International Journal of Finance and Managerial Accounting, Vol.7, No.27, Autumn 2022

Banking Crisis Prediction Modeling with Bayesian Model Averaging Approach

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Submit: 19/09/2021 **Accept:** 24/11/2021

ABSTRACT

Banking crises are occurring intermittently. This indicates that pre-current warning models have not been successful in identifying these crises. Examination of existing models specifies that the failure of these models is mainly due to the identification of explanatory variables and experimental design of the model, which the researchers of the present study aimed at improving. In order to moderate the problem of model uncertainty by averaging all models (Bayesian averaging) the present research attempted to determine the factors affecting the banking crisis in Iran. In this study, 49 variables affecting the banking crisis were included in the model. Finally, using the Bayesian averaging model approach, 12 non-fragile variables affecting the financial crisis were identified consisting of cost of funding, none performing loan (NPL), deposit to loan (DTL), spread, capital adequacy, earning assets to total assets ratio, net LTD (after deducted Legal reserves), cash coverage ratio, net stable funding ratio (NSFR) in the presence of all variables, duration of assets and liabilities, interest rate duration, and increase in properties' possession. According to the results, it could be deduced that the banking crisis index in the Iranian economy is a problem with wide dimensions as the variables related to monetary and financial sector policy makers affect this index. The banks studied in this study are 10 banks listed on the Tehran Stock Exchange (Kar Afarin, Eghtesad-e Novin, Parsian, Sina, Mellat, Tejarat, Saderat, Post Bank, Mellat, Dey) in an 11-year period from 2008 to 2019.

Keywords: Crisis, banking crisis, warning models, Bayesian model averaging.

1. Introduction

The irreparable consequences of financial crises in the banking industry pose a serious threat to the financial systems of countries and even the global financial system. In some ways, the Covid-19 pandemic could be compared to financial crises for two reasons. Firstly, the epidemic of diseases is the essence of the natural system and secondly, it exists regularly and continuously. Some viral diseases are so weak that they might only be recorded and identified in developed countries with stronger information systems. This is while some others have serious risks, some are significantly worrying, and some are even catastrophic internationally. An examination of the world's banking crises over time reveals that some of them are destructive. Therefore, it is necessary to design a system that would prevent the disparaging outcomes of these crises.

Accordingly, the early warning system (EWS) is utilized as an experimental diagnostic tool with the aim of halting the mentioned undesirable effects. Its purpose is to develop a warning system as a tool to determine the threshold of bankruptcy and crisis in banks. That is, an effective early warning system makes it probable to use a precautionary policy that may reduce the need for real-time monitoring. The basic rationale for early warnings is that some economic variables behave in a way that differs from their trend in terms of financial stability before a financial crisis occurs in banks; Therefore, studying the trend of these variables might indicate the occurrence of a crisis or the continuation of the stability process. The warning system was first introduced in the world after the currency crises of European countries in 1992-93, the crisis of Latin American countries in 1994-95, and more seriously after the crisis of East Asian countries in 1997-98. In addition to the International Monetary Fund, which is leading the way, some universities and central banks also have conducted some research. Thus, some recent works in the literature is related to predicting financial crises and in this regard, a wide range of indicators have been identified and tested as leading indicators.

Discrete and continuous models (not yet used in the financial crisis literature in banks) might be used to predict early warning systems. Each of these models has advantages and disadvantages.

In discrete models, it is assumed that if any of the variables exceeds its threshold, a crisis will ensue. This is while the continuous model does not require expert opinion on the occurrence of the crisis, but focuses on the real economic costs measured by the data. Besides, in the continuous model, the issue of lack of dependent variable fluctuations will not be a problem when a small number of crises have occurred in the sample data under the investigation. On the other hand, the continuous approach has disadvantages. For instance, the capacity of such models to transmit the crisis signal directly to policy makers (decision makers) is limited. This is while the discrete model is able to transmit the crisis signal more easily (however, there is a limit to the signal-to-noise ratios for discrete indices). In addition, the practical application of the discrete model is challenged due to the necessity to find an optimal relationship between erroneous signals (no crisis has occurred, but the signal is propagating) and no signal propagation (no signal has been emitted while the crisis has occurred). Thus, in this research, the early warning system is presented by the continuous model in order to find the optimal model. As a result, the main query of the present investigation is how to clarify an early warning system model or a set of models that could inform the banking industry policymakers before the financial crisis occurs and take the essential precautionary policies to avoid it.

In empirical and theoretical studies, a wide range of variables have been introduced as determinants of financial crises in banks. Nonetheless, conventional econometric methods are not beneficial for assessing the effect of all these variables on the financial crisis because in conventional econometric methods, a wide range of explanatory variables cannot be entered into the model due to the decrease in the degree of freedom and uncertainty of the coefficients. Hence, researchers incorporate a limited combination of variables into econometric models according to their type of study and taste. Nevertheless, the problem with this approach is that the effect of one variable on the financial crisis of banks depends on the combination of other variables that are comprised of the variable in the financial crisis equation. In fact, the wide range of explanatory variables affecting the financial crisis of banks have raised the fundamental question among researchers regarding what variables should be included in the empirical model of financial crisis regression? This problem is known as "model uncertainty". Failure to pay attention to the problem of model uncertainty would lead to bias and inefficiency

in estimating the parameters which results in inadequate predictions and incorrect statistical inference. Thus, in experimental studies, it is necessary to consider the model uncertainty. One of the appropriate methods to moderate the problem of model uncertainty is "all models averaging", or the method of "Bayesian model averaging" (Koop, 2003).

In the present study, we aim at identifying the factors affecting the financial crisis in the banking system by using a continuous approach through means of a combination of Bayesian average and space models. In addition, the use of several variables to determine the optimal model of the current study is one of the most imperative factors affecting the identification of the financial crisis in the Iranian banking industry.

2. Theoretical Foundations

In the course of their activities, banks mainly allocate a major percentage of deposits to lending and credit. Fundamentally, when the depositors of a commercial bank lose their trust and a significant part of them turn to withdraw their deposits (called Bank Run), the bank is not able to repay its debt to them. It may lead to the banks' bankruptcy. If depositors do not have deposit insurance (current situation in Iran) they might suffer severe losses (Diamond & Dybvig, 1983). If bank runs are prevalent, it is called a banking crisis or "banking panic." Whenever such a situation spreads from one bank to another, it is called a "systemic banking crisis," or "systemic banking panic" (Claessens & Kose, 2013). Fear of bank runs or panics refers to a set of unexpected cash withdrawals that occur due to a sudden decrease in the depositor's confidence in the bank or fear of the bank closing down by an official institution; This means that most investors withdraw cash from their accounts at the same time. Since the bank's cash reserve consists of only a fraction of the total cash deposits, withdrawing large amounts of money in a short period of time would deplete the bank's cash reserve and cause the bank to close or go out of business (Hoggarth et al., 2002).

Financial and economic crises in developed countries of the world in recent decades have turned the attention of economists and researchers to how to deal with these predicaments. Given the economic history of societies, the study of economic crises and the factors affecting them to predict and handle them is of great importance (Jing, 2017). The financial crisis is the collapse of financial markets. This is a situation in which the problems of reverse selection and moral hazard are exacerbated and financial markets are unable to transfer funds to those who have more profitable investment opportunities. Thus, the financial crisis is the consequence of the unfavorable performance of financial markets which leads to a sharp contraction in economic activity (Moshiri and Nadali, 2013).

In addition, conditions in which the bank run is not widespread but banks do not have easy access to funds and are generally reluctant to grant credit, is called "credit crunch" (Tabibian, 2009).

An example of this is the crisis of American banks in 2007 (Gorton, 2007). Besides, the bank run of American banks in 1931 and the credit facility crisis of the 1980s in the United States, which provided the credit crunch and the economic recession of the 1990 and 1991 are other cases throughout the economic history.

Due to the special circumstances of Iran, there are strong forces that have the capability to create a crisis in the banking system. The most important of these forces is the high interest rate. High interest rates on both sides lead to the continuation and intensification of the current situation. The first force includes fostering the growth of accounting and endogenous deposits. Paying high interest rates (more than 20%) in the banking network is considered as a slow process due to the decline of the fundamental factors affecting the power of income by the banking system (reduction of inflation, real estate recession, business slump). The endogenous growth of deposits is from the place of receiving interest, which automatically widens the asset-debt gap and encourages banks to compete for deposits and therefore escalate bank interest rates. Paying high interest rates in these circumstances keeps the banking network's need for new reserves high in addition to increasing the volume of deposits disproportionate to the capability to grow assets. In other words, in the current situation of the country's economy, high interest rates on the deposit side are like salt water, the very existence of which creates more thirst for reserves and the continuation of damaging competition of banks. The second factor in the persistence of the problem is the existence of a huge volume of imaginary and even frozen assets. In such a situation, the banking system will have limited power in meeting new applications for loans and

credits as an important part of its crediting power is occupied by the survival of fictitious and frozen assets and the continuation of renewal periods and its transfer to the next period. This should be added to the bank's capacity to generate money from the direct payment of interest to deposits (provided that the bank has not actually earned cash equivalent to these interest rates). Under these circumstances, due to the mismatch between the interest rates of banking facilities and the fundamental factors of the economy, the dimensions of the problem of fictitious assets will be permanently larger and more of the frozen assets will become fictitious.

Chart (1): Factors of occurrence, survival and intensification of hidden imbalances in the Iranian banking network

In short, the flawed banking environment and uncontrolled competition between banks in Iran has been formed since the beginning of the 2001s, whose main characteristics embrace lack of governance in setting interest rates, lack of authoritarian treatment of bad players (without collateral, violators of regulatory ratios such as capital adequacy, etc.), the possibility of identifying income and profits independent of the actual income generation of the bank and repayment of receivables (accrual accounting with very poor auditing and supervision), the ability of the banking system to build fictitious assets and paying high interest rates on deposits was through money creation without asset backing. This led to imbalances in the banking system due to the emergence of shocks and the implementation of some macroeconomic policies in the 2010s. Accordingly, due to government and unfitting competition between the private and the public sector, the situation of the banking system entered a fragile state leaving the state of stability.

Accordingly, banking fragility refers to the sectoral sensitivity to large-scale financial crises caused by small, common economic shocks. Thus, the fragility of the banking system is defined as the vulnerability of the banking system during times of crisis; A state where the excessive risks, liquidity, credit, interest rate, or exchange rate risk, banks are under pressure to suspend the ability to convert their internal debt (Pourabdollahian Kovich et al., 2018). If the problem of bank failure weakens the entire banking system, the crisis turns into a systemic crisis. The cycle of financial stability is indicated by the data in Chart 2 during which, the banking system improves and returns to stabilization in the event of a crisis. The ultimate aim of this study is to identify and predict the factors affecting the fragility stage before the banking system enters into crisis.

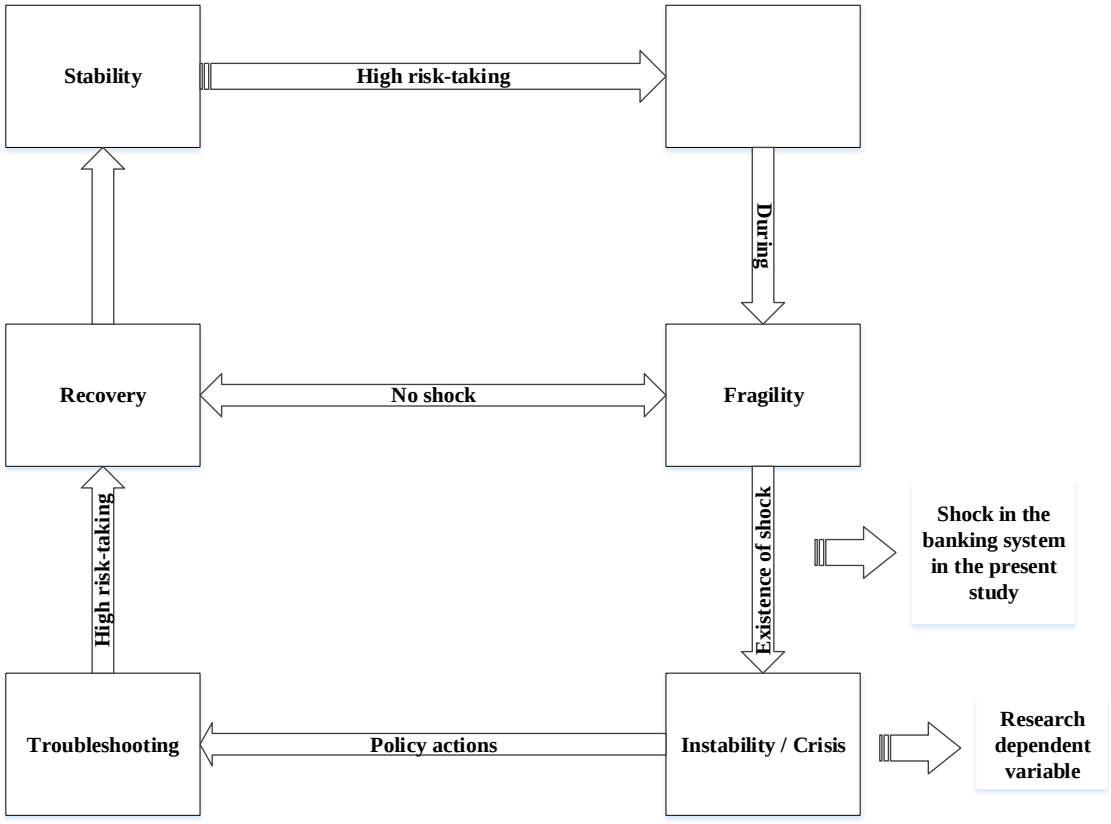

Chart 2: Stability and crisis in the banking system
Source: Lulu (2015) and the researcher's perception

3. Research Background

Some foreign and domestic empirical studies on financial and banking crises are as follows:

Foreign studies:

Chen and et al (2021); in the article on twin crises, examined the relationship between currency and banking crises in Turkey between 1990 and 2013 and the determinants of this type of crisis. For this purpose, these researchers have used "logit models". The empirical findings of the study demonstrate that the Turkish currency crisis is chiefly due to excessive government deficit, increase in short-term foreign debt, and overvaluation of the Turkish Lira while adverse external shocks and banking crises are mostly due to oversupply of money.

Ferancis and Kartas (2021); in the study titled "Together or Apart?", they investigated the relationship between currency and banking crises; it is stated that the purpose of the research is to provide empirical evidence on the relationship between currency and banking crises. Using logit and probit binary models for developed and developing countries between 1985 and 2010, the findings reveal that banking crises precede value crises and vice versa. Currency crises indirectly affect the likelihood of future banking crises through external shocks and free financial markets. This study also found evidence of a correlation with the simultaneous relationship between the two crises.

Sylvester et al. (2020); In an article entitled "Together or Separately?", examine the relationship between the currency and banking crises. The purpose of this study is to provide empirical evidence on the relationship between currency and banking crises. Two-variable data and probit data models were developed for a sample of 21 developed and developing countries with monthly observations between 1985 and 2010. The results indicate that banking crises precede currency crises and vice versa. Currency crises also indirectly affect the likelihood of future banking crises through external shocks, liberalized financial markets, or highly leveraged banking sectors. This investigation also finds evidence of a simultaneous correlation between the two crises. The results confirm the theoretical relationship between banking and currency crises.

Matsuoka et al. (2019); in a study entitled "Banking Crises and Liquidity in the Monetary Economy", scrutinize the liquidity of banks using the Lagos and Wright monetary exchange model. With total uncertainty, it proves that banks sometimes run out of cash reserves and fail to meet the needs of their depositors to smooth their liquidity.

Bellettini et al. (2019); "Income Inequality and Banking Crises" is the title and it provides an empirical analysis to inspect the relationship between income inequality and the occurrence of banking crises in a study of 33 developed countries in the period of 1970-2011. Unlike other empirical studies, it focuses on levels rather than income inequality growth rates. It proves a statistically significant and positive relationship between the value of the Gini index and the probability of banking crises. This result is confirmed when the income distribution is summarized with the top 1% revenue share.

Yang Deng et al. (2019); in the article "Real Estate Prices and Systematic Banking Crises", specified that falling real estate prices have historically endangered banking stability and triggered systemic banking crises. This article examines the issue of risk in the banking system in real estate price shock by adopting a complex network theory. By modeling real estate-related assets as banks' common exposure to the real estate market, a model is proposed that comprises two main channels of risk spread, namely the financial network and the sudden sale of assets, and shows how real estate price shocks are transferred and published through Banks. This investigation demonstrates that banking stability is significantly sensitive to real estate price shocks. In addition, due to the particularly low liquidity of the real estate market, the sale of assets resulting from the sale of real estate assets puts pressure on the financial network and plays a dominant role in the spread of risk.

Adam Geršl et al. (2018); in the article titled "Early Credit-Based Warning Indicators of Banking Crises in Emerging Markets" explore the role of credit-based variables as early warning indicators of banking crises in emerging economies. They collect bank and total credit data to the private sector in emerging markets and evaluate signaling performance using the area under the receiver performance characteristics curve. The results prove that the nominal growth of credit and the change in the ratio of credit to GDP have the best signaling characteristics. The findings emphasize the importance of caution when using

calibrated statistical methods for advanced markets relative to emerging economies.

Al-Assaf (2017); in this study, he provides an early warning system for monetary crises in Jordan and Egypt. For this purpose, he uses the monthly data of the financial and economic variables of the two countries during the period 1980-2015 and the polynomial logit model. The research dependent variable is the money market pressure index, which takes three values of -1, 0, and 1. The results state that the real exchange rate, the ratio of liquidity to reserves, the growth rate of credit to the private sector, and the ratio of foreign assets of the central bank to debt and the growth of exports play a significant role in explaining monetary crises in both countries. However, the ratio of liquidity to reserves is the most important indicator in predicting the crisis in Jordan while the most important warning sign for Egypt is the real exchange rate. The results also show that the likelihood of a crisis in Jordan decreases as the real exchange rate rises and exports grow. In the case of Egypt, the likelihood of a crisis decreases with the growth of exports.

Chang et al. (2015); In their study, bank balance sheet liabilities were categorized into principal and non-principal liabilities. Major liabilities are micro-deposits that generally grow in line with the economy.

Shin et al. (2011); used debt-based indicators of the bank balance sheet to predict financial fragility in Korea. They found that a high growth rate of bank debt was closely linked to increased credit expansion.

Domestic studies:

Kamalian et al. (2020); in an article, they investigated the role of the banking crisis in the impact of income diversity on the profitability of the banking industry in Iran. The results reveal that the increase in the share of non-interest income in times of banking crisis has a significant negative effect on equity returns. However, there is a positive and significant relationship between the ratio of facilities granted to the bank's assets and the return on equity in the event of a banking crisis. This means that in times of banking crisis, it is better for banks to generate interest rates instead of diversifying their activities and investments. Besides, the results of the research prove that the variables of capital adequacy and efficiency index in the conditions of banking crisis have a positive and significant effect on the return on equity, but the degree of banking concentration (Lerner), has a negative and significant effect on the return on equity in the banking crisis.

Asgarian et al. (2020); in a study, they attempted to predict the likelihood of systematic banking crises in selected developing countries (a multiple logit approach). The results demonstrated that in the multi-logit model, the percentage of correctly predicted critical periods is higher than the double-logit model, and the multi-logit model is more appropriate. The results of the multi-logit model reveal the positive effect of inflation, real interest rate, and trade relations while the economic growth rate, per capita production, and capital flow showed a negative effect. Besides, the ratio of banks' credits to the private sector to production on the likelihood of a banking crisis in the countries under study was another factor. On the other hand, the ratio of large money to reserves has not been a good predictor of the possibility of a banking crisis in the countries under review.

Sadeghi Amroabadi and Mahmoudinia (2020); in a study, they worked on the simultaneous occurrence of banking, debt and currency crises (triple crises) and its determinants in the Iranian economy during the period 1981-2017. Using crisis indicators (non-virtual), the short-term results of the VAR model showed that the variables of banking crisis and currency crisis are positive and significant on the debt crisis and also indicated that increasing the likelihood of banking and currency crisis leads to increased government and domestic debt. Correspondingly, the effects of banking and debt crises on the currency crisis are positive and significant, which indicates the existence of a causal linkages between banking and debt crises on the currency crisis, the results of the model. The logit model shows that the effect of inflation, liquidity growth, and exchange rate growth on the indicators of triple crises is positive in most models.

Sadeghi Sharif et al. (2019); in a research entitled "Comparison of Indicators for Determining the Financial Crisis Threshold of Banks in the Early Warning System Based on the Factor of Business Cycles", they examined the probability of banks being on the verge of bankruptcy and forecasting time based on business and economic cycles. In this study, the effect of different approaches on the definition of bankruptcy threshold in predicting the time of bankruptcy of banks in Iran has been investigated

Using Kaplan-Meier model and Cox proportional hazard model in the framework of survival analysis while utilizing the restated financial statements of banks listed on the Tehran Stock Exchange from 2006 to 2016. The results express that the survival of Iranian banks is affected by 5 variables: ratio of operating profit to operating expenses, ratio of total net interest income and operating income to average total assets, banking service fee income to total income, ratio of administrative and general expenses to total expenses and bank size. The results of this research show that according to AIC criterion, the z-score stability index approach is the best criterion for defining and identifying the bankruptcy threshold of banks in comparison with the capital adequacy approach and the ratio of delinquent receivables. According to the above research, this approach shows that the bankruptcy threshold of the surveyed banks will be up to 7 years on average, up to 5 years in a recession and up to 8 years if the boom period returns to the country's economy.

Bayani and Mohammadi (2019); in a study entitled "Factors Affecting Financial Crises Using the Bayesian Average Model Approach", 12 non-fragile variables affecting the financial crisis, including budget deficits or surpluses; deviation of informal exchange rate from formal; the inflation rate; the ratio of foreign debt to foreign assets of the central bank; increasing money ratio (liquidity/ monetary base); ratio of exports to gross domestic product (GDP); ratio of imports to GDP; The ratio of government spending to GDP; budget deficit to GDP; liquidity ratio to foreign assets of the central bank; the growth rate of loans to the private sector and the square of the inflation rate were identified. According to the results, it can be said that the index of financial crisis in the Iranian economy is a multidimensional problem because the variables related to fiscal policy, monetary policy, and exchange rate policy affect this index.

Zomorrodian et al. (2019); worked on their article entitled "Designing a System for Warning the Systemic Banking Crisis in the Iranian Financial Market (Using Markov Chains)". In this study, the occurrence of a systemic banking crisis in the Iranian economy has been identified and designed using an appropriate model of warning signs and the Markov chain model. The model variables include the ratio of non-refundable receivables, inflation rate, exchange rate and debt of banks to the central bank, which have been identified as indicators of the banking crisis in accordance with this financial system due to their explanatory power. Based on these indicators, a binary logit model was designed to assess the likelihood of a banking crisis in the Iranian financial sector using the Markov switching model. The findings of this model demonstrate that they have been able to identify the signs of the banking crisis of 1993 a year before the occurrence in the Iranian economy.

Nazari et al. (2018); have examined the impact of the financial crisis on the financial risk of banks. Financial risk is considered as three types of interest rate risks, credit risk, and liquidity risk. The financial crisis is also included in the model based on macroeconomic factors (inflation rate, economic growth and exchange rate) and specific banking factors (bank size, profitability and capital adequacy). The research approach was using panel data in the form of 13 banks. According to the results, the financial risk of banks has increased in a state of crisis, and also inflation and economic growth have significantly increased the risk; Nonetheless, specific banking factors all had a negative and significant effect on reducing the financial risk of the banking system.

Zarei and Komijani (2015); presented an article entitled "Identifying and Predicting Banking Crises". Due to government support, the Iranian banking sector has never faced phenomena such as bank runs and bankruptcy; However, money market pressure index using the Markov switching model approach shows that Iran has experienced a banking crisis in some periods in the period 1990 to 2013 with seasonal frequency the evaluation.

Moshiri and Nadali (2012); worked on an article entitled "Identifying the Factors Affecting the Banking Crisis in the Iranian economy." In this article, with reference to the times identified as the banking crisis in the study of Moshiri and Nadali (2010), the effective factors in the probability of the banking crisis in the Iranian economy during the period ۱۹۷۳-۲۰۰8 have been studied. For this purpose, two models of logit and the model with the probability of crisis as a dependent variable and the methods of maximum likelihood and minimum weight squares have been used.

Shajari and Mohebbikhah (2010); presented an article entitled "Banking Crisis Prediction and Balance of Payments Using the KLR Signaling Method (Case

Study: Iran)". The signaling method, despite being non-parametric, can provide a crisis warning system.

Moshiri and Nadali (2010); researched on identifying the factors affecting the banking crisis in the Iranian economy in which the effective factors in the probability of financial crisis are discussed in Iran in the period of 1973-2008. Two models of logit and the probability of crisis as a dependent variable along with the methods of maximum likelihood and minimum weight squares were used for this purpose. The results of estimating the mentioned research models designate that the variables of inflation and its square footage, real interest rate and the ratio of loans granted by banks to the private sector to GDP have a significant relationship with the probability of a banking crisis in Iran. The results of the research also proves that the relationship between inflation and the banking crisis in Iran is U-shaped. The exchange rate also has no significant effect on the likelihood of a banking crisis in Iran (due to their lack of connection with financial markets and international financial institutions).

Talebnia et al. (2008); in their study entitled "Evaluating the Efficiency of Financial Variables and Economic Variables in Predicting Corporate Financial Crisis", tried to prove that a model consisting of macroeconomic variables and financial variables (cash flow ratios and financial statements of profit and loss statements and balance sheets) had the power to predict the financial crisis. In this article, four financial crisis forecasting models (Springate, SAF Shirata, Wallace, and Taida) have been developed with cash flow ratios and macroeconomic variables with a time interval of one and two years. Logistic regression statistical method was used to test the ability to predict financial crisis patterns. In the next step, a good fit test was used to determine the best predictive patterns. The results of the tests have proved that the Springate and Wallace models developed with cash flow ratios and macroeconomic variables have variables that affect the forecast.

According to the presented research results, the structure of the banking system in the Iranian economy has fluctuated a lot during the last three decades. Before the revolution, the banking network had a public and private management structure, and after the revolution, all the country's banks became state-owned. In recent years, the management of the country's banks has become public and private once again.

Table 1: Critical Years Identified in the Iranian Economy in Previous Studies

Source of the Study	Type of Crisis	Iran's economy Crisis Years	Source of the Study	Type of Crisis	Iran's economy Crisis Years
Naderi (2006)	Monetary crisis	1988 and 1991-1994	Tavakkoliand and Ebrahimi (2010)	Currency crisis	1988 second half; 1989 first 9 months; 1990 first quarter; 1993 second half; 1994; 1995 first half; 1996 third quarter; 1998 and 1999
Erfani (2006)	Currency crisis	1993:2-1994:1, 1996:4-1998:2, 2000:2, 2000:1, 2000:4 (1985-88: Iran's economic recession)	Zarei and Komijani (2015)	Banking crisis	1993:1- 1995:4; 1991:2; 2001:1; 1999:1-2000:2
Abu Nuri and Erfani (2010)	Banking crisis	1989-1990, 1994-1998	Bayeni et al. (2020)	Baking Crisis	Based on the results of time periods 1992 (1); 1992 (2); 1992 (4); 1992 (4); 1996 (2); 1996 (4); 1997(2); 1997(2); 1998(2); 1998(4); 1999(3); 2000(3); 2001(1); 2002(2); 2003(1); 2003(3) 2004(1); 2005(2); 2006(4); 2009(2); 2010(1); 2010(4); 2011(2); 2013(1); 2013(4); 2013(4); 2014(3); 2015(2); 2015(4); 2016(1); 2016(3); 2017(4); 2018(4); 2018(4), and 2019(4)-2019(4) are in crisis.
Moshiri and Nadali (2010)	Banking crisis	1972-1975, 1978-1980, 1984-1990, 1991-1994, and 2001-2007	Nadali (2013)	Banking crisis	1972-1976; 1975-1978; 1984-1990; 1991-1995; 2001-2008

Source of the Study	Type of Crisis	Iran's economy Crisis Years	Source of the Study	Type of Crisis	Iran's economy Crisis Years
Sayyadnia et al. (2005)	Banking crisis-Monetary crisis	1980, 1986, 1994, 1995	Shajari and Mohebbikhah (2010)	Currency crisis, balance of payments crisis and banking crisis	1988:4-1993:4; 1989:1-1994:1; 1998:4; 1998:3; 1995:1 2005:1-2009:2

Source: Researcher collection from various researches

4. Research Method and Model Estimation

The present study is inductive in terms of execution logic (or type of argument). By collecting data from banks operating in the Tehran stock market, this study depicts the relationship between these two variables and it is also is longitudinal (post-event) in terms of time dimension as the studied data are collected and analyzed over time (several years). Besides, this research is being done at the moment, but it uses the information and data of the previous year to examine the relationship between the variables. The time of this investigation is an 11-year period from 2008 to 2017 for the banks listed on Tehran Stock Exchange. Due to the spatial scope of research and the limited number of banks active in Tehran Stock Exchange, we examine all banks active in the capital market. The following are research variables and theoretical perspectives on how to affect the banking crisis variable. Then, the effect of 49 potential variables mentioned in Table (2) on the banking crisis in Iran is investigated using the Bayesian averaging model method.

Table 2. Introduction of Research Variables

No.	Variable type	Variable name	Theoretical expectation
	Variable	Crisis	
1	Independent	Foreign assets of the Central Bank (billion Rials)	has negative effect on creating a crisis
2		Foreign Debts of the Central Bank (billion Rials)	has positive effect on creating a crisis
3		Debt of banks to the Central Bank (billion Rials)	has positive effect on creating a crisis
4		Monetary base in terms of resources (billion rials)	has positive effect on creating a crisis
5		Banknotes and coins with banks and non-bank credit institutions (billion Rials)	has positive effect on creating a crisis
6		Increase in Properties' possession	has positive effect on creating a crisis
7		NPL (None Performing Loan)	has positive effect on creating a crisis
8		Foreign assets of the banking system (billion Rials)	has negative effect on creating a crisis
9		Foreign assets of the Central Bank (billion Rials)	has negative effect on creating a crisis
10		Foreign assets of banks (billion Rials)	has negative effect on creating a crisis
11		Foreign exchange debts of the banking system (billion Rials)	has positive effect on creating a crisis
12		Foreign Exchange Debts of the Central Bank (billion Rials)	has positive effect on creating a crisis
13		Foreign currency debts of banks (billion Rials)	has positive effect on creating a crisis
14		Cost of money	has positive effect on creating a crisis
15		Government debt to the central bank (billion rials)	has positive effect on creating a crisis
16		Government debt to banks and non-bank credit institutions (billion Rials)	has positive effect on creating a crisis
17		Total government debt to the banking system (billion rials)	has positive effect on creating a crisis
18		Debt of the non-governmental sector to the banking system (billion Rials)	has positive effect on creating a crisis
19		Money (billion Rials)	has positive effect on creating a crisis
20		Quasi-money (billion Rials)	has negative effect on creating a crisis
21		Liquidity based on its constituent factors (billion Rials)	has positive effect on creating a crisis
22		Visual deposits (billion Rials)	has positive effect on creating a crisis
23		Budget deficit (-) or surplus (+) (billion Rials)	has positive effect on creating a crisis
24		Money multiplier (money / monetary base)	has positive effect on creating a crisis
25		Increasing money ratio (liquidity / monetary base)	has positive effect on creating a crisis
26		DTL (deposit to loan)	has positive effect on creating a crisis
27		Spread	has positive effect on creating a crisis
28		Deviation of informal exchange rate from official (Rials)	has positive effect on creating a crisis
29		Official exchange rate (Rials)	has positive effect on creating a crisis

No.	Variable type	Variable name	Theoretical expectation
	Variable	Crisis	
30		Informal market exchange rate (Rials)	has positive effect on creating a crisis
31		The inflation rate (%)	has positive effect on creating a crisis
32		Cash coverage ratio	has negative effect on creating a crisis
33		Export of goods and services (billion Rials) at current prices	has negative effect on creating a crisis
34		Import of goods and services (billion Rials) at current prices	has positive effect on creating a crisis
35		Income-generating assets to total assets	has negative effect on creating a crisis
36		The ratio of government spending to government deficit	has positive effect on creating a crisis
37		Duration of Assets and Liabilities	has positive effect on creating a crisis
38		Net LTD (after deducted Legal reserves)	has positive effect on creating a crisis
39		Gross domestic product at current price (billion Rials)	has negative effect on creating a crisis
40		Liquidity growth rate (%)	has positive effect on creating a crisis
41		Liquidity to foreign assets ratio of the central bank	has positive effect on creating a crisis
42		Interest rate Duration	has positive effect on creating a crisis
43		NSFR (Net Stable Funding Ratio)	has negative effect on creating a crisis
44		Liquidity to net assets of the banking system	has positive effect on creating a crisis
45		Ratio of loans granted by banks to the private sector divided by GDP	has positive effect on creating a crisis
46		The ratio of government debt to GDP	has positive effect on creating a crisis
47		Capital Adequacy ratio	has negative effect on creating a crisis
48		Growth rate of credits granted to the private sector (%)	has positive effect on creating a crisis
49		Square the inflation rate	has positive effect on creating a crisis

Next, the research model will be estimated. One of the most important challenges that modeling researchers face is the divergence of views on potential variables that can be considered in the explanatory model. These differences, however, often lead to differences in conclusions. So far, economists have worked hard to solve this problem. For instance, one of the solutions they offer is to perform sequential tests to add or subtract deleted variables to the model and test the hypothesis about their significance. Nevertheless, these methods do not lead to satisfactory results due to the invalidity of the hypothesis test in incorrect formulations and cumulative and consecutive errors (Poirier, 1995). The Bayesian solution to the problem of uncertainty is called the Bayesian model averaging (BMA) (Hoeting et al., 1999), in which the values in question are often calculated by weighting the values of specific models. Weights depend on the amount of data support of the model, which is measured by the posterior probability of each model. Jeffreys (1961) was the founder of the Bayesian model averaging method, developed by Leamer (1978).

In fact, two categories of variables are used in econometric models: 1- The focus variable, which is based on formal and strong theories that are generally based on optimizing the behavior of economic entities and their presence in the template is supported such as price and income as a function of demand and 2- suspicious (auxiliary) variables, which provide justifications for their presence in the model based on informal theories. Bayesian approach helps a lot in identifying these (auxiliary) variables in the model. In addition, in this approach, unlike the conventional econometric method, no decision is made definitively about the presence or absence of the variable and only the probability of the presence of the variable in the model is estimated. In fact, in the traditional econometric method, a variable should be added to or removed from the pattern based on the black and white solution or zeros and ones while in Bayesian approach, all variables are included in the model and this uncertainty is acknowledged. Furthermore, for all of these variables (based on the researcher's confidence in each), a coefficient is estimated and ranked in terms of importance and effectiveness (Magnus et al., 2010).

Unlike the classical method, which uses statistical inference to test the statistical significance of coefficients, the Bayesian method is based on statistical analysis and probabilistic distributions. Bayesian method is based on Bayesian theorem which is also based on inductive logic. Unlike deductive logic, in which usually "when the theorem is true, the result will surely be true", in inductive logic, this accuracy is probabilistic and depending on the number of interpretations and models in which the theorem

applies, the accuracy of the results is measured. (Gower, 1997).

Paying attention to the introduced variables may raise the question of how it is possible to study the model in the event of problems such as alignment of variables. The important point in this method is that such issues do not pose a problem for the model. In this method, considering that the presence and absence of each variable can affect the amount of effect and even the significance of the variables within the model, using Bayesian averaging method, the model tries to identify variables that affect the desired variable in the presence of all possible variables.

A distinctive feature of Bayesian approach to inference is the attribution of numerical probabilities to the degree of researcher's belief. The degree of the researcher's belief in the correctness of a hypothesis, in perspective, depends on the amount of information he has at that moment. As a result, by changing the information about a phrase, the probability of the correctness or inaccuracy of the phrase must also be reconsidered (Koop, 2003). The process of probability revision by the new information identified by y is summarized in Chart 3 (Zellner, 1971).

The previous probability density function of Hypothesis H is based on initial information. This information is usually a combination of previous data, empirical studies, observations, and theories. The density function is a posterior probability for new observations of y by Hypothesis H. This probability density function is known as the likelihood function. To obtain the posterior probability density function, the prior probability density function must be combined with the likelihood function by Bayesian theory. The posterior probability depends on both the previous information I_0 and the sample information y, and with the effect that the new data information has on the prior probability density function by Bayesian theory, the prior probability density function is transformed into the posterior probability density function. It shall be emphasized that posterior probability includes the researcher's opinion about the parameter, data information, and prior information (Sornsen & Gianola, 2002).

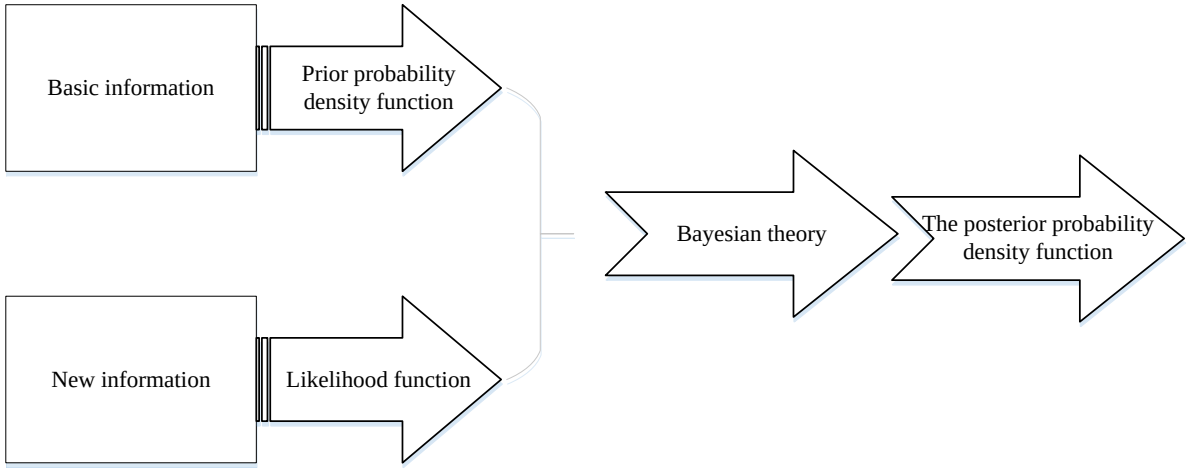

Chart 3: Bayesian model averaging

The previous information and the sample information is entered through the prior probability function and the posterior probability function through the likelihood function, respectively. The posterior probability function is used to deduce variables in Bayesian attitudes. According to the research field, prior probability density functions could have different shapes such as normal. It should be noted that the parameters related to the prior probability distribution function are determined based on the researcher's point of view. If the previous information is derived from the information in previous examples, this type of probability density function is called a priori data. In other cases, prior information is obtained from observed cause-and-effect relationships, theoretical discussions, or from sources other than existing

examples of past data. When an a priori probability density function is of this type of information and that is called non-data priori information while the probability density functions are also called non-data. When non-data backgrounds are used due to lack of access to data in the past, this non-data information may be very vague and inaccurate. If the researcher wants to determine how to improve the information about the model parameters with the new sample information and the primary information is non-data, he must use a non-data anterior probability density function combined with a likelihood function to obtain the posterior probability density function. Then, by comparing the prior non-data probability density function with the posterior probability density function, it could be seen that the data of the new sample data lead to a revision of the initial beliefs about non-data information (Zellner 1971; Koop 2003).

In the following, we will present the research findings. As mentioned, in this study, no predetermined model is considered as the correct model and in fact it should be extracted based on the data. To achieve the result, calculations must be performed on all models in the model space. According to the number of variables studied, the number of existing models (based on the presence or absence of each variable) in the model space is equal to 2^{49} models, which is more than 563 quadrillion (million billion[1]), is a regression model. In other words, the model space consists of 2^{49} models, which according to the assumption of model uncertainty and far from applying personal opinion in model selection, all models shall be examined and their information should be used to achieve the result. Even with the right processors which can estimate every million models in one second, we need more than 17,000 days for 2^{49} regressions. Nevertheless, if the number of variables rises from 49 to 50, the computational volume and time required will at least double. Therefore, the model space should be sampled. The calculations were performed by determining a meta-parameter which is the expected size of the model and is considered equal to 12 in the present study following Salay Martin et al. The number 12 was chosen according to the experimental work done in the past. It is expected that finally 12 variables will be introduced as non-fragile variables by the calculation process, but it is quite clear that the final number might be less or more than 12 non-fragile variables. Accordingly, the prior probability of entering each variable is obtained. The algorithm essential for sampling the model space is not found in the available software packages. As a result, Motleb software was used to codify the required program for random sampling and estimation of sampled regressions. Primarily, the coefficients and standard deviation of the variables were calculated by obtaining a sample containing 4 million regressions from the model space and the posterior probability of each variable is obtained from the sum of the probabilities of the models that contain the variable. Later, another sample including 4 million regressions was sampled from the model space. Calculations were performed for 8 million regressions by adding this sample to the first sample and next, coefficients and probabilities were obtained. Convergence between the coefficients was achieved by continuing this trend in the sample that included 200 million regressions. Besides, by observing the convergence, the first stage was completed (Table 3). It should be noted that the criterion of convergence without variable coefficients is up to two digits. According to Salay Martin et al. (2008) and to reach the answer as rapidly as possible, the calculations were performed in two stages. In this fashion, the posterior probability of each variable is used in the first stage as data information for that variable. It is worth mentioning that in the first stage, due to the assumption of model uncertainty and in the second stage, due to faster access to convergence of data, we used non-data and data information, respectively. Additionally, variables that had a posterior probability less than the prior probability were excluded from the model due to their fragility against other variables (in the first stage, there were 27 non-fragile variables, and in the second stage, the calculations continue with these variables, which have a higher probability than the prior probability).

[1] The above number is equivalent to ۵۶۲۹۴۹۹۵۳۴۲۱۳۱۲.

Table 3: The First Stage of the Sampling and Calculation Process with the Assumption $^{2}\bar{K}$= 12 Including 200 Million Regressions

No.	The first sample consisting of 200 million regressions		The first sample consisting of 4 million regressions		Variable
	Prior Probability	Posterior Probability	Prior Probability	Posterior Probability	
1	0.2587	-0.9868	0.2203	-1.0142	Foreign assets of the Central Bank (billion Rials)
2	0.2513	0.212	0.2141	0.1854	Foreign Debts of the Central Bank (billion Rials)
3	0.1338	0.7564	0.1194	0.745	Debt of banks to the Central Bank (billion Rials)
4	0.2504	0.8034	0.2144	0.7776	Monetary base in terms of resources (billion rials)
5	0.2495	0.2001	0.2147	0.1751	Banknotes and coins with banks and non-bank credit institutions (billion Rials)
6	0.9365	0.2931	0.8765	0.2513	Increase in Properties' possession
7	0.9874	0.3248	0.9262	0.2822	None performing loan (NPL)
8	0.2338	-0.8687	0.205	-0.8897	Foreign assets of the banking system (billion Rials)
9	0.2477	-0.6381	0.2153	-0.6615	Foreign assets of the Central Bank (billion Rials)
10	0.2468	-0.4245	0.2156	-0.4471	Foreign assets of banks (billion Rials)
11	0.2459	0.7449	0.2159	0.7231	Foreign exchange debts of the banking system (billion Rials)
12	0.2486	-0.1856	0.215	-0.2098	Foreign Exchange Debts of the Central Bank (billion Rials)
13	0.2302	0.2666	0.2026	0.2464	Foreign currency debts of banks (billion Rials)
14	0.8329	0.9037	0.7741	0.8627	Cost of funding
15	0.2266	0.5726	0.2002	0.5532	Government debt to the central bank (billion rials)
16	0.223	0.2751	0.1978	0.2565	Government debt to banks and non-bank credit institutions (billion Rials)
17	0.2173	0.9301	0.1957	0.9139	Total government debt to the banking system (billion rials)
18	0.2192	0.9853	0.1964	0.9683	Debt of the non-governmental sector to the banking system (billion Rials)
19	0.2957	0.2959	0.2513	0.2645	Money (billion Rials)
20	0.2883	-0.0485	0.2451	-0.0791	Quasi-money (billion Rials)
21	0.2809	0.1697	0.2389	0.1399	Liquidity based on its constituent factors (billion Rials)
22	0.3201	0.3653	0.2745	0.3331	Visual deposits (billion Rials)
23	0.2211	0.9959	0.1971	0.9781	Budget deficit (-) or surplus (+) (billion Rials)
24	0.2154	0.8247	0.195	0.8093	Money multiplier (money / monetary base)
25	0.1542	0.9482	0.1386	0.936	Increasing money ratio (liquidity / monetary base)
26	0.7922	0.9444	0.7346	0.9042	deposit to loan (DTL)
27	0.7515	0.0881	0.6951	0.0487	Spread
28	0.1882	0.8289	0.1702	0.8151	Deviation of informal exchange rate from official (Rials)
29	0.1746	0.2594	0.1578	0.2464	Official exchange rate (Rials)
30	0.2018	0.2351	0.1826	0.2205	Informal market exchange rate (Rials)
31	0.3445	0.7804	0.2977	0.7474	The inflation rate (%)
32	0.6701	0.0913	0.6161	0.0535	Cash coverage ratio

[2] Given that the value of K is equal to 12, the probability value of the initial presence of each variable will be equal to 0.2449 =12/49.

No.	The first sample consisting of 200 million regressions		The first sample consisting of 4 million regressions		Variable
	Prior Probability	Posterior Probability	Prior Probability	Posterior Probability	
33	0.1134	-0.8753	0.1002	-0.8859	Export of goods and services (billion Rials) at current prices
34	0.1011	0.2757	0.0891	0.2659	Import of goods and services (billion Rials) at current prices
35	0.7108	0.9516	0.6556	0.913	Earning Assets to Total Assets Ratio
36	0.0888	0.4132	0.078	0.4042	The ratio of government spending to government deficit
37	0.6009	0.7291	0.5481	0.6921	Duration of Assets and Liabilities
38	0.5317	0.3029	0.4801	0.2667	Net LTD (after deducted Legal reserves)
39					Gross domestic product at current price (billion Rials)
40	0.0765	-0.2009	0.0669	-0.2091	Liquidity growth rate (%)
41	0.0642	0.6498	0.0558	0.6424	Liquidity to foreign assets ratio of the central bank
42	0.2735	0.7388	0.2327	0.7098	Interest rate Duration
43	0.4625	0.3194	0.4121	0.284	Net Stable Funding Ratio (NSFR)
44	0.2661	0.7815	0.2265	0.7533	Liquidity to net assets of the banking system
45	0.0273	0.5874	0.0225	0.5824	Ratio of loans granted by banks to the private sector divided by GDP
46	0.0396	0.2763	0.0336	0.2705	The ratio of government debt to GDP
47	0.3689	-0.1923	0.3209	-0.2261	Capital Adequacy ratio
48	0.0519	0.2799	0.0447	0.2733	Growth rate of credits granted to the private sector (%)
49	0.0019	0.4182	0.0011	0.414	Square the inflation rate

Source: Research calculations

In the second stage, a sample containing 2 million regressions was selected and the calculations of coefficients, standard deviation, and posterior probabilities were performed. Then, calculations were performed on a sample containing 2 million regressions (by adding another 2 million samples to the original sample) and in the last sample containing 100 million regression coefficients of posterior coefficients were observed. Due to the convergence of the obtained coefficients, the results of the last sample including 100 million regressions were accepted as the final Bayesian averaging results of the model, which can be seen in Table (4).

As stated, the posterior input probability of a variable is the sum of the posterior probabilities of all the models that include the variable in question; Thus, the posterior probability entry of the variable could be considered as a criterion for the appropriateness of the models that include the variable. Hence, the variables that have a high posterior probability entry, have a great role in the good fit of the model (Ghasemi, 2009). Regarding the posterior coefficients, it would be stated that these coefficients determine the average effect of the studied variable on the dependent variable. A posteriori coefficient of variables that have a higher posterior probability than the prior probability and are, in other words, fragile, are meaningful and reliable. In the first and third columns, the posterior coefficients are presented in the second stage, respectively. In Table (4), due to the presence of the other variables the first 12 variables are expected to increase into regression and for this reason, these variables are called strong or non-fragile while the rest that are more likely the posterior variables than prior variables are called fragile. Fragility indicates low data support for these variables. According to Table (5), it is quite obvious that cost of funding, none performing loan (NPL), deposit to loan (DTL), spread, capital adequacy, earning assets to total assets ratio, net LTD (after deducted Legal reserves), cash coverage ratio, net stable funding ratio (NSFR) in the presence of all variables, duration of assets and liabilities, interest rate duration, and increase in properties' possession they found a higher posterior probability of entering than their prior probability. Consequently, due to the

increase in our speculation for the presence of these 12 variables in the model, the effect of these variables on the crisis could be examined; in other words, these variables are meaningful. In the first and third columns, the posterior coefficients and the deviation of the posterior criteria of the variables are expressed, respectively. In the last column, the ratio of regressions was expressed that the absolute value of t-statistic for the desired variable is greater than 2; in other words, the desired coefficient is significant at the level of 0.95.

Table 4: The Second Stage of the Sampling and Calculation Process with the Assumption $\bar{K}$ = 12 Including 100 Million Regressions[3]

No.	The first sample consisting of 200 million regressions		The first sample consisting of 4 million regressions		Variable
	Prior Probability	Posterior Probability	Prior Probability	Posterior Probability	
1	0.3099	-1.0142	0.2751	-1.0392	Foreign assets of the Central Bank (billion Rials)
2	0.2836	0.1854	0.25	0.1612	Foreign Debts of the Central Bank (billion Rials)
3	0.2765	0.7776	0.2441	0.7542	Monetary base in terms of resources (billion rials)
4	0.2279	0.1751	0.1967	0.1525	Banknotes and coins with banks and non-bank credit institutions (billion Rials)
5	0.9625	0.2513	0.9061	0.2119	Increase in Properties' possession
6	0.9871	0.2822	0.9295	0.242	None performing loan (NPL)
7	0.1965	-0.6615	0.1677	-0.6825	Foreign assets of the Central Bank (billion Rials)
8	0.1904	-0.4471	0.1628	-0.4673	Foreign assets of banks (billion Rials)
9	0.1875	0.7231	0.1611	0.7037	Foreign exchange debts of the banking system (billion Rials)
10	0.217	-0.2098	0.187	-0.2316	Foreign Exchange Debts of the Central Bank (billion Rials)
11	0.95101	0.8627	0.89581	0.8241	Cost of funding
12	0.4265	0.2645	0.3857	0.2355	Money (billion Rials)
13	0.4087	-0.0791	0.3691	-0.1073	Quasi-money (billion Rials)
14	0.3675	0.1399	0.3291	0.1125	Liquidity based on its constituent factors (billion Rials)
15	0.4327	0.3331	0.3907	0.3033	Visual deposits (billion Rials)
16	0.9172	0.9042	0.8632	0.8664	deposit to loan (DTL)
17	0.8802	0.0487	0.8274	0.0117	Spread
18	0.4439	0.7474	0.4007	0.7168	The inflation rate (%)
19	0.7325	0.0535	0.6821	0.0181	Cash coverage ratio
20	0.8633	0.913	0.8117	0.8768	Earning Assets to Total Assets Ratio
21	0.6452	0.6921	0.596	0.6575	Duration of Assets and Liabilities
22	0.587	0.2667	0.539	0.2329	Net LTD (after deducted Legal reserves)
23	0.3368	0.7098	0.2996	0.6832	Liquidity to foreign assets ratio of the central bank
24	0.5636	0.284	0.5168	0.251	Interest rate Duration
25	0.4892	-0.5207	0.4436	-0.5529	Net Stable Funding Ratio (NSFR)
26	0.311	0.7533	0.275	0.7275	Liquidity to net assets of the banking system
27	0.4591	-0.2261	0.4512	-0.2575	Capital Adequacy ratio

Source: Research calculations

[3] Considering that the value of K is assumed equal to 12 and the number of variables is considered to be 27, the value of the probability of the initial presence of each variable will be equal to 0.48=12/25.

Table 5: Results of the Sampling Process and Calculations Based on Two Stages Including 190 Million Regressions

No.	Regressions	Posterior standard deviation	Posterior Probability	Posterior Coefficient	Variable
1	0.9765	0.1687	0.9625	0.2513	Increase in Properties' possession
2	0.9896	0.1125	0.9871	0.2822	None performing loan (NPL)
3	0.9701	0.1912	0.951	0.8627	Cost of Funding
4	0.9403	0.2672	0.9172	0.9042	deposit to loan (DTL)
5	0.8985	0.2785	0.8802	0.0487	Spread
6	0.8322	0.4251	0.7325	0.0535	Cash Coverage ratio
7	0.8672	0.3664	0.8633	0.913	Earning Assets to Total Assets Ratio
8	0.8213	0.4685	0.6452	0.6921	Duration of Assets and Liabilities
9	0.8108	0.5263	0.587	0.2667	Net LTD (after deducted Legal reserves)
10	0.7825	0.6172	0.5636	0.284	Interest rate Duration
11	0.762	0.6823	0.4892	-0.5207	Net Stable Funding Ratio (NSFR)
12	0.7492	0.6927	0.4501	-0.2261	Capital Adequacy ratio

Source: Research calculations

In Bayesian averaging method, however, in order to perform calculations, review and analyze the results, only the value of one meta-parameter must be specified (minimum limit). This is because the results based on the value of this meta-parameter raise the question of whether the results of the research change if the value of the meta-parameter changes, and if so, what is the rate of change? In other words, will the choice of the expected size of the model affect the results?

Accordingly, by selecting different Ks and re-performing the whole sampling process and related calculations, the results were compared. In investigating the effect of selecting the expected size of the model on the research results (sensitivity of the results to the expected size or meta-parameter), two cases $\bar{K}$= 10 results and $\bar{K}$= 8 results were included. Assuming $\bar{K}$=10, the results of the first and second stages were converged in a sample of 75 and 140 million observations, respectively. However, if $\bar{K}$=8, these numbers would be 48 and 105 millions for the two stages, correspondingly. It should be noted that in these three cases, the model space and therefore the variables and data are the same and the only difference is the expected size of the model. Undeniably, the samples and the consequent result will be different by changing the expected size of the model; This means that it is possible that A) The variables are fragile (or non-fragile) in all three assumed K values, so selecting the K value did not affect the fragility of the variables; B) The fragility of some variables could be changed by changing the value of K. Accordingly, a variable that is assumed to be fragile becomes non-fragile by increasing the expected size of the model, so that other variables are required to be present in the model to reveal the effect of this variable.

Table 6: Comparison of Posterior Probabilities Based on Different K's Assumptions

Posterior Probability $\bar{K}=12$	Posterior Probability $\bar{K}=10$	Posterior Probability $\bar{K}=8$	Variable
0.9871	0.9679	0.9533	Increase in Properties' possession
0.9625	0.9445	0.9307	None performing loan (NPL)
0.95101	0.93421	0.92121	Cost of Funding
0.9172	0.9016	0.8894	deposit to loan (DTL)
0.8802	0.8658	0.8544	Spread
0.8633	0.8501	0.8395	Cash Coverage ratio
0.7325	0.7205	0.7107	Earning Assets to Total Assets Ratio
0.6452	0.6344	0.6254	Duration of Assets and Liabilities
0.587	0.5774	0.5692	Net LTD (after deducted Legal reserves)
0.5636	0.5552	0.5478	Interest rate Duration
0.4892	0.482	0.4754	Net Stable Funding Ratio (NSFR)
0.4501	0.4441	0.4383	Capital Adequacy ratio

Source: Research calculations

In Table 5, the aim was to identify the correct number K if the researcher mistakenly provided the number of the initial proposed variable. According to the example of Salay Martin et al., The value of K in this paper is considered to be equal to one to twelve variables. This number indicates what is expected to finally be introduced as 12 variables as non-fragile variables by the calculation process, but clearly it is possible that in the end the number is less than or more than 12 non-fragile variables. The output results of K from 1 to 12 are presented in the table below.

Based on the results, it can be seen that banking crises are generally due to the deviation of variables from their long-term path (maturity of assets and liabilities, maturity of interest rates) or factors that affect liquidity risk (volume of property, income-generating assets to total assets, ratio Cash coverage, net ratio of fixed funds) and credit risk variables (capital adequacy, facilities granted to all non-government deposits, overdue and deferred receivables to all facilities); Banks are effective, and the occurrence of risk is due to the scattering of long-term variables. As a result, the use of regular policies that stabilize the behavior of functions will reduce the occurrence of crises in the banking system, and the use of temporary and discretionary policies will cause a sharp deviation from the long-term path of variables affecting the crisis in the banking system. This is because discretionary policies in economic policy-making arise when the goals of the policymaker are in conflict with the public interest. A group of analysts fear that the politician will use macroeconomic policy-making for his electoral purposes.

Table 7: Results of non-fragile variables in different models

Non-fragile Variables	K
None performing loan (NPL)	K= 1
None performing loan (NPL), Cost of funding	K= 2
None performing loan (NPL), Cost of funding, Cash coverage ratio	K= 3
None performing loan (NPL), Cost of funding, Cash coverage ratio, Deposit to loan (DTL)	K= 4
None performing loan (NPL), Cost of funding, Cash coverage ratio, Deposit to loan (DTL), Capital adequacy	K= 5
None performing loan (NPL), Cost of funding, Cash coverage ratio, Deposit to loan (DTL), Capital adequacy, Duration of assets and liabilities	K= 6
None performing loan (NPL), Cost of funding, Cash coverage ratio, Deposit to loan (DTL), Capital adequacy, Duration of assets and liabilities, Spread	K= 7
None performing loan (NPL), Cost of funding, Cash coverage ratio, Deposit to loan (DTL), Capital adequacy, Duration of assets and liabilities, Spread, Net LTD (after deducted legal reserves)	K= 8
None performing loan (NPL), Cost of funding, Cash coverage ratio, Deposit to loan (DTL), Capital adequacy, Duration of assets and liabilities, Spread, Net LTD (after deducted legal reserves), Interest rate duration	K= 9
None performing loan (NPL), Cost of funding, Cash coverage ratio, Deposit to loan (DTL), Capital adequacy, Duration of assets and liabilities, Spread, Net LTD (after deducted legal reserves), Interest rate duration, Increase in properties' possession	K= 10
None performing loan (NPL), Cost of funding, Cash coverage ratio, Deposit to loan (DTL), Capital adequacy, Duration of assets and liabilities, Spread, Net LTD (after deducted legal reserves), Interest rate duration, Increase in properties' possession, Net stable funding ratio (NSFR)	K= 11
None performing loan (NPL), Cost of funding, Cash coverage ratio, Deposit to loan (DTL), Capital adequacy, Duration of assets and liabilities, Spread, Net LTD (after deducted legal reserves), Interest rate duration, Increase in properties' possession, Net stable funding ratio (NSFR), Duration of assets and liabilities, Interest rate duration, Increase in properties' possession	K= 12

5. Conclusions and Suggestions

The escalation of the crisis over the past decade in many countries have led to an increase in researchers' attitudes toward reforming the banking system and ways to deal with it. Based on the existing literature, financial crises could have devastating consequences both economically and politically. Financial crises might involve a variety of crises including banking, debt, and currency crises. Thus, examining the simultaneous occurrence of these three crises, also known as triple crises, could be vital. The state of Iran's economy demonstrates that sharp fluctuations in exchange rates, inflation, and the ratio of government debt and foreign debt along with fluctuations in liquidity and output have coincided with banking, currency and debt crises in the country's economy. In some periods, such as the early 1980s, late 1990s and early 2000s, we have witnessed sharp fluctuations in variables such as inflation, economic growth, exchange rate growth, bank debt, government debt, etc. in recent years. In recent years, a better understanding has been achieved of how factors such as macroeconomic shocks, the banking market structure, institutions and variables of the political economy as well as how external shocks have affected banking crises. The results of international studies illustrate: 1. Crisis is more likely to occur in countries with high volatility, production growth, and inflation; 2. The banking crisis is more likely to occur at a time when real economic growth is negative or weak; 3. High inflation rates increase the likelihood of a banking crisis; 4. Weak domestic macroeconomic policies are among the main reasons for the banking crisis; 5. Among the macroeconomic factors, the variables of economic growth, inflation rate, credit growth, interest rate and exchange rate have been significantly important and have been key factors in most studies in explaining the banking crisis.

Due to the state-owned banks, there has been no traditional banking crisis including bankruptcy and closure of banks and a bank runs to withdraw their deposits from banks in the Iranian economic history. Nevertheless, according to the money market pressure index, it is possible to identify banking crises in Iran.

In this study, by performing calculations and examining the effect of 49 factors that were known to be effective in the banking crisis in experimental studies, 49 variables affecting the banking crisis were entered into the model. Finally, using the Bayesian averaging model approach, 12 non-fragile variables affecting the financial crisis were identified consisting of cost of funding, none performing loan (NPL), deposit to loan (DTL), spread, capital adequacy, earning assets to total assets ratio, net LTD (after deducted Legal reserves), cash coverage ratio, net stable funding ratio (NSFR) in the presence of all variables, duration of assets and liabilities, interest rate duration, and increase in properties' possession. Comparison of the posterior probabilities of the variables shows that in all 12 variables, the expected size of the model of the studied variables has the necessary non-fragility. According to the variables that are significant in the model, it is concluded that the banking crisis index in the Iranian economy is a multidimensional problem because the variables related to fiscal policy and monetary policy have a positive and significant effect on this index. Consequently, in providing policy solutions to reduce the crisis, it is necessary to consider the policy packages in which time and implementation inconsistencies are included. Therefore, in providing policy solutions to reduce the crisis, it is necessary to consider the policy packages in which time and implementation inconsistencies are included.

It is worth noting that in this method, the coefficient of variables in each model (even in the final model), alone is not a criterion and does not indicate the effect of the variable on the dependent variable. Rather, the average weight of the coefficient of each given variable should be considered in all models by Bayesian method (and with a particular weight). This method shows us which variables we need to pay more attention to in order to arrive at a suitable model to explain a particular (dependent) variable. Another point is that in this method, and considering the assumption of model uncertainty, no subjective background is considered for the economic model so that all variables and in fact all models are considered. Theoretically, all the variables considered in the model affect the crisis, and the number of 15 variables versus the 12 variables obtained in the second stage calculations are fragile and have lost their effect. It should be noted that the effect of such variables on the non-fragile variables obtained has been such that they have not had much effect on the crisis. Therefore, the fragility of such a variable does not mean that it is insignificant, but indicates the need

to pay more attention to the appropriate effectiveness of this variable.

Considering the identification of non-fragile variables affecting the financial crisis, the following suggestions are presented in order to improve the mentioned variables. To achieve the optimal ratio of capital adequacy, three strategies are proposed:

- Taking advantage from tax exemption in revaluation of assets of banks and subsidiaries as well as increasing the capital of banks through this.
- Many banks have been losing money in recent years. Finding ways to increase the profitability of banks can help rectify this situation. Some of the proposed suggestions are ways such as rationalizing interest rates on deposits commensurate with inflation or reducing past due and overdue receivables (which increase banks' losses).
- Reducing and stopping the use of banking resources in the form of mandatory facilities might make the banking facilities more available to the non-governmental sector than before.

Reducing overdue debts

One of the factors that increases bank overdue debts is that banking services are "collateral-based" instead of "risk-based". The "guarantee-based" approach both increases the cost of money and increases the costs of receiving banking services. In this method, due to the principle of collateral, customer risk assessment and the subject of banking services (investment plan, etc.) are not taken seriously; Thus, the volume of arrears increases, and as a result, administrative costs and depreciation of facility assets increase, and ultimately the cost of money increases. In this method, due to the high transaction costs, the cost of money is higher; But in the "risk-based management" approach, by validating customers and assessing the risk of banking services, the amount of arrears is reduced and the cost of money is reduced. In this method, due to the significantly lower transaction costs, the cost of money is lower. In the "risk-based management" approach, the transaction costs of customers are greatly reduced and even the rate of service to many of them is lower than the current situation. Therefore, the justifiability of productive activity increases and this can play an important role in helping to get out of the current recession. On the one hand, replacing the "collateral-based" approach with the "risk-based" approach in providing banking services requires upgrading the specialized capacity of banks and creating the required databases and on the other hand, appropriate amendments to banking regulations.

Reducing spread rate

Banks' spread rate margins are a function of how their resources are distributed. The greater the authority of banks to freely and competitively allocate these resources in the form of lending facilities, the lower the bank spread rate would be. However, if the allocation of bank resources is mandatory and non-competitive, they need higher profit spreads to provide dividends and other expenses (organizational and operational). Banks in Iran face many restrictions on the distribution of equipped resources from public deposits to which they must pay interest; These restrictions consist of high legal deposit rates for mandatory facilities and public sector credit. As inflation increases, banks' operating and non-operating costs increase simultaneously; At the same time, applicants for facilities will also incur unwanted costs with this increase as the operating costs of the banks will make it possible to provide new facilities to the applicants in order to maintain the profit margin at a higher rate.

Reducing the cost of money

1) Due to the inflationary conditions of recent years, banks faced a decrease in the supply of deposits. On the other hand, the liquidity of assets of banks (lending facilities, etc.) has also decreased. These two phenomena forced banks to compete for deposit absorption and caused interest rates on deposits to rise. Accordingly, the central bank is able to reduce the interest rates paid through banks by reducing the interest rate on its loans to them.
2) One of the important indicators of the impact on the three crises in the Iranian economy is the increase in inflation and liquidity growth, and therefore inflation targeting should be on the agenda as a major goal of monetary and fiscal policymakers.
3) Liquidity has destructive effects on crises in the country and also today in many different countries of the world, open market operations play an important role in the implementation of monetary policy due to its advantages. As a result, the government, along with the central

bank, could solve its liquidity problems in the short term by applying Islamic open market operations and using sukuk bonds, and reduce its dependence on the banking system; Besides, one of the important factors in the growth of liquidity in the country is the increase in government debt; Thus, considering the destructive effects of liquidity on crises, it is suggested that with the publication of the Islamic Treasury, the government would be able to settle its overdue debts to banks and other creditors. Furthermore, it will reduce borrowing from the central bank and the banking network and prevent the monetary base from growing too much.

4) A deep cash interbank market along with the deepening of the capital market, should be a prerequisite for the development of the debt market and open market operations. In the current situation where Iran's economy is bank-oriented, the functioning of the interbank market is of great importance; This is because it causes the central bank to have more control over the interbank market, which plays an important role in reducing the occurrence of banking and currency crises.
5) Given the devastating effects of the government debt crisis on monetary and currency crises, the country's financial authorities should pay special attention to controlling the budget deficit and the accumulation of government debt. Policymakers must balance the government budget through an appropriate tax policy and its reform and the optimal use of oil revenues, and this prevents the government from borrowing too much from the banking system and increasing the multiplier of money and the consequences that play an important role in prevents debt and banking crises.
6) .To prevent currency and banking crises, the economic policy-maker can deal with it by controlling the bank's lending performance through the discount valve and reducing the share of imports and managing foreign exchange earnings and foreign assets of the central bank.

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