

Banking Soundness System: A System Dynamics Model

Mohammad Bagheri Mazrae

Department of Industrial Engineering
University of Eyvanekey
Garmsar, Iran
m.bagheri@eyc.ac.ir

Azam Ghezelbash

International Institute of Social Studies
Erasmus University Rotterdam
Netherlands
azam.ghezelbash@gmail.com

Alimohammad Ahmadvand

University of Eyvanekey
Garmsar, Iran
am.ahmadvand@eyc.ac.ir

Abstract

Banks need a way to evaluate performance and consider some important financial ratios and find the strengths and weaknesses. The banking system is one of the most important economic sectors in the Iran that has the most relationships with the country's macroeconomic; therefore, any kind of volatility and instability in it can influence the country's macroeconomics. Therefore, assessing the performance of the country's banking industry and analyzing the banking soundness is important. One of the more conventional methods to analyze and evaluate the banking soundness is using the CAMELS rating system which has six dimensions included to measure the performance of the bank. Each of these dimensions has many components and together with the variables that influence them and the interactions between them constitute a complex economic and monetary system. In this study, using the system dynamics approach, a systemic analysis of the structure of this issue will be provided. The results show that the factors Incomes and Expense are the most important issues of an Iranian bank in managing banking soundness and the way out of them is the development of these two factors.

Keywords: Banking Soundness, CAMELS, Rating, System Dynamics

1. Introduction

In both developing and developed countries, banks contribute to economic growth by their important part in financial intermediation. There is a strong relationship between the financial sector and economic growth [1]. The growth and financial stability of the country depend on the financial soundness of its banking sector [2].

In banking system of every country, analysis of banks is done with various objectives such as stock valuation, earning, performance and efficiency evaluation. In addition, the experience of the recent financial crisis and the destructive impacts resulting from the transition of crisis from the financial sector to the real economy has revealed the importance of paying ever more attention to the issue of banking soundness [3]. According to Evans and the Bank for International Settlements, the bank health indicators can well identify the main points of vulnerability of banking system and explain related reasons as well [4]. Banks need a way to evaluate performance and consider some important financial ratios and find the strengths and weaknesses [5].

In this way, one of the most popular methods for the analysis and evaluation of the banking soundness is represented by the CAMELS framework. This framework, firstly known as CAMEL, was created in 1979 in the USA by the bank regulatory agencies, and its use has been extended since then, is considered a useful tool for the regulatory authorities from different countries in order to assess the soundness of financial institutions [6]. CAMELS consists of five components; Capital adequacy, Asset quality, Management quality, Earnings and Liquidity [7]. In fact, U.S. regulators recognized that the current global competitive markets had not been adequately factored into CAMEL and, in 1997, added a sixth factor designed to capture systemic risk. This systemic component, S, attempts to capture banks' sensitivity to market factors that include interest rate, foreign exchange and price risk [8]. The most common way to measure the financial performance and quality management of the banks is examination if financial ratio and their comparison with the benchmarks [9]. Each component of this rating is calculated on a 1 to 5 scale, being accumulated into a composite evaluation, also defined by the 1 to 5 scale [10].

In figure 1, CAMELS model is shown to clarify six categories.

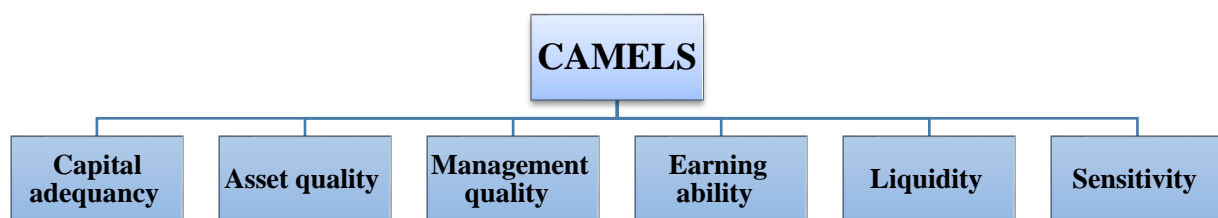


Fig 1: CAMELS model

Those categories as [11,15,12,13] pointed, are:

Capital (C) is one of the most important indicators for the financial soundness of the banking sector because it guarantees the capacity of this sector to absorb the eventual losses generated by the manifestation of certain risks or certain significant macroeconomic imbalances [4].

Asset Quality (A) is an important parameter to examine the degree of financial strength. The maintenance of asset quality is a fundamental feature of banking. The prime motto behind

measuring the asset quality is to ascertain the component of nonperforming assets as a percentage of the total assets [2].

Management Quality (M) is not just dependent on the current financial performance. This component consists of a large range of issues such as the education level and expertise of the management. Thus, it is the hardest.[9]

Earning Ability (E) and earning profile of a bank reflect its ability to support present and future operations. More specifically, this determines the capacity to absorb losses by building an adequate capital base, finance its expansion and pay adequate dividends to its shareholders [10]

Liquidity (L) management in banks has assumed prime importance due to competitive pressure and the easy flow of foreign capital in the domestic markets. The impact of a liquidity crisis in the banks can adversely impact the financial performance of the banks.[11]

Sensitivity (S) Sensitivity ratios those are related to risk and covering power of organization are defined and calculated to finalize bank's performance model because risk indicators are very important and highlighted in CAMELS model.[12]

Commercial banks are increasingly involved in diversified operations such as lending and borrowing, a transaction in foreign exchange, selling off assets pledged for securities and so on. All these are subject to market risks like interest rate risk, foreign exchange rate risk, and financial asset and commodity price risk [17].

Although Iranian banks use of CAMELS indicators to assess the soundness banking, however, they do not have the health and stability. Therefore, reducing the banking soundness of banks and financial institutions happens. In this study, using a systemic approach, the causal relations between the components of this rating system is identified, and the important feedback loops of this dynamic system are represented, also ways for improvement will be presented according to the acquired knowledge of how the system's variables interact.

2. Literature and Background

System dynamics is a methodology and mathematical modeling technique to a frame, understand and discuss complex issues and problems. Originally developed in the 1950s by Professor Jay Forrester of the Massachusetts Institute of Technology to help corporate managers improve their understanding of industrial processes, SD is currently being used throughout the public and private sector for policy analysis and design. System dynamics is an aspect of systems theory as a method to understand the dynamic behavior of complex systems. The basis of the method is the recognition that the structure of any system, the many circulars, interlocking, sometimes time-delayed relationships among its components, is often just as important in determining its behavior as the individual components themselves. It is also claimed that because there are often properties-of-the-whole which cannot be found among the properties-of-the-elements, in some cases the behavior of the whole cannot be explained in terms of the behavior of the parts. In the system dynamics methodology, a problem or a system is first represented as a causal loop diagram. A causal loop diagram is a simple map of a system with all its constituent components and their interactions. By capturing interactions and consequently the feedback loops, a causal loop diagram reveals the structure of a system. By understanding the structure of a system, it becomes possible to

ascertain a system's behavior over a certain time period. Applied the system dynamics approach to representing causal structure of CAMELS system [14].

Sterman [18] is described steps in modeling process as follows:

- Define the problem boundary
- Draw a causal loop diagram that links the stocks, flows, and sources of information
- Identify the most important stocks and flows that change these stock levels
- Simulation Model
- Define different scenarios, evaluate, select and implement the right solution

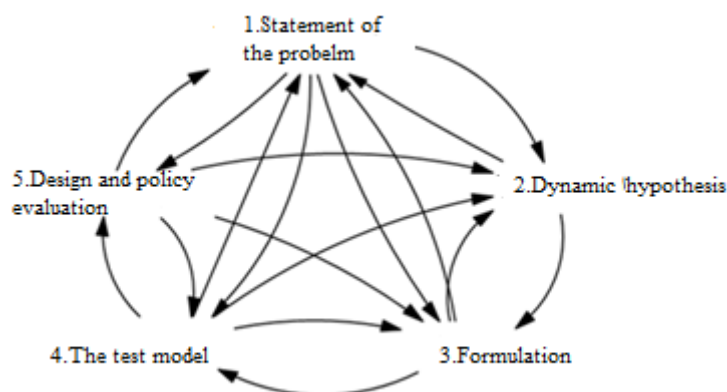


Fig 2. Iterative process and feedback system dynamics modeling methodology (Sterman, 2000)

The system's methodology of the present issue is using the system's approach and tools available in system dynamics approach. System dynamics is a powerful solution that simulates a system using computational approaches and allows to study the issues and explain the behavior of complex systems [18]. System dynamics is a simulation-based approach to gain helpful insight into the dynamic complexity of the system [19]. After specifying the system and the included elements, we consider their change over time and determine feedbacks between the elements present in the system. When an element of the system is indirectly influenced by itself, it forms a causal or feedback loop [20]. In fact, the efficiency of dynamic modeling of the system is understanding and presenting the feedbacks procedure [18]. Causal-Loop Diagram is one of the important tools to show the feedback structure in the systems [21].

In table 1, some important indicators those are employed in CAMELS model studies are shown. As study literature, there are 6 categories in this model that in each category some practical and relevant elements are used.

Author	Year	Title of study	Result
Kabir et.,al	2012	Ranking by using CAMELS	Compare the performance of two private sector [22].
Ulas et.,al	2015	Data covering analysis	Technical efficiency in banks [1].
Dincer et.,al	2011	Evaluation of Turkish banks	Critical periods 2001 to 2008 [14].
Keovongvichit h	2012	CAMELS key financial indicators and the development	The financial performance of the banking sector [23].
Roman	2013	Using the index Rankings CAMELS	Analysis of the financial health of banks [6].
Kumar et.,al	2012	Using the index Rankings CAMELS	Performance analysis of 12 public and private banks in a period of eleven years old [16].
Rozzani et.,al	2013	Using the index Rankings CAMELS	Islamic banks and performance of both old Malaysia [10].
Rodica	2014	Through analysis of the theoretical and empirical research	View the changes in the banking system in Romania and communicate critical period effects [24].
Dang	2011	Using the index CAMEL rating	Identify the benefits as well as drawbacks which the system Camel brought to the agency [25].
Altan et.,al	2014	Using the index CAMEL rating	Wide performance and financial health of public and private banks in Turkey for the period 2005-2012
Doumpos et.,al	2015	The empirical analysis	How it affects the health of the banking and central bank independence [26].
Mihailović et.,al	2009	Data covering analysis	Banks ranked Serbia [9].
García et.,al	2010	Topsis	Spanish banks ratings [27].

In this study, it is attempted to examine all of the factors influencing the system's banking soundness using a systemic, integrated and holistic approach in Iran between 2011 to 2015, whereas other conventional methods in analyzing this issue mostly have an island and static approach to the issue of banking soundness; hence benefiting from a holistic and dynamic approach in the analysis of this issue is its most important innovative aspect.

3. Methodology

System Dynamics methodology can be used in qualitative and quantitative approach. In the qualitative approach to analyze the dynamics of the system, try to identify feedback structure, reinforcing and balancing loops and also delays, then according to generated perception, will also be provided feedback solutions. Some of the application of this approach is are [25-36]. In quantitative approach, by a mathematical model, the model of a problem can be simulated and it can lead to finding the effective solution by learning from model behavior[37].

3-1. Definition of problem

By focusing on the issue of banking soundness analysis, the present study aims at examining factors, relations and thus feedback structure affecting it and after identifying leverage points in the system and also understanding resulted from the systemic view, create scenarios to improve conditions. Providing such a dynamic model allows for simulating the results of implementing policies and provides an appropriate backup system for bank executives as well as banking industry policy-makers.

3-2. Draw a causal loop diagram

Using the rankings CAMELS is provided a macro picture of the interaction between bank health factors, including capital adequacy, asset quality, management quality, earnings, liquidity and sensitivity to market risk. Increase capital adequacy causes the growth of risk-free assets (total assets of cash, receivables) over the growth of risky assets (facilities). Change approach banks from risky assets to less risky assets resulted to improve capital adequacy. On the other hand, reduces the earning and asset quality facing as well as the bank's health at risk.

Increase liquidity in the bank will increase the liquidity risk and this makes decline banking soundness and earning. The relationship between liquidity and earning is inverse, so financial institutions should establish the right balance between liquidity and earning. Increasing the quality of bank management and reduce sensitivity to market risk helps to the health of a bank.

This sub-system is evident in figure 3 the graph charting will help to better understand a system and the causal links.

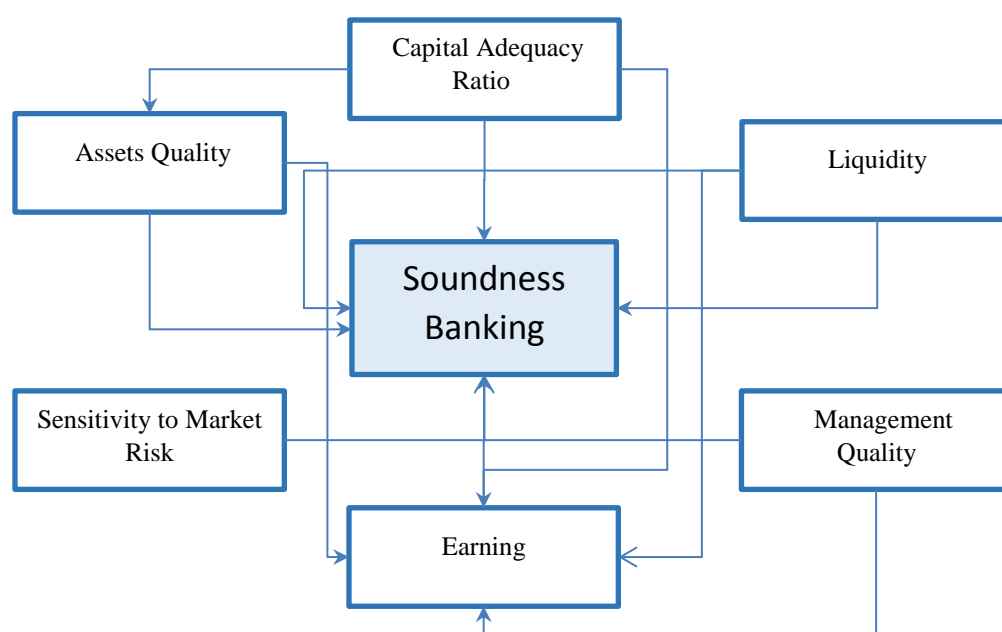
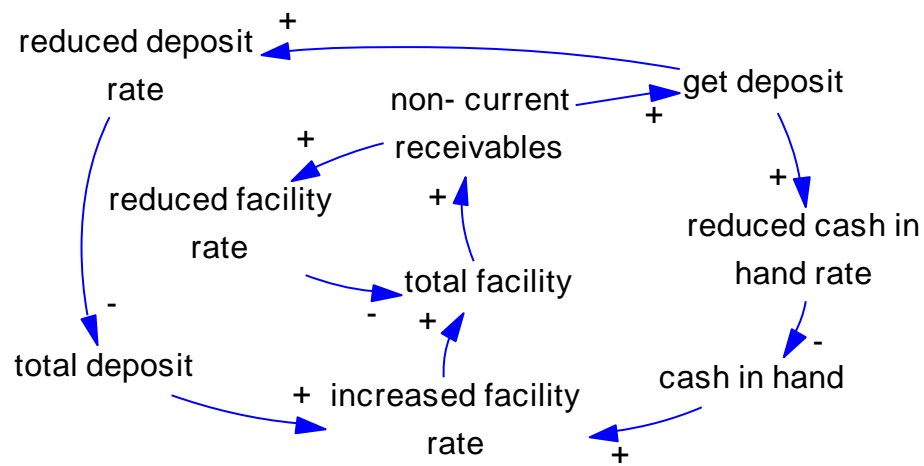


Figure 3. Model framework

In this section main loops in the chart are introduced in detail:

a. Receivables Loop

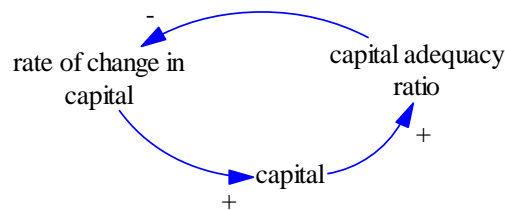
The main factor of receivables is facilities. Increased receivables cause banks to go into bankruptcy. Hence, in this case, people are more willing to a withdrawal of deposits which this leads to a decline in bank balance and cash balance and increases lending rate. This also leads to an increase in decline rate of deposit which decreases total deposits. As a result, a growth rate of facilities and thereby the volume of facilities decreases.



i. Receivables loop

b. Capital Loop

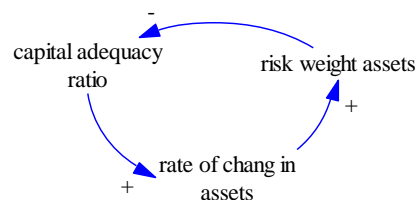
Capital makes the capital adequacy ratio to increase. In this case, the rate of change to capital reduces. As a result, if the rate of change to capital increases, this increases the capital adequacy ratio.



ii. Capital loop

c. Risk-weighted assets Loop

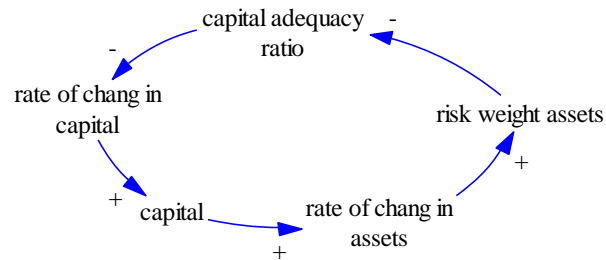
With the increase in risk-weighted assets, capital adequacy ratio reduces and by increasing the capital adequacy ratio rate of change to assets increases which this increases the risk-weighted assets.



iii. Risk-weighted assets loop

d. Capital adequacy ratio Loop

Capital adequacy ratio should have a balance between 8 to 12%. Increasing the capital adequacy ratio reduces the rate of change to capital. Therefore, raising capital will increase the rate of change to assets which this increases the risk-weighted assets. This ultimately will decrease the capital adequacy ratio.



iv. Capital adequacy ratio loop

The direction of "Bank Performance from 2011 to 2015" is shown by figure 4.

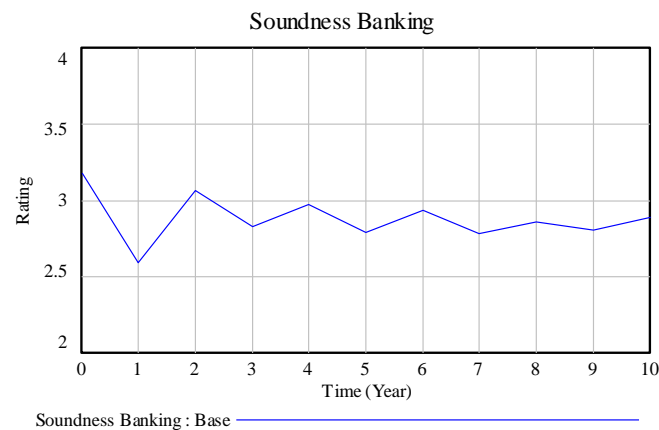
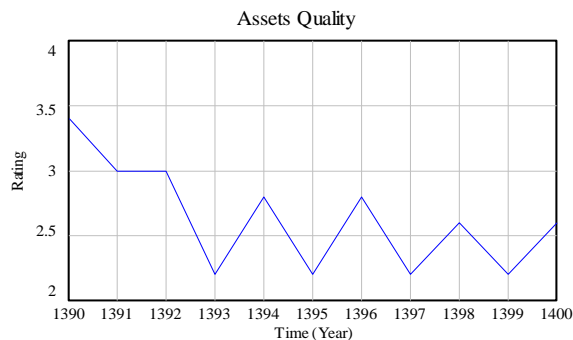


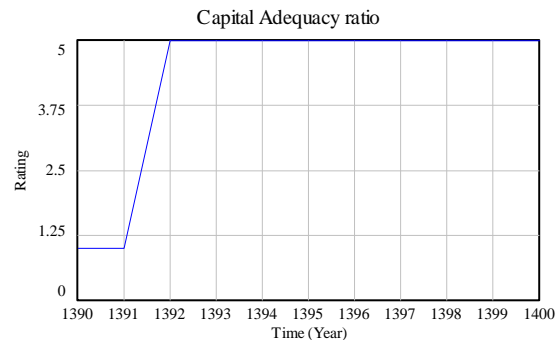
Figure 4. Soundness banking changes

3-4. Simulating Model

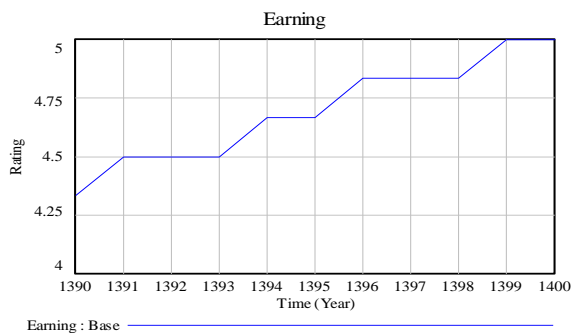
Providing such a dynamic model allows for simulating the results of implementing policies and provides an appropriate backup system for bank executives as well as banking industry policy-makers. Simulating soundness banking criteria are shown:



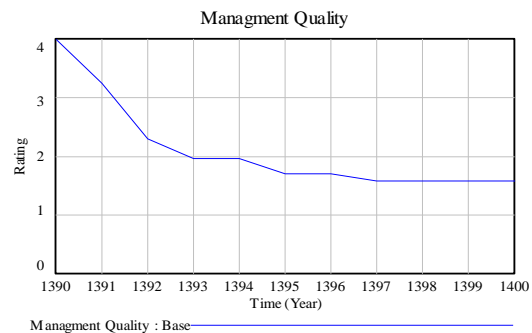
b. Asset Quality changes



a. Capital Adequacy changes



d. Earning changes



c. Management Quality changes

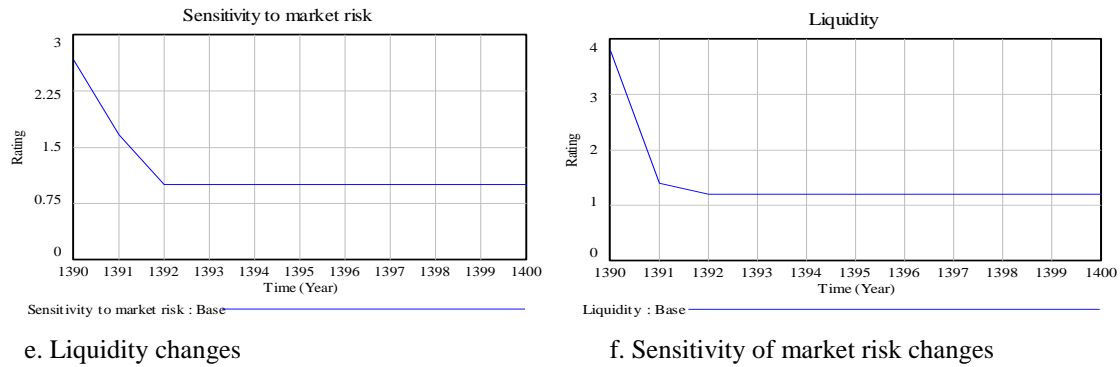
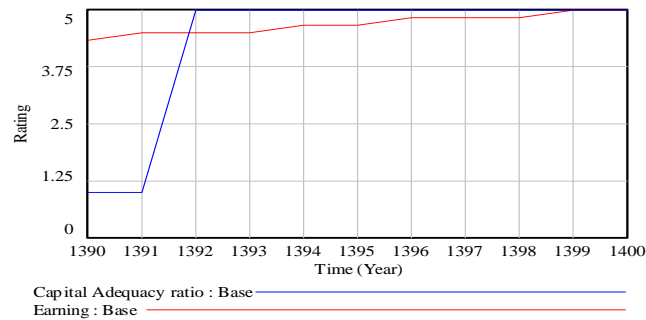


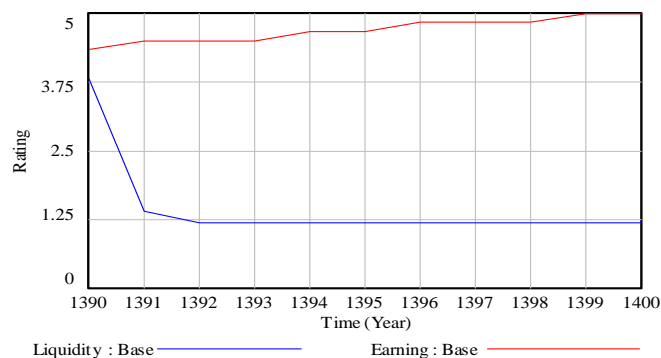
Figure 5. Simulation

3-4-1. Comparing Soundness banking indicators

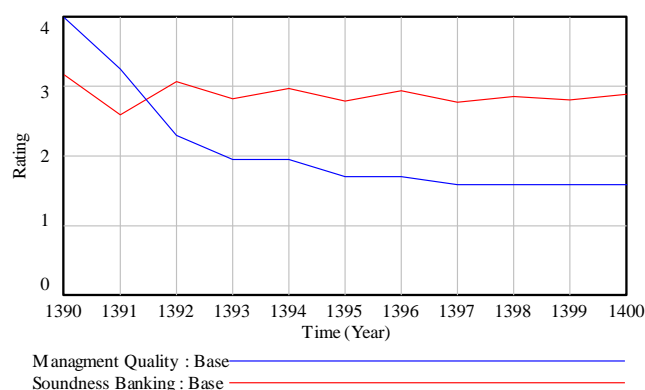
In this section, Soundness banking indicators are compared.



As the figure shows, when capital adequacy is in the ideal case bank earning is better than other states. When the capital adequacy approaches to its worst-case, bank earning falls relative to the possible worst state.



Earning and the liquidity ratio is reversed. As observed in the above figure, when the bank comes to the best in the liquidity over time, on the contrary earning tends to the worst state. The management quality has the greatest possible impact on banks rating.



i. Management Quality and Soundness Banking

According to the graph, when the quality of management is in a better position, banking soundness will be also improved.

3-5. Scenario building

To design scenarios, the leverage points should be first identified. Given that the highest weights of CAMELS ratings are 25% management quality, 20% capital adequacy, 20% assets quality, 15% earning, 10% liquidity, 10% sensitivity to market risk, respectively, leverage points of the proposed model include:

- A) Capital
- B) Earning
- C) Costs
- D) Deposits

Based on the leverage points identified in the CAMELS model, one can examine the following scenarios for implementation and predict its behavior:

- First scenario: In this scenario, given that the change in bank's capital is possible by changing the numerator and the denominator, banks may choose different approaches regarding different economic conditions. Since by increasing capital the capacity of lending and providing facilities to customers will also increase and thus this makes receivables to further increase, high capital in a bank not only does not improve the capital adequacy of a bank but also has high costs and reduces bank rating. Hence the management's role is greater in this case and it is better than capital adequacy in a bank to have a balanced mode.

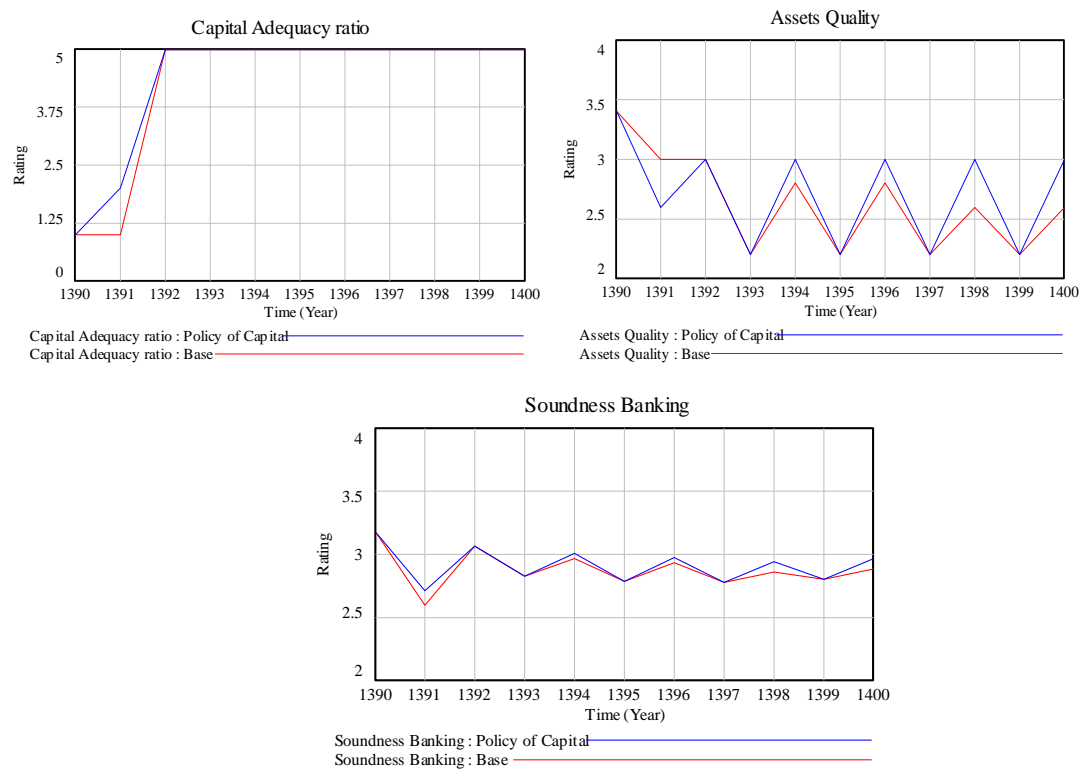


Figure 6. The result of first scenario

As the figure shows, with increasing capital, the rating of capital adequacy ratio and asset quality gets worse than the previous state. As a result, changes in banking soundness is negligible.

- Second scenario: In this scenario, given that bank's earning comes through joint and non-joint incomes. Therefore, with an increase of which the ratios of return on assets, return on investment, profit margin and operating margin increase and lead to improved earning and thereby banking soundness. On the other hand, it increases productivity and improves the quality of management.



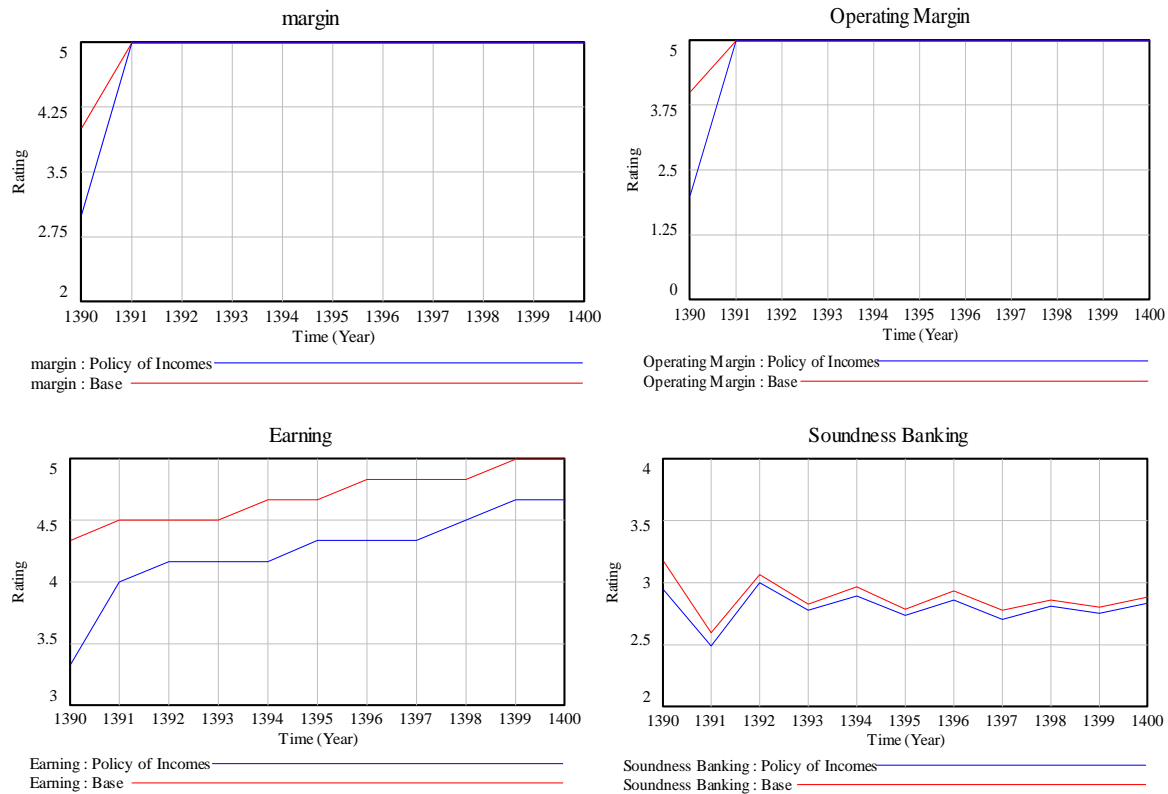


Figure 7. The result of second scenario

- Third scenario: In this scenario, with decreasing costs the rating of net profit, quality management, and productivity gets better. As a result, as shown in the figure, the rating of banking soundness gets better as well.

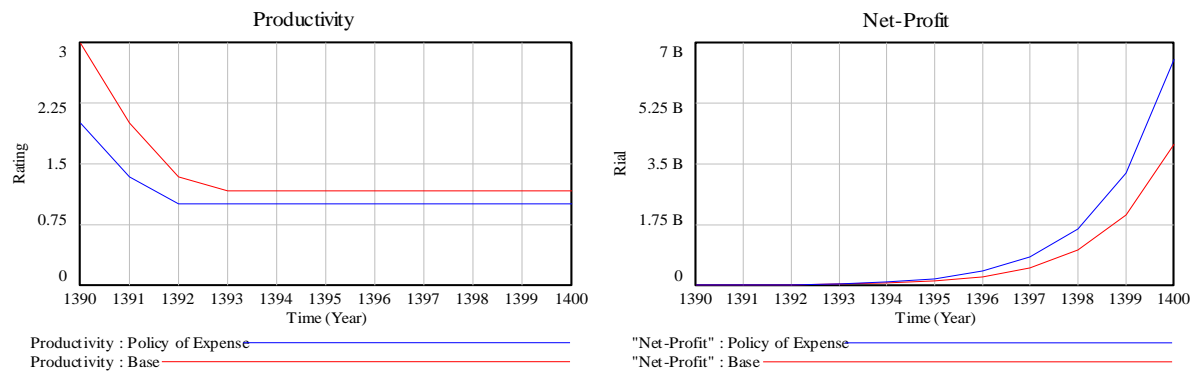
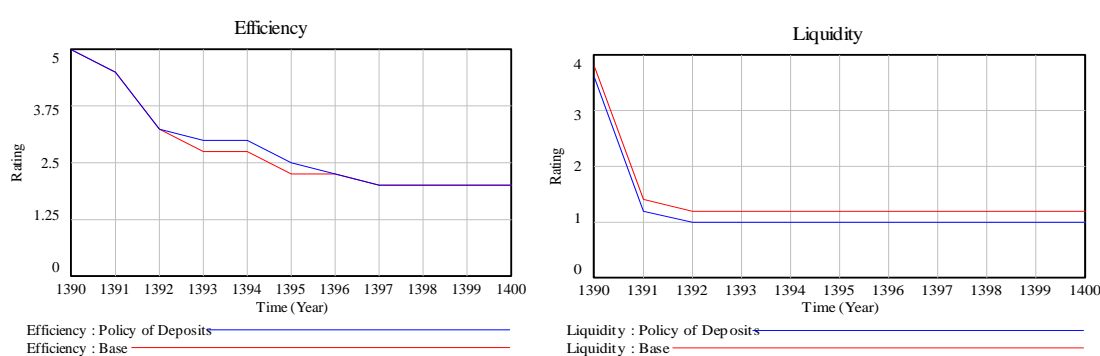




Figure 8. The result of third scenario

- Fourth scenario: Regarding the liquidity, if the goal is earning, targeting should be based on cheap sources (volatile deposits). In that case, the bank faces the risk of non-sustainability of such resources and deposits. In contrast, since earning is inversely related to liquidity, if the objective is to reduce risk, the bank has to gather resources and deposits that are more stable (persistent deposits) which this is associated with an increase in operating costs. It is therefore essential that the banks choose the right mix of volatile deposits and persistent deposits. Banks also need the right mix of volatile liabilities, coverage fluctuations, and coverage short-term debt so that they can succeed in their liquidity management. Therefore, with the increase in stable deposits banks efficiency decreases and thereby liquidity increases. As a result, on one hand, banking soundness improves and, on the other hand, bank rating increases. In addition, with increased volatile deposit the liquidity rating increases, so, it is better for a bank to plan for attracting more long-term sources.



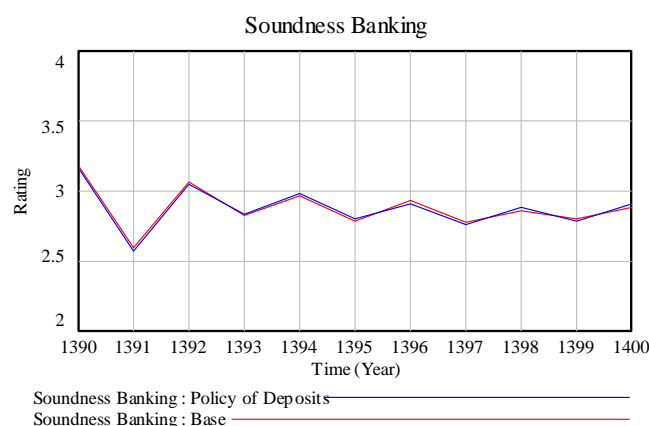


Figure 9. The result of fourth scenario

In this scenario, as is clear from Figures, with an increase in volatile deposits and non-volatile deposits, bank liquidity gets better. But the bank efficiency rating gets worse compared to the previous state and thus does not affect significantly banking soundness.

4. Conclusion

Using data from the financial statements of Iranian banks for the period 2011-2015, in the form of system dynamics, this study explores a significant relationship between CAMELS sextet ratios (capital adequacy, asset quality, management quality, earnings, liquidity and sensitivity to market risk) and banking soundness status of Iranian bank. Rating of banks in terms of performance is a suitable measure which in the prevailing space may lead to qualitative and quantitative improvement of banks and eventually causes the country's economic growth and prosperity. some researchers such as Kabir, Keovongvichith, Roman, Kumar, Rozzani, Rodica [21], Dang, Altan and Bassett [38] use CAMELS criteria to evaluate banks rating.

Therefore, due to the complexity of the banking soundness structure and non-linear interactions among the elements of this structure as well as its importance, in this research, we used system dynamics approach which is based on the discovery of the feedback structures and causal relationships.

Due to the importance of increasing banking soundness and its rating, the results of simulating proposed scenarios indicate that:

Although the scenario of capital increase is associated with decreased capital adequacy ratio, asset quality and bank ratings, it does not have so much impact on banking soundness

Also, in the scenario of bank deposits increase, though the stable deposits make better bank liquidity, and volatile deposits will reduce the liquidity of banks, hence, the sum of these two factors has a very little impact on improving the banking soundness.

It seems, for proposed model of banking soundness, the scenario of increasing revenue and reduces costs are the effective scenarios. Because one of the ways to increase profits, is increasing revenue and thereby leads to an improved rate of return, the rate of return on assets, profit margin, operating margin, productivity and earning of a bank which ultimately has a huge impact on the banking soundness. Also, another way to increase earning is to lower costs through which the ratings of productivity, quality of management, and earning are improved which ultimately further affects the banking soundness.

According to the results of simulating, we can say that one may control this system through two way: management and planning to increase earning and cost reduction.

The results of recognizing system indicate that the factors that can increase the banking soundness, are mainly those which affect the banking soundness qualitatively. As a result, the study points out that it is better that banking executives apply their policies on this factors to get a better position of banking.

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