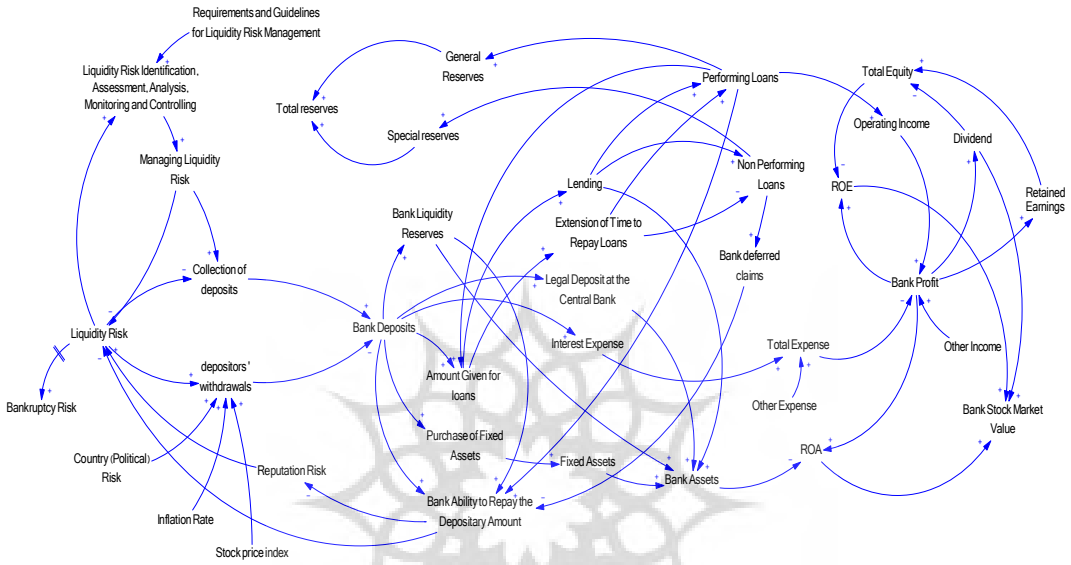

Fig. 3: Casual Loop Diagram of System Structure

5.5 Stock and Flow Model

After presenting the dynamic hypothesis of the structure of the problem and representing the causal structure of liquidity risk management, a stock and flow model of the problem and the relating mathematical equations based on the data from the given bank are required to make a quantitative model and to simulate it. In Fig.4, concerning the dynamic hypothesis, stock and flow model of liquidity risk management has been provided.

6 Model Validation, Sensitivity Analysis and Identifying the Pivotal Points

6.1 Model Validation

After developing the model and before devising a scenario and analyzing the results, some validating tests are performed to confirm the validity of the model under various conditions. First, with the aid of managers and experts in risk management, Structure Verification Test is performed to ensure the compatibility of the structure of the model with the existing knowledge in the actual system structure and Boundary-Adequacy Test, to ensure the adequacy of generalization level of the model and, therefore, a consensus was reached.

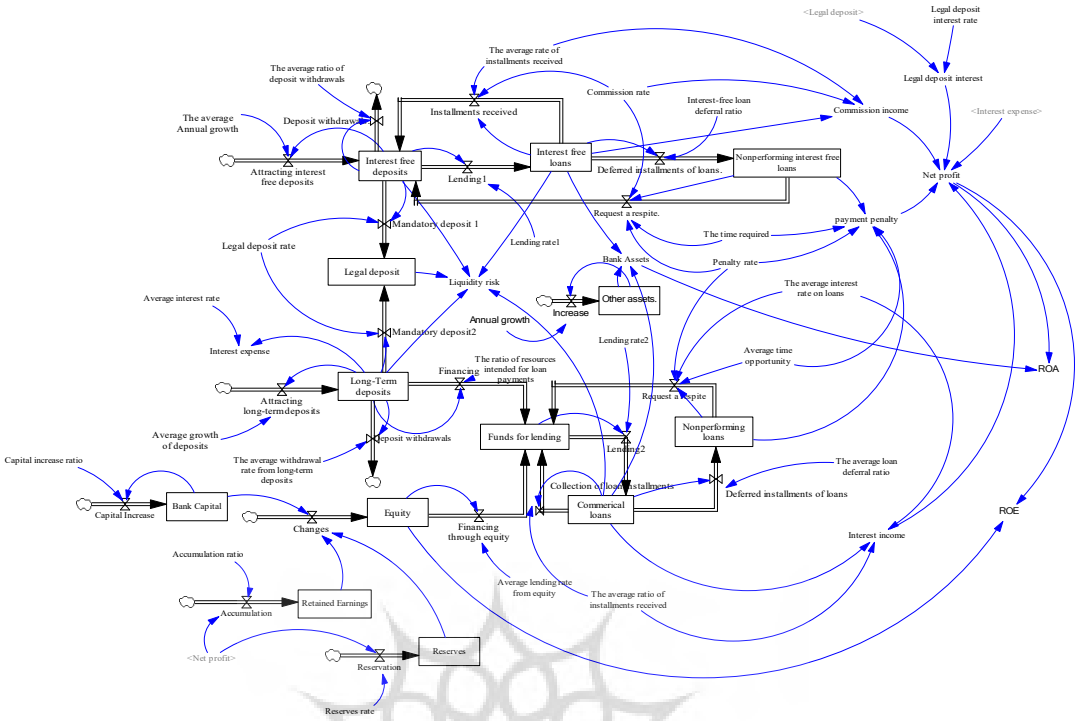

Fig. 4: Stock and Flow Model of Liquidity Risk Management System

To Conduct Extreme Conditions Test, some parameters and primary data of the model were considerably changed. Re-performing this model indicated that the behaviour of the model is still significant in all parts. Finally, to ensure the accurate performance of behaviour of the model and a match between behaviour of the model and real data, Behaviour Reproduction Test was used. In this test, the simulated behaviour for the model was reproduced to be compared with real data.

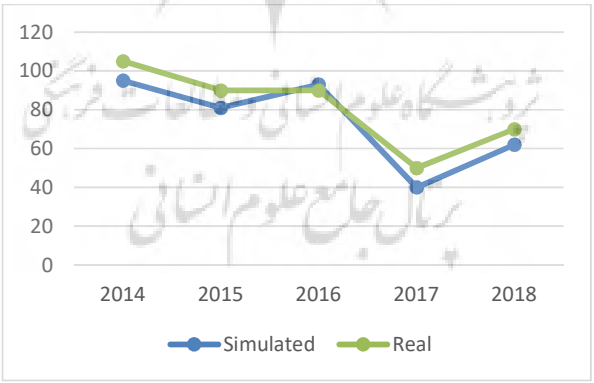

Fig. 5: Historical Behaviour Reproduction Test for Bank Liquidity Risk Index

In addition to the above-mentioned tests, to ensure that the behaviour of the model matches real data and increasing reliability of the simulated results, error of key variables was measured via the following methods:

A. Root Mean Square Percentage Error: Based on the index, the smaller the difference between real data and simulated data is, the more reliable the simulated findings are. According to Eq. (1), if this index is much closer to zero, it means fewer errors and proximity to 1 reveals higher errors [52].

$$RMSPE = \sqrt{\frac{1}{N}\sum_{i=1}^{n}(\frac{S_t - A_t}{A_t})^2} \quad (1)$$

In this equation, S_t is the results of simulating the model variable, A_t is real data and N is number of observations.

B. Identifying error roots: Besides measuring the amount of error, identifying the source of error is crucial since knowing the source of error and reducing it can increase the reliability of the results of the model. Hence, U-Theil`s test was calculated based on Eq.(2). This index is always between 0 and 1 and the more it is closer to 0, the smaller SD simulated and real data have [44].

$$UT = \sqrt{\frac{\frac{1}{N}\sum_{i=1}^{n}(S_t - A_t)^2}{\frac{1}{N}\sum_{i=1}^{n}S_t^2 + \frac{1}{N}\sum_{i=1}^{n}A_t^2}} \quad (2)$$

C. Computing error roots: error roots are calculated using the following Eq.

$$U^M + U^S + U^C = 1 \quad (3)$$

Where U^M shows inequality of mean of the output of the model with real data, U^S inequality between variance of real data with simulated one and U^C inequality of covariance of results of the model and real data which are calculated using the following equations:

$$U^M = \frac{(\bar{S} - \bar{A})^2}{\left[\frac{1}{N}\sum_{i=1}^{n}(S_t - A_t)^2\right]} \quad (4)$$

$$U^S = \frac{= (SD_S - SD_A)^2}{\left[\frac{1}{N}\sum_{i=1}^{n}(S_t - A_t)^2\right]} \quad (5)$$

$$U^C = \frac{[2 \times (1 - r) \times SD_S \times SD_A]}{\left[\frac{1}{N}\sum_{i=1}^{n}(S_t - A_t)^2\right]} \quad (6)$$

In these equations, $\bar{S}$ and $\bar{A}$ are mean of simulated and real data, SD_S and SD_A their standard deviation and r is correlation coefficient between real and simulated data.

In Eq. (3), smaller U^M and U^S indicates accurate performance of the simulated model. In the most idealistic state, U^S=U^M=0 and U^C=1. Table 1 shows the results from error measurement tests for key variables of the model. As shown, the amount of error in all of these errors is at a desirable level.

Table 1: The Results of Calculating the Error of the Key Variables of the Model

Variables	RMSPE	UT	U^M	U^S	U^C	$U^M+ U^S+ U^C$
Liquidity risk	0.0937	0.0884	0.1811	0.0056	0.8133	1
Net profit	0.0902	0.0873	0.1893	0.0068	0.8039	1
ROA	0.0829	0.0806	0.2218	0.0078	0.7704	1
ROE	0.0809	0.0791	0.2967	0.0084	0.6949	1

Overall, doing these tests calibrates the model and in the next step results of the performing the chosen scenarios on the model can be analyzed.

6.2 Model Sensitivity Analysis

Since system dynamics is a behaviour-driven field which emphasizes on behavioural patterns of variables rather than numerical values of the variables, analysing sensitivity of the model is a crucial test to evaluate reliability of simulation results which provides a useful tool for evaluating the model though measuring sensitivity of key variables of the model compared to its parameters and indicating how the behaviour of the model reacts to parameters' changes [22, 64]. Sensitivity analysis is generally done in the form of some tests in which the researcher changes the values of different parameters so that they evaluate the changes in behaviour of the model and understand the dynamics of the system and gain a broader insight into the behaviour of the system. In this section, the sensitivity of liquidity risk, net profit, ROE and ROA were evaluated against the parameters of the average loan deferral ratio, average growth of deposit and legal deposit rate. As Fig.6 shows the key variables of the study are highly sensitive compared to changes in parameters related to resource equipment. As this analysis affirms the crucial role of liquidity risk in controlling and managing liquidity risk of commercial banks, different scenarios are devised to improve the performance of liquidity risk management along with optimum use of resources.

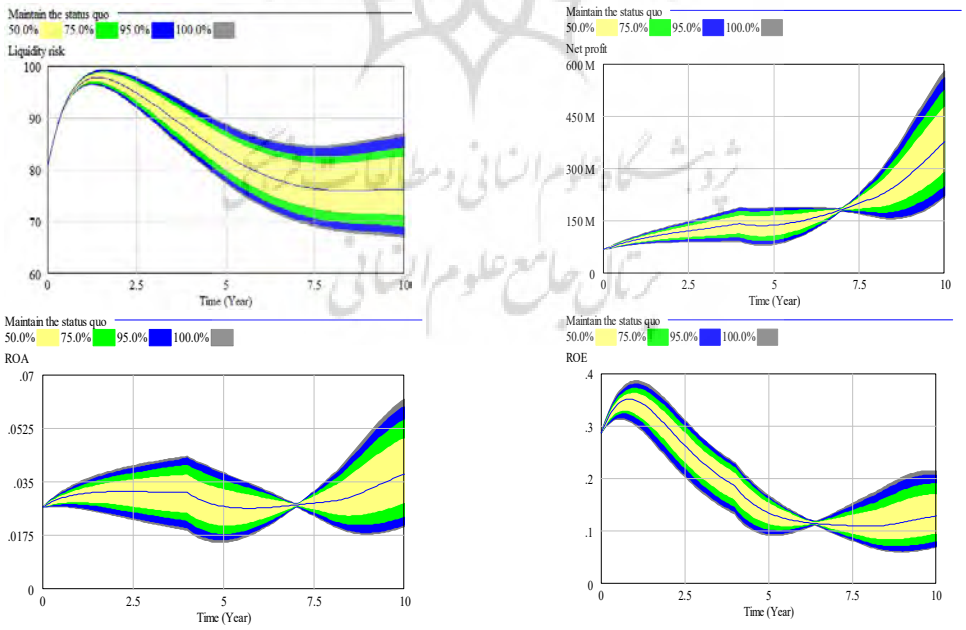

Fig. 6: Sensitivity of Key Variables to Change Model Parameters

6.3 Identifying the Pivotal Points of the Model and Making Building

After designing a liquidity risk management model, it is required to identify pivotal points of the problem and then design some recommended scenarios effective for the model. Regarding the existing variables in the structure of the system, the most important pivotal points are as follows:

1. Changing the amount of legal deposit at Central Bank
2. Taking necessary actions to reduce the number of nonperforming loans
3. Taking some fundamental actions to collect more deposits

After collecting the managers 'opinions and regarding the recommended hypotheses in the literature of risk management and the related research, some scenarios were presented to identify the process of liquidity risk and to take the required steps so that by implementing the results using simulation model, managers can learn and understand the risk and make appropriate decisions.

7 The Result from Simulating the Scenarios

7.1 Simulating the First Scenario

In this scenario, dynamic behavior of variables during the simulation process assuming the status quo is indicated. Since in this study, loan to deposit ratio is considered as an index of liquidity risk, dynamic behavior of parameters of this index on status quo was investigated. As shown in Fig.7, continuing status quo, the amount of the attracted deposits as long-term deposits is on the rise and, consequently, the bank can grant more loans by maintaining a specific level of liquidity.

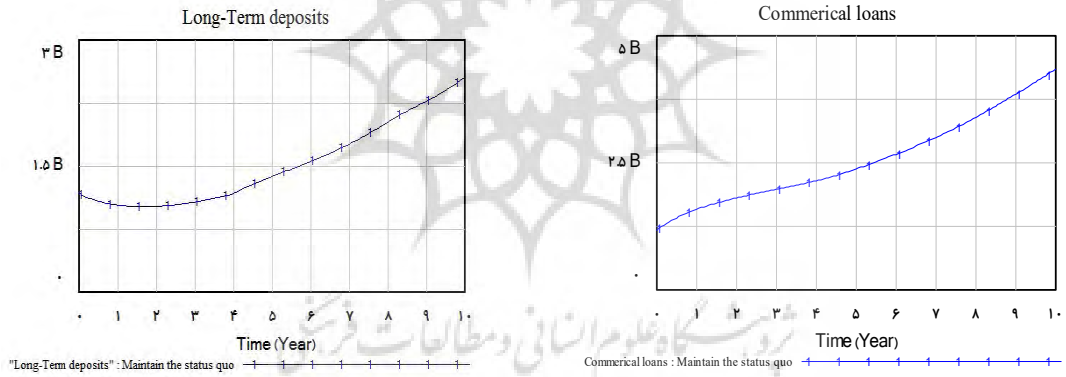

Fig. 7: Behavior of the Resources, the Attracted Deposits and Granted Loans in Case of Maintaining the Status Quo

As shown in Fig. 8, increase in resources leads to a fall in liquidity risk, on one hand, and if they are used properly, on the other hand, bank`s profitability rises. Two indices of ROA and ROE were chosen to evaluate the performance of each recommended scenario. The results indicate that ROA fairly changes in proportion to net profit but ROA reduces despite rise in profit. Since ROE indicates the percentage of net profit a bank earns for equity, in spite of several increases in capital by the bank to provide funding, the results reveal that due to lack of proper management of this capital proper returns are not achieved.

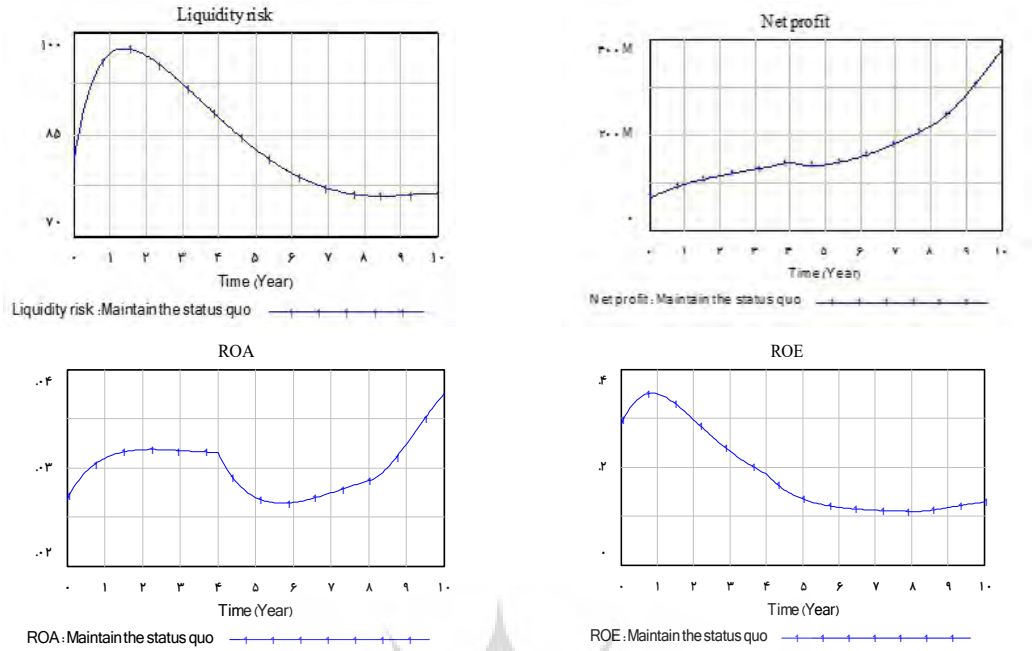

Fig. 8: Behaviour of Liquidity Risk, Net Profit, ROA and ROE in Case of Maintaining the Status Quo

7.2 Simulating the Second Scenario

Legal deposit to Central Bank is one of the indirect monetary tools for Central Banks to influence significantly on the lending and credit power of a bank and in turn on money supply. Banks are required to keep a proportion of their deposits to Central bank which is currently between 10% and 13%. Some managers argue that Central Bank decreases their lending power and as a result their profitability by blocking some of the resources as legal deposits. Hence, in the second scenario, the effect of reducing the ratio of legal deposit up to 8% on lending power and liquidity risk was examined.

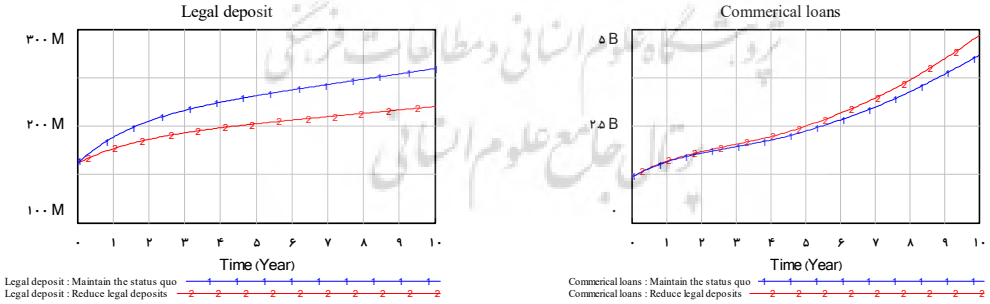

Fig. 9: Behaviour of Legal Deposit at the Central Bank, Commercial Loans in Case of Implementing the Second Scenario

As shown in Fig. 9, the results of simulation of the second scenario reveal that reducing the ratio of legal deposit can influence the bank`s lending power.

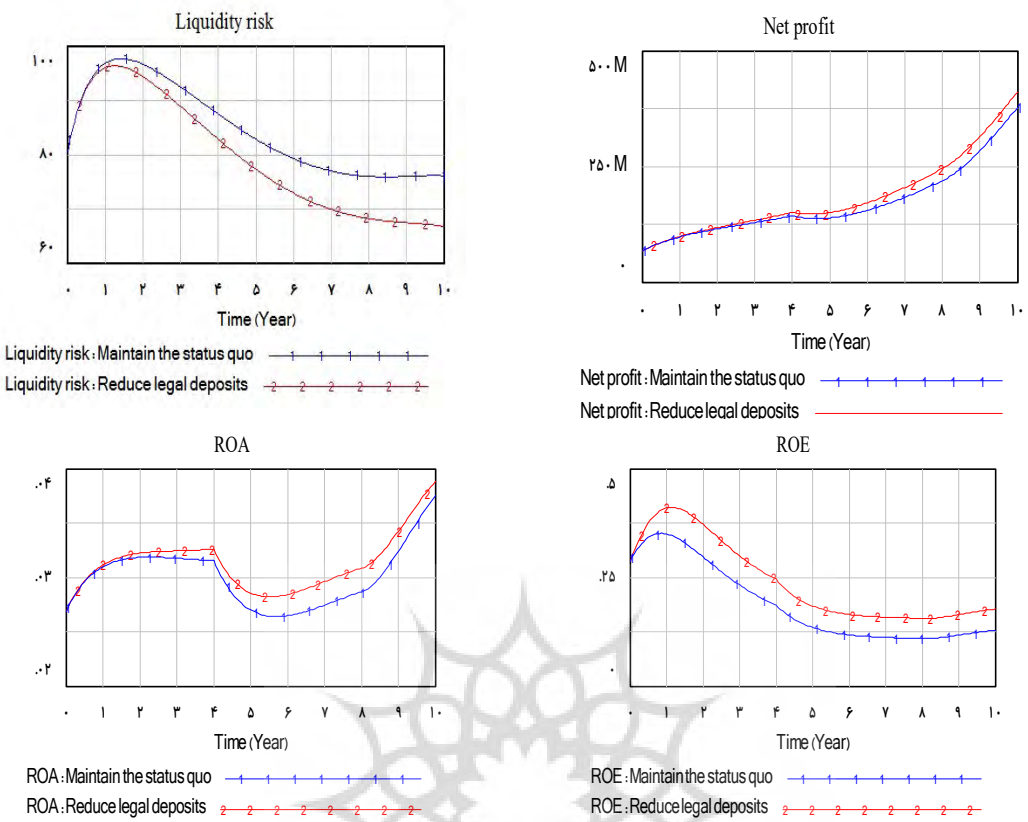

Fig. 10: Behaviour of Net Profit, ROA, ROE and Liquidity Risk in Case of Implementing the Second Scenario

The obtained results in Fig.10, however, indicate that implementing the second scenario increases net profit, ROA and ROE, and due to giving legal deposits at the Central Bank, the flexibility of the bank rises and liquidity risk drops. Therefore, reducing the amount of legal deposits to banks improves performance index of a bank and by reducing its liquidity risk it contributes to retaining the current customers, attracting more new ones and enhances the bank role in the competitive environment.

7.3 The Third Scenario

Accumulating nonperforming loans means blockage of some resources of a bank and being removed from lending cycle which weakens its lending power to different sectors, especially manufacturing sectors, by interrupting the intermediary role of the banks. In other words, increases in nonperforming loans relative to total granted loans reflect mismanagement of financial resources and lack of formation of an optimal portfolio from assets and as a consequence decrease in the quality of bank assets and liquidity risk rise, unfavourable effects on the performance of banking network and the country's economic indices. Hence, in the third scenario, the effect of reducing nonperforming loans up to 3% on performance indices and liquidity risk were studied.

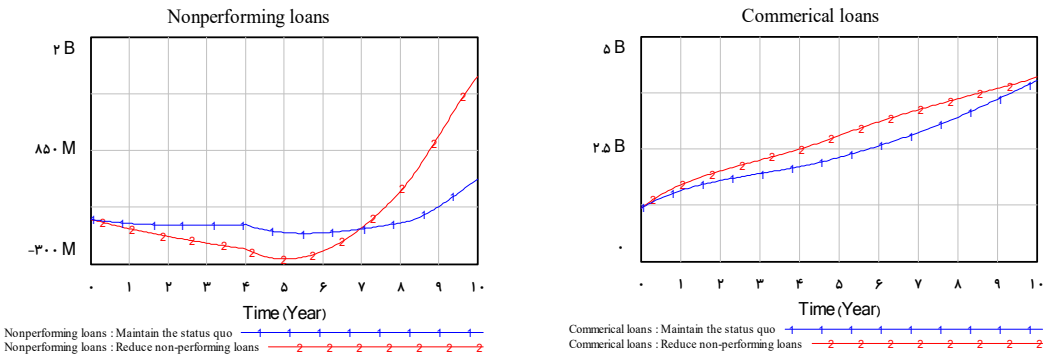

Fig. 11: Behavior of Nonperforming Loans and Commercial Loans in Case of Implementing the Third Scenario

As Fig. 11 shows, success in reducing nonperforming loans reclaims a major amount of resources so that they can be utilized to grant more loans, invest in new activities or take on more payment commitment making a bank more powerful in planning for using the resources, accepting commitment and earning income.

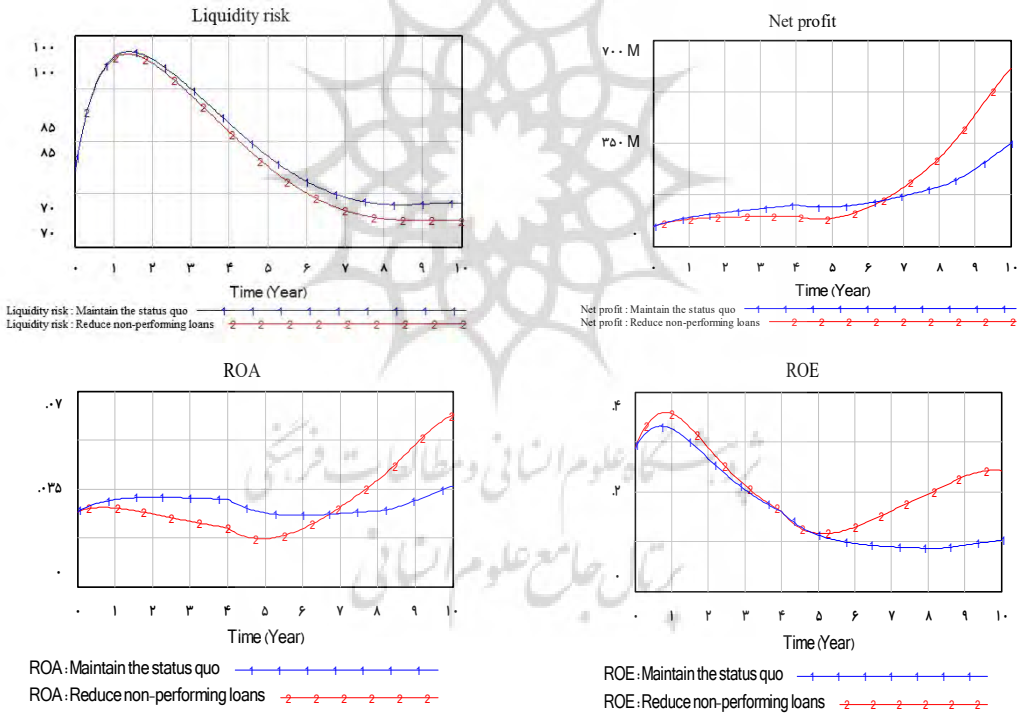

Fig. 12: Behavior of Net Profit, ROA, ROE and Liquidity Risk in the Third Scenario

By reducing the nonperforming loans, banks are able to manage inflow and outflow resources and keep a balance between resources and spending which causes higher profitability (as shown in Fig. 12) and, consequently, improves ROA and ROE and reduces liquidity risk.

7.4 The Fourth Scenario

Today, due to competition among banks and financial institutions to attract more deposits, dominating factors influencing funding financial resources is of great importance. Being the inherent feature of a bank, attracting financial resources has a profound effect on cash flow and maintaining a proper and suitable monetary system for short and long term plans of a country. Thus, the fourth scenario examines the effect of attracting more deposits on performance indices and liquidity risk.

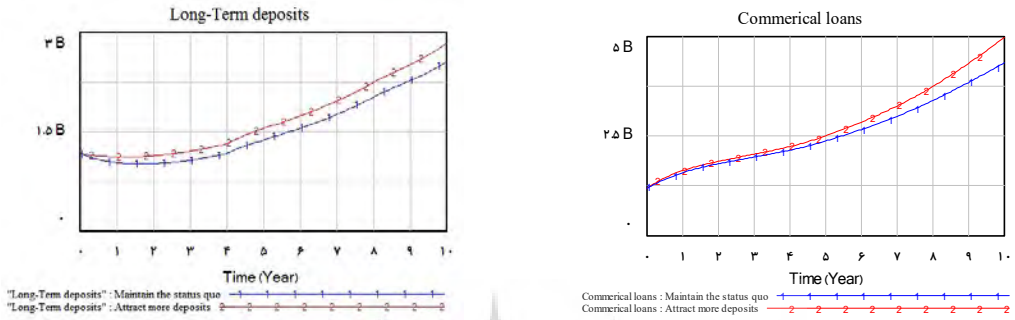

Fig. 13: Behaviour of Commercial Deposits, Nonperforming Loans in the Fourth Scenario

Given 3% increase in attracting deposits, the diagrams in Fig.13 reveal that the more deposits are attracted, the higher lending power of a bank is. This makes banks to encourage their customers to invest in order to raise their financial resources and to achieve maximum efficiency by utilizing them properly and optimally.

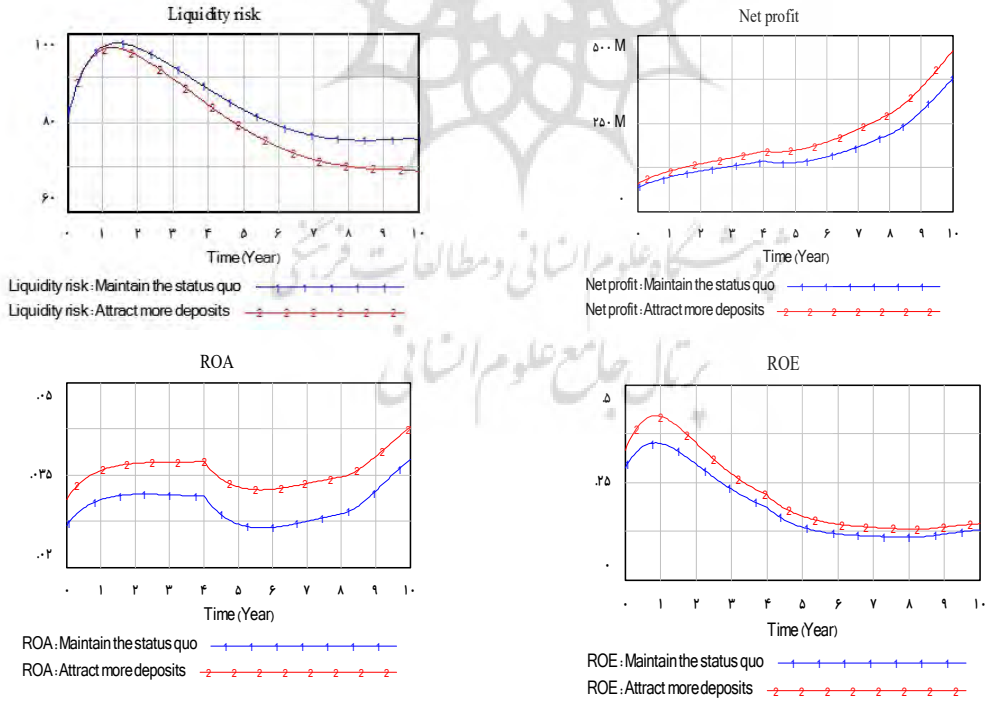

Fig. 14: Behaviour of Net Profit, ROA, ROE and Liquidity Risk in Case of the Fourth Scenario

The results of using the model in Fig. 14 show that making reasonable and suitable decisions to attract deposits as well as their proper management contributes to rise in net profit, ROA and ROE, and, therefore, increase in liquidity resources reduces liquidity risk. Therefore, by proper management of liquidity and correct definition of liquidity policy, it is expected to meet the bank`s varying maturity of assets and liabilities as well as to provide a safe margin to cover withdraw risk from deposits.

8 Conclusions and Discussion

One of the most crucial risks related to banking is liquidity risk. Although it has a unique nature in each bank, it simply means inability of a bank to cover outflow cash which is mainly result from long-term funding of a bank through short-term liabilities so that demand for cash does not equal its supply and banks are always encountered with liquidity deficit or surplus, called liquidity gap. They need to try to manage liquidity risk by creating a balance between liquidity deficit and surplus, which highlights the importance of liquidity and managing it. Effective management of this risk can be facilitated by identifying factors influencing it, building a model and analysing the existing dynamics. Thus, the present study was carried out based on indicating the dynamic behaviour of factors affecting liquidity risk and identifying the productive structure of these behaviours. In other words, the research is to identify systemic and casual structures of liquidity risk management model by designing and presenting a dynamic model. This model is able to simulate various scenarios and this study investigated four scenarios and their results were simulated. The first scenario indicates the results of continuing status quo for liquidity risk management and the results of the simulation reveal that the volume of deposits and granted loans increased proportionally. Thus, increase in liquidity resources reduces liquidity risk in one hand and increases net profit and ROA in the other due to rise in lending power. It is worth mentioning that net profit growth is not in proportion to ROE which can be due to mismanagement in liquidity resources resulting from rise in bank`s capital.

Therefore, managers are suggested to make reasonable investment policies to allocate resources and to determine an optimal portfolio combination of assets and pay attention to lending capacity via granting less risky loans and maximum use of resources. Banks are required to redefine the existing model of assets and liabilities by using an integrated management system and try to enhance their efficiency and performance in different areas by devising appropriate strategies to combine assets and liabilities optimally. The second scenario studied the effect of reducing legal deposits rate at the Central Bank on liquidity risk. Simulation results show that reducing legal deposit rate enhances lending power and the bank can use these resources as an incentive to attract more deposits and promote its performance. Releasing these deposits can improve flexibility of a bank and reduces liquidity risk. It is noteworthy that, nowadays, using legal deposit as a monetary tool has been limited and tends to zero. Therefore, the Central Bank can provide a considerable amount of financial resources to increase banks` lending power by reducing legal deposit rate so that they can fund manufacturing sectors and support domestic production in existing sanctions in Iran. In the third scenario, the effect of reducing nonperforming loans on performance indices and liquidity risk was simulated. The results indicate that taking actions that lead to reduction of nonperforming loans increases lending power of banks and as a consequence net profit and ROA which all lead to less uncertainty in accessing liquidity resources that drops liquidity risk as a result. Hence, banks can investigate the reasons and formation of nonperforming loans to avoid them. These factors often originate from internal weaknesses of banks, many are external, though. One

of the main reasons for increasing nonperforming loans is determining and implementing some prescribed and unreasonable policies in banking which results in funding some business plans that lack economic justification. Therefore, banks are required to take various actions, take advantage of different solutions, implement guidelines issued by Central Bank, monitor their precise implementation and prevent the loans from being spent elsewhere. Finally, in the fourth scenario, the effect of increase in attracting deposits on liquidity risk was examined and the results of simulating the model indicate that increase in deposits, if the attracted resources are managed properly, can improve the performance of the bank, create a safety margin to cover the risk of withdraw from bank accounts and, in turn, reduces liquidity risk. Banks can establish their funding strategies so that there are adequate variations in resources and due dates. They can also identify different alternative resources to confront sudden and unexpected withdraws and try to empower themselves against liquidity shocks by enhancing their resources. They can provide more funds by focusing on various factors affecting the process of funding financial resources. Theses recourses include the latest Information and Communication Technologies, human resource skills, diversity and quality of the provided services, Customer Satisfaction, branch Location and so forth. In addition to the proposed suggestions regarding these scenarios, the following recommendations are offered to manage and control liquidity risk:

1. Banks need to examine the behavior of debts and the factors influencing them in normal business condition and reduce liquidity risk by debt diversification techniques.
2. Since liquidity risk is closely related to other banking risks, it is recommended to identify effects and causes of different risks and to analyze the relationships among them to determine the optimal combination of banking activities to reduce risk at expected return rate level.
3. In order to reduce liquidity risk, bank managers should take advantage of both decrease in repayment flows and new loan applications along with controlling credit risk and identifying customers and using more consistency in risk control take better and more serious steps. As a result, it is suggested to provide a more integrated network of all the information related to banks` customers so that banks can make decisions about granting or not granting loans.
4. It is suggested that in order to reduce liquidity risk, investment deposit / volatile deposit ratio is increased. Increasing this ratio indicates that a bank is less dependent on volatile deposits.
5. In every organization, overcoming complex risks requires new ideas and approaches and systematic thinking is a solution for improving and promoting the current process of risk management. Therefore, it is recommended that banks try to promote such thinking among their managers and personnel by holding interactive courses so they can understand the issues and systems and carry out their tasks in a known environment.

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