Journal of Money and Economy
Vol. 14, No. 3, Summer 2019
pp. 421-440

Efficiency and Information Asymmetry in the Iranian Banking System

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Received: 25 Jan 2020 Approved: 29 Feb 2020

The soundness and efficiency of banks is one of the important subjects that neglecting it can have adverse consequences for every country's economy. For economies depending on the money market, such as the Iran economy, this subject is more critical. Therefore, in this study, using panel data related to 16 Iranian banks for the annual period of 2010-2017, the economic efficiency was determined using a translog cost function and stochastic frontier analysis method then, by estimating the model of panel vector autoregression model and Granger causality test, the causal relationships between efficiency and information asymmetry in terms of adverse selection (the ratio of loans to assets and the ratio of loans to deposits) and moral hazard (the ratio of non-performing loans), were investigated, both of which are caused due to the information asymmetry. The estimations confirm the unilateral causal relationship of adverse selection and moral hazard with banking system efficiency. And, on the contrary, they claim that low efficiency of the banking system increases the adverse selection and moral hazard is not confirmed. Besides, the results of other estimates based on the panel model with random effects indicate a negative and significant impact of moral hazard and adverse selection on efficiency.

Keywords: Cost Efficiency; Stochastic Frontier Analysis; Information Asymmetry; Panel Vector Auto-Regression; Granger Causality Test
JEL Classification: C33, D61, D82

1 Introduction

As an economic component, efficiency includes rich literature and numerous definitions that can be used for all economic enterprises, including banks. One of the most comprehensive definitions is as follows: Efficiency is the ability to produce the highest amount of output with the lowest input. Banks are also

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included in this definition so that the bank's efficiency is its ability to generate maximum revenue by using resources (Aguenaou et al. (2017). The calculation of efficiency as a small variable has been considered since the mid-1950s. It has gone through the development of methods for estimating efficiency calculation evolution. According to the efficiency literature, there are several methods to calculate them, which can be all grouped into two categories of parametric and non-parametric methods. The parametric method itself consists of several subsets. In this evolution, it is possible to use panel data with a truncated distribution by Greene (2005b), which is one of the relatively new methods in this area.

Information asymmetry in the banking industry is causing problems to be considered as adverse selection and moral hazard. Adverse selection and moral hazards affect banks' efficiency and performance. But, since the criteria used for them in the cost function of the bank, which is a translog cost function, itself, are not helpful; another model can be used to investigate the impact of information asymmetry on the efficiency of banks. This model can identify the facts to be exploited to manage resources and expenditures as well as overall policy. There are several models to carry out this study, but according to the type of data and the purpose of the present study, which is to study the existence or non-existence of causal relationships between variables, the panel vector autoregressive model can be used. The present study tries to analyze the operational status of the banking system in Iran in recent years by examining the causal relationships between the cost-effectiveness of banks and the variables related to information asymmetry in terms of adverse selection and moral hazard. This study is important because, during the period under review, 2010 to 2017, Iran's economy has been accompanied by several problems, such as sanctions, and stagflation. The widespread impact of these cases on the banking system made the vast majority of banks encountered the downturn of a large part of assets and balance disorders.

Meanwhile, the atmosphere of stagflation and the disorders mentioned above has been reflected in the bankers' adverse behaviors and the bank customers' hazardous behavior. On the other hand, the low efficiency of banks has always been structurally present in the banking system; this is typically attributed to the root of the state ownership of most of the large and old banks of the country. Therefore, it is necessary to study the banks' cost efficiency and its relationship with unfavorable behaviors in the banking system of the country by using new scientific methods.

The present study has been organized into six sections. After the introduction, in the literature review section, two concepts of efficiency and

information asymmetry in the banking system and the way of measuring banks' efficiency will be explained. In the research methodology section, the proposed model and then the required data sources and research variables are introduced. In the fifth section, we will estimate the variables analysis model and the analysis of the findings. Finally, the overviews, conclusions, and suggestions will be presented in the sixth section.

2 Review of the Related Literature

The literature on the causal relationships between banking efficiency and the information asymmetry in the banking industry can be illustrated from both aspects of the concept and method of calculation. Hence, at first, the literature on efficiency will be presented, and then the literature on information asymmetry will be explored.

2.1 The Concept of Efficiency

Farrell (1957), as one of the pioneers of the study in this regard, distinguished efficiency into three components of technical efficiency, allocative efficiency, and economic (cost) efficiency. Technical efficiency is achieving maximum profit by an enterprise with given input and technology; allocative efficiency indicates the choice of each input based on price; Economic efficiency is achieved when both technical and allocative efficiency has taken place. To explain this important issue, Figure 1 is used.

Figure 1 consists of an IsoqL (y) curve showing the production of a certain level of input based on different combinations of inputs X_1 and X_2. Anywhere on this curve, there is technical efficiency. Its points on the right are unattainable with a certain input level, and its points on the left lack technical efficiency. The point X_e, which is obtained from the tangent of the isocost line with the Iso-quantity curve is the point that has both technical and allocation efficiency. Hence, there is economic efficiency at this point, too. Now, if the Iso-cost line is transferred to the right and reaches the point X_b, at this point, there is technical efficiency, but there is no allocative efficiency. Because it is possible to have more production by this isocost line. At this point, the distance from economic efficiency is slack A (Porcelli, 2009).

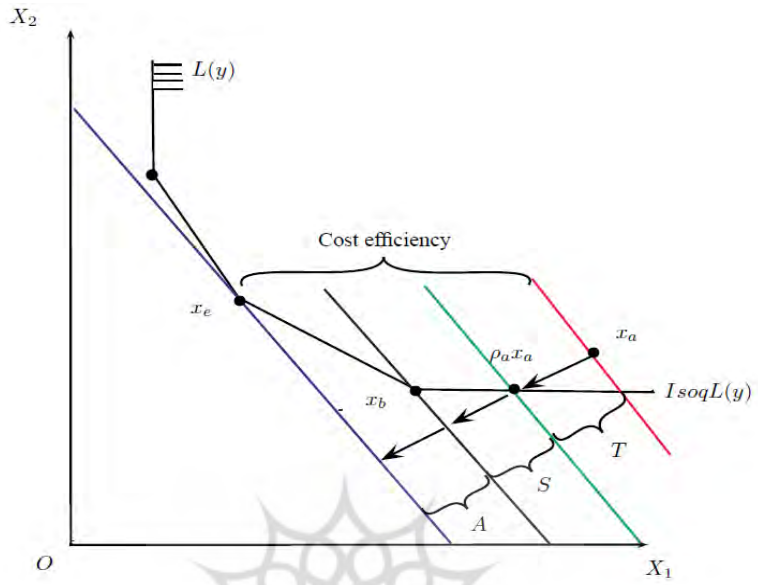

Figure 1. Investigating the combination of economic efficiency
Source: Porcelli (2009)

2.2 Calculation of Efficiency in the Banking System

Measuring efficiency in the banking industry has an extensive literature focused on the mathematical (nonparametric) and economic methods (Parametric). In the nonparametric method, the components of the disorder are not considered, and the inefficiency combined with the components of the disorder is estimated, which is called the Data Envelopment Analysis (DEA). But in the economical method, called stochastic Frontier Analysis (SFA), the error term is important, and it results in cleaner inefficiencies (Silva et al., 2017). DEA is a nonparametric method that uses data achieved from all samples and solves the problems using mathematical programming models. The most basic method among nonparametric DEA methods was proposed as the CCR model by Charnes, Cooper, and Rhodes (1978).

This model converts the outputs and inputs of each decision unit into a virtual output and input and solves this model using mathematical programming methods. Years later, Charnes, Cooper, Rhodes, and Banker (1984) introduced the BCC model, and then Charens, Cooper, Golani, Seiford, and Stutz (1985) presented the ADD (or Pareto efficiency) model, both of which included the concept of " economies of scale ".

The SFA method is one of the most commonly used parametric methods in studies, which was first used by Aigner and Chu (1968), which includes two deterministic statistical parametric methods (including production function and one-way error correction that reflects technical inefficiency) and parametric statistical (Including production function, technical inefficiency, and stochastic agent). This method is based on econometric models and microeconomic theories (Emami Meybodi, 2010). The stochastic frontier production function was independently used by the statistical parametric method of Aigner, Lovell, and Schmidt (1977) and Meeusen and Van den Broeck (1977) for cross-sectional data. Battese and Colli (1998) also used a stochastic frontier function and panel data to estimate the efficiency of a model as well as factors affecting efficiency (Hosseini et al., 2009).

Studies on the bank's efficiency can be divided into several general categories; the first category includes studies aiming at the comparison of the extracted efficiency of the two nonparametric and parametric methods. The following studies can be mentioned: Fiorentino et al. (2006) and Silva et al. (2017). It is worth noting that these studies often have similar results and suggest a divergence between the efficiency extracted from both methods. The second group of studies is about extracting and studying bank efficiency, which often uses a cost function and parametric method to extract economic efficiency. Hosseini and Soori (2007) Hosseini et al. (2009), Dehghan Dehnavi et al. (2011), Casu and Girardone (2009), Gunes and Yildirim (2016), Musko and Boddo (2016) Mosko and Bozdo can be mentioned.

The third group includes studies focused on the extraction of technical efficiency in banks, and Miller and Noulas (1996), Sturm and Williams (2004), Adusei (2016), and Zenebe Lema (2017) studies can be mentioned. Some other studies, including the study by Beccalli et al. (2006) and Kohers et al. (2000), are placed in more than one category of general studies; In addition to efficiency extracted from both nonparametric and parametric methods, these studies also examine the relationship between the extracted efficiency of each method and other banking components. Despite the widespread use of nonparametric methods, in the studies on the efficiency calculation, econometricians consider it to be inefficient. The main reason is the determining nature of these methods, in which the results are susceptible to outlier observations and measurement errors (Cazals, Florens, and Simar, 2002). In econometrics, since consistency is more important than other attributes of estimators, Pindyck, and Rubinfeld (1988), most economic studies tend to use frontier analysis methods in most economic studies.

2.3 Information Asymmetry

To better understand the notion of information asymmetry among the many definitions exist, a reference to the Principal-Agent Model will be helpful (Shahchera et al., 2013. The principal-agent theory refers to the risk of the representative's problem, in which the agent is more likely to seek the benefit of himself (Hatch, 1997). Such action is due to the superior information about the specific duties and position it has. Therefore, the most important aspect in the theory of the principal-agent is the observation and control of the actions of the agent by the principal stakeholders, because such control will be costly for them (Hendrikse, 2003). Asymmetric information is one of the main issues for the principal stakeholders regarding the impossibility of controlling the behavior and actions of the agent. The agent may also be affected by irregular information that the main beneficiary has sought to conceal. Therefore, the asymmetry will increase the uncertainty for both sides and will be undesirable. Asymmetric information from the agent's side can only be presented in two ways: the agent can take actions that are not visible to the main beneficiary, these actions are referred to as Hidden actions; The agent has unique information about the value or costs that the primary beneficiary is unaware of, and this is referred to as reverse selection or hidden knowledge (Laffont and Martimort, 2002). In the banking system, asymmetric information refers to a situation in which a customer has been informed about the risk of its investment in a loan agreement, but the bank has far less information. In this case, the bank's policies will be less efficient. But moral hazard occurs when the customers of a bank can affect their obligations to the bank without being informed and causes the banks to be exposed to risk (Nazarpur and Oulad, 2017).

Usually, banks with less capital will face higher non-performing loans because less capital reduces bankruptcy concerns and increases the likelihood of moral hazard and, consequently, the provision of riskier loans by banks (Berger and Deyoung, 1997). In this regard, considering that one of the main objectives of this paper is to explain the relationship between efficiency and information asymmetry, it should be noted that low efficiency in banks can be found in the poor screening of loan applicants (adverse selection). Therefore, banks with low efficiency will have higher credit risk and hence more non-performing loans (Rajan and Dhal, 2003). On the other hand, the increase in non-performing loans in the portfolios of bank loans represents a higher risk for liquidity and profitability because part of the assets will not generate income. Reducing the quality of banking assets will not only weaken the financial stability of the banking system, but also undermine their economic

efficiency and, at macro levels, reduce the volume of economic activity. Therefore, the reduction of non-performing loans is necessary to increase confidence in the banking system and restore stability. (Diamond and Rajan, 2011). Generally, it is expected that there is a twofold causality between moral hazard (such as non-performing loans) and efficiency in the banking system, and this relationship will be reversed. Among the studies that explore the relationship between efficiency and moral hazards, studies such as Berger and Deyoung (1997), Podpiera and Weill (2008), Karim, Chan, and Hassan (2010) and Benthem (2017) are often based on panel data, found the two-way causal relationship between efficiency and moral hazard (usually non-performing loans) meaningful and reversed. However, some of the studies have examined one-way causalities, such as Louzis, Vouldis, and Metaxas. (2012), Ghosh (2015), and Cincinelli and Piatti (2017), found a result of the reversal of the effectiveness of non-performing loans and Akhigbe and McNulty (2003) and Park And Weber (2006) found the negative impact of non-performing loans on bank efficiency. But there are very limited studies in Iran that have addressed this issue. For example, Ranjbar, Becky H., and Farahani Fard (2015) obtained the result of the negative impact of non-performing loans on efficiency in the framework of modeling with panel data.

3 Methodology and Variables

3.1 Experimental Methodology

This paper seeks to investigate the causal relationship between cost efficiency and information asymmetry in selected banks of Iran. To achieve this goal, three methods, including stochastic frontier analysis for efficiency extraction, panel vector autoregressive model, and Granger test for determining the causality relationship as well as the panel model, will be used to determine the direction and extent of the effects of the variables.

3.1.1 Stochastic Frontier Analysis and Efficiency Extraction

To estimate the cost-effectiveness, a stochastic frontier analysis method, which is a parametric method, will be used. Its efficiency and extraction was proposed by Debreu and Koopmans in 1951, and then proposed in 1968, DFA method was proposed by Aigner and Chu, in which the errors were ignored, and in the development of this, in 1977, Aigner, Lovell, and Schmidt proposed SFA method, and used the assumption of a half-normal distribution to extract efficiency. Besides, in the same year, Meeusen and Broeck did the same thing as Aigner, Lovell, and Schmidt, with the difference that they proposed an

exponential distribution assumption. Stevenson in 1980 applies truncated normal distribution, while Greene 1980 used gamma distribution assumption.

In the evolution of the efficient extraction method, in 2005, Greene attempted to extract the efficiency in the cost function in panel data. In this approach, in a stochastic frontier model with panel data, Greene considered the width of a unique source for each section, which is unlike the previous models presented by Pitt and Lee (1981) and Battese and Coelli (1988) in SF approach. In the form of formula, Greene introduced the following equation:

$$y_{it} = \alpha + x'_{it} + \varepsilon_{it} \quad (1)$$

In comparison with previous models, this model allows the separation of the inefficiency of the time-varying variable from the invisible heterogeneity at any point. Because in Pitt and Lee's (1981) model it was assumed that the inefficiency of all homogeneous sections is constant:

$$\begin{aligned} &y_{it} = \alpha + x'_{it} + \varepsilon_{it} \\ &\varepsilon_{it} = \upsilon_{it} - u_{it} \\ &\upsilon_{it} \sim N(0, \sigma_{\upsilon}^2) \\ &u_{it} \sim N(0, \sigma_{u}^2) \end{aligned} \quad (2)$$

In equation (2), u_{it} is an inefficiency that has constant property over time, but in the Greene model, inefficiency finds the property of time-varying. Greene believes that the estimation of the model (1) is possible by using two methods of fixed effects and random effects using the panel data and maximum likelihood (ML) estimator. While simulation-based models can easily estimate the model with random effects, the estimation of the maximum likelihood of fixed effects requires attention to two important issues related to the models with non-linear panel data. The first issue is purely computational, which is due to the high dimensions of parametric space.

Nevertheless, Greene showed that the maximum-likelihood dummy variable (MLDV) approach is computable despite the existence of a large number of disturbing parameters α_i (N> 1000). The second is the incidental parameters problem that occurs when the number of sections is relatively large compared to the length of the panels. In such situations with $N \to \infty$ and fixed periods (constant T), intercepts (constant) is estimated as inconsistency because Ti is used to estimate the specific parameter of each unit (Neyman and Scott, 1948, Lancaster, 2002). As Belotti and Ilardi (2012) have shown, due to inconsistency, the variance of parameters is affected, which leads to inefficiencies of estimation. It seems that the MLDV approach is only

appropriate when the length of the panels is large enough (T≥10). Therefore, model (1) is the most flexible and parsimonious choice among several versions of time-varying models. The cost function used in this paper is a translog cost function according to empirical studies published by Koutsomanoli-Filippaki, Mamatzakis and Pasiouras (2013) and Jiang, Yao and Feng (2013), and in particular according to the study published by Silva et al. (2017), with the difference that loans from other banks are cashed as an alternative variable of the banks performance in the interbank market. The reason for the succession of this variable is the particular conditions of the banking system in Iran, where the banks' reserve deficit is a normal task.

$$\mathrm{Ln}\left(\frac{\mathrm{TC}}{w_2}\right)_{it} = \delta_0 + \sum_j \delta_j \ln(y_j)_{it} + \frac{1}{2}\sum_j \sum_k \delta_{jk} \ln(y_j)_{it} \ln(y_k)_{it} + \beta_1 \ln\left(\frac{w_1}{w_2}\right)_{it} + \frac{1}{2}\beta_{11} \ln\left(\frac{w_1}{w_2}\right)_{it} \ln\left(\frac{w_1}{w_2}\right)_{it} + \sum_j \theta_j \ln(y_j)_{it} \ln\left(\frac{w_1}{w_2}\right)_{it} + \ln u_{it} + \ln u_{it} \quad (3)$$

In Equation (3), TC is the equivalent of the total cost, which includes the interest and non-interest costs as the input, and the three variables, including the sum of deposits, the total loans, and loans from other banks, as a yield y. In this equation, the input prices are considered by using the ratio of cost of profits to the total amount of deposits as w_1 and the ratio of staff costs to fixed assets as w_2. u_{it} is the non-negative inefficiency, υ_{it} is the stochastic error, and δ, β, and θ are model parameters. On the other hand, the linear homogeneity restriction is ensured by normalizing costs and input prices using one of the input prices w_2 (Gunes and Yildirim, 2016).

3.1.2 Panel Vector Auto-Regression and Granger Casualty

In this section, a panel vector autoregressive model (PVAR) is estimated to investigate the causality relationship between the efficiency and Information Asymmetry of adverse selection and the variable of the ratio of total loans to total assets based on the Mosko and Bozdo study, and the variable ratio of loan to deposit and the moral hazard will be investigated by variable of the ratio of non-performing loans to total loans based on a study by Zhang et al. (2016).

The vector auto-regression model described in equation (4) is based on the notation used by Abrigo and Love (2016), which can be used to determine the causal relationships between the variables, but to find out the size and direction, a panel model should be used according to equation (5).

$$Y_{it} = Y_{it-1}A_1 + Y_{it-2}A_2 + \cdots + Y_{it-p}A_{p-1} + Y_{it-p}A_p + X_{it}\beta + u_i + e_{it} \quad (4)$$

According to (4), Y_{it} is a vector of the dependent variable, i.e., the efficiency, X_{it} is a vector of independent variables, including the ratio of non-performance loan to total loans and the ratio of total loans to total assets, the ratio of loans to deposits, u_i and e_{it} are the vectors of specific effects and residual, respectively.

3.1.3 Panel and Determining the Size and Direction of Relationships between the Variables

Using equation (4), it is only possible to decide on the existence or non-existence of the causality relationship between the studied variables, but the direction and size of the effect of these variables are also important. To determine them, one can use a single equation panel model similar to Equation (5).

$$Y_{it} = \beta_0 + \beta_i X_{it} + e_{it} \quad (5)$$

In (5), the definition of Y_{it}, X_{it}, and e_{it} is similar to equation (4), and the calculated coefficients for β can be used to determine the size and direction of the effect of the variables under consideration.

3-2 Definitions of Variables and Data

In this paper, data published by the Iranian Institute for Banking Education (www.ibi.ac.ir), has been used, which publishes the aggregated data of the banking system. Due to the existing limitations, this review is based on an 8-year period from 2010 to 2017. Information gathered from 16 private, state and privatized banks of the country has been used, selected based on the completeness of their information during the period under review (Appendix A). In Table (1), the explanatory variables used to estimate the regression equation (4) have been presented. The variables introduced in this table are related to the estimation of a panel vector auto-regression model (Akande, 2018). The use of the panel vector auto-regression method is to examine the hypothesis of the existence of a two-way causality relationship between efficiency and information asymmetry. Meanwhile, the ratio of the total amount of loans to total assets and deposits is a symbol of adverse selection, and the variable of the ratio of non-performing loans is a symbol of the moral hazard.

Table 1
Variables used in the models for measuring the relationship between the efficiency, adverse selection, and moral hazard

row	Explanatory variable	symbol	impact type based on theoretical expectations
1	efficiency	effi	In the present study, the efficiency means the banks economic (cost) efficiency. Based on the theoretic expectations, inefficiency can lead to the adverse selection and moral hazard.
2	Non-performing loans ratio to total loans	npltl	In addition to showing the credit risk, this ratio can also be used as a representative of the moral hazard of bank customers. This ratio reflects the default of loans and expectations based on its negative impact on the efficiency of the banking system as it results in the non-production of a portion of banking assets.
3	The ratio of total loans to total assets	lta	The ratio of total loans to total assets is one of the common criteria for adverse selection, which has been used in many empirical studies, including Zhang et al. (2016). This ratio shows the selection of bank managers in resource allocation. Granting loans is the main activity in the banking industry, but its amount from the bank's total assets should have a reasonable proportion to manage the market risk. It is expected that the excessive increase in the ratio of loans to total assets leads the bank to face serious risks and hurt efficiency.
4	The ratio of total loans to total deposits	ltd	The ratio of loans to total deposits is another variable that can be used as a representative of the adverse selection; this criterion shows the number of accumulated resources allocated by the banks to the main activity. This ratio is related to operational risk and has been used in banking studies, including a study by Mosko and Bozdo (2016), which is expected to hurt efficiency.

4 Estimation Results

4.1 Efficiency Extraction Results

According to the methodology section, the cost translog function has been estimated by using the SFA method in the panel data using the uncommon effects method according to Greene's (2005a) approach, and the Hausman test was used to determine the final decision about choosing a better method. The

results of the Hausman test are presented in Table (2), which implies confirmation of the fixed-effect model for estimating the cost function presented in equation (3).

Table 2
Hausman test results related to the cost function estimation by the SFA method

test	statistic	result
Hausman	45.91***	existence of fixed effects

*,**,*** show the significance in the error level of 1, 5 and 10%, respectively.

After estimating the equation (3) that introduced the cost function, the cost-effectiveness of banks is derived from this equation. In Figure 2, the annual cost efficiency of each bank can be observed. As shown in Figure 2, the efficiency of the banking system had an ascending trend from 2010 to 2017. The investigation of the curves shows that the most of the banks' cost efficiency had a descending trend from 2010 to 2011, ascending from 2011 to 2015, descending from 2015 up to 2016 and ascending from 2016 to 2017. The decline in the efficiency of the banking system in 2011 could be attributed to the political environment, and the imposition of foreign sanctions, as well as the beginning of the first wave of the devaluation of the national currency, and the general upward trend from 2010-2017 could be based on the lack of permission in the expansion of bank branches, due to the policies of the central bank, which has led banks to push the spread of information technology-based banking services.

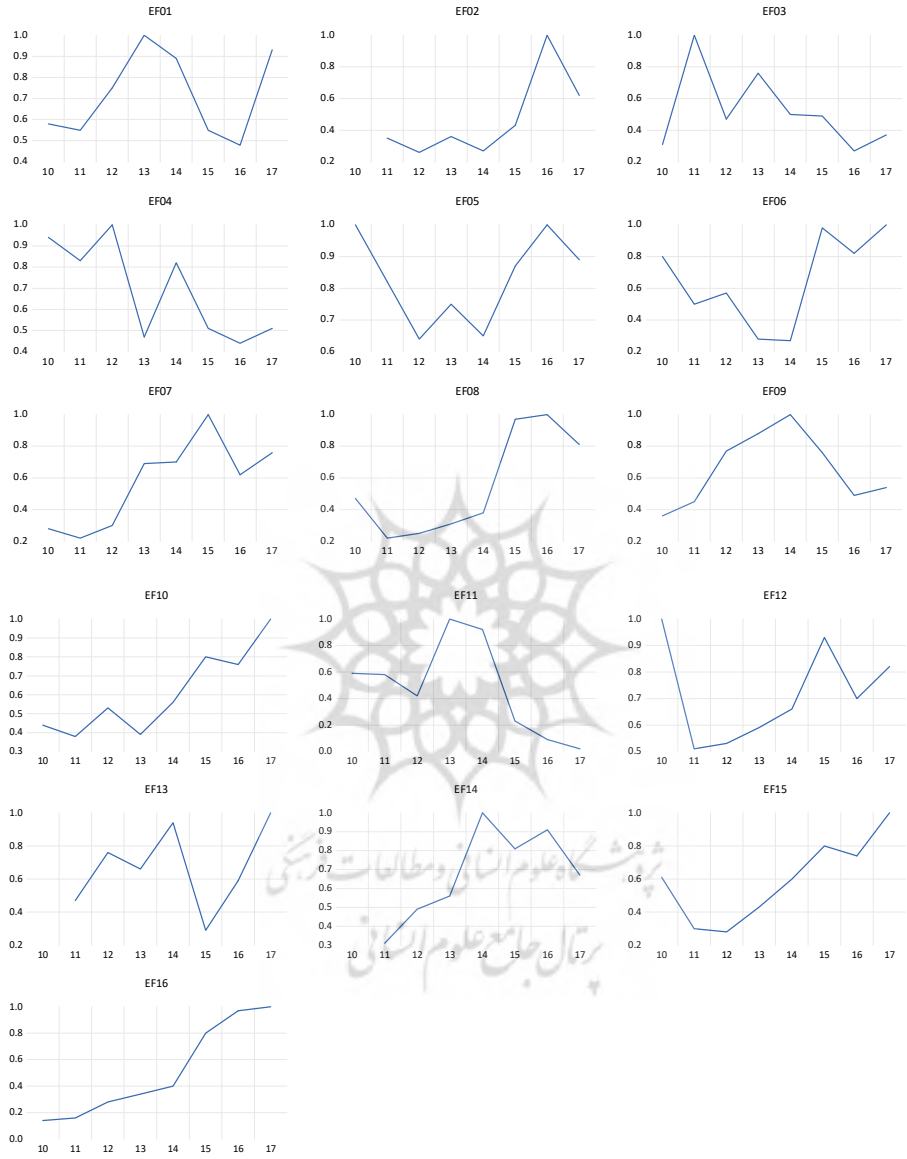

Figure 2. Cost Efficiency of Banks.

Source: authors computations.

An examination of the results of the extracted efficiency for each bank indicates that only one bank has had an uptrend in all of the studied periods, and the amount of efficiency extracted for other banks examined during the reviewed period had fluctuations. The extracted efficiency indicates the absolute inefficiency (efficiency is 0.02) and the absolute efficiency (the obtained efficiency is 0.99) in the banking system of the country, which shows the dispersion of the range of results.

4.2 The Results of Causality Relationships

To determine the causal relationship between the studied variables, such as efficiency, adverse selection (loans to asset ratio) and moral hazard (ratio of non-performing loans to total loans), as well as in another model, the study of the causal relationship between these variables and another variable, called the ratio of loans to deposits, which itself can also be indicative of an adverse selection, a vector auto-regression panel model was estimated according to (4) and then using the Granger causality test, which its results can be seen in Table (3); the causality relationship between the variables was studied.

Table 3
Investigation of causality relationship using Granger causality test and Chi-square statistics

model	Cause/effect	efficiency	NPL	Loans to assets ratio	Loans to deposits ratio	total
first model (three-variables)	Efficiency	-	24.777 ***	4.391 **	-	34.929 ***
	NPL	1.854	-	28.87 ***	-	31.307 ***
	Loans to assets ratio	4.470 **	22.813 ***	-	-	60.811 ***
The second model (four-variables)	Efficiency	-	3.06 *	5.342 **	4.984 **	19.039 ***
	NPL	8.268 ***	-	8.740 ***	5.712 **	25.369 ***
	Loans to assets ratio	0.002	1.38	-	19.659 ***	27.107 ***
	Loans to deposits ratio	0.723	1.602	0.146	-	1.757

*, **, *** are the significance in the error levels of 1, 5 and 10%, respectively.

The results of both models indicate that the ratio of non-performing loans to the total loans and loans to assets ratio at an error level of 10% causes efficiency changes; in other words, both models confirm the impact of the adverse selection and moral hazard on the efficiency of the banking system.

On the basis of the first model, the changes in the efficiency cause the changes in the ratio of loans to assets, which indicates the impact of inefficiency on rejection or adverse selection. Based on the second model, the efficiency is the reason for changes in the ratio of non-performing loans to total loans. Also, this model states that the ratio of loans to deposits due to efficiency changes, but the reverse is not supported by any of the estimated models.

The two-way causality relationship between the efficiency and the ratio of loans to assets and the relationship between the causality of the two-way relationship between efficiency and the ratio of non-performing loans are confirmed by the first and second models, respectively.

In both models, the ratio of loans to assets is the cause for changes in the ratio of non-performing loans to the total loans, which could be an indicator of an increase in non-performing loans due to the ease of granting the loan and the lack of proper credit assessment to allocate more resources to the loan.

4.3 Results of the Direction and Size of the Relationship

In order to determine the direction of the effect of the variables related to adverse selection and moral hazard, the model will be estimated. According to the data, the modeling process was initiated during which, without rejecting the F-Leamer's zero-hypothesis, the random-effects model was described in equation (6).

$$\underset{}{\mathrm{EF}_{it}} = \underset{(6.88)}{0.644} - \underset{(-1.91)}{0.285}\ \mathrm{NPLTL}_{it} + \underset{(0.87)}{0.154}\ \mathrm{LTA}_{it} - \underset{(-1.81)}{0.068}\ \mathrm{LTD}_{it} + \mathrm{e}_{it} \quad (6)$$

To estimate this model, the use of other variables such as return on assets and return on equity was considered, but, from the viewpoint of modeling, the estimated models were not recognized as better models. Therefore, the main model was introduced. The estimation results showed a negative and significant relationship between the ratio of non-performing loans and the ratio of loans to deposits with efficiency, which was consistent with theoretical expectations. In this model, the estimated coefficient for the loans to assets ratio is not statistically significant at the 10% error level. In sum, the obtained

coefficients confirm the negative impact of the adverse selection and moral hazard on efficiency.

5 Overviews, Conclusions, and Suggestions

This paper investigates the relationship between the cost efficiency of banks in the country with information asymmetry. In the first step, the cost-effectiveness of 16 selected banks in Iran was described as Appendix A as the representative of the banking system. To do so, the cost-efficiency values of each bank was extracted during the annual period from 2010 to 2017 by writing the translog cost function and estimating it based on the Greene approach. The general trend of extracted efficiencies in the banking system of Iran during this period was ascending, which can be attributed to the policy of lack of expansion in branches. The findings also indicate a sharp decline in efficiency in 2011, which could be the result of the currency crisis due to the sanctions. After extracting the efficiency by using the panel data vector auto-regression method, the causal relationships between the cost efficiency and information asymmetry for adverse selection and moral hazard aspects were investigated using the Granger test. The results indicated that there has been a unilateral causality from moral hazard and adverse selection in the efficiency of the banking system. Finally, according to the one-way causality result obtained from the model of the PVAR model, another model with panel data that estimated the impact of moral hazard and adverse selection variables on efficiency was estimated. The estimation results of this model showed that both adverse selection and moral hazard hurt efficiency, which corresponds to the theoretical expectations.

In recent years, the expansion of non-performing loans in the banking system as a moral hazardous behavior of the customers of banks has led to the non-production of part of the assets of banks and, consequently, to the reduction of income generation capacity; thus, liquidity and profitability and banks economic efficiency have been facing a challenge. On the other hand, the ratio of loans to deposits as a symbol of the bank's adverse selection behavior has not moved in the proper direction in recent years, and this has led to the spread of liquidity risk because most banks are in the competition of attracting the deposits and thus their main focus is On deposits instead of providing loans. Therefore, this behavior of banks hurts their cost efficiency because it has affected the necessary balance in their managerial quality.

Given the importance of the banking sector in the country's economy, the necessity to improve its efficiency to get away from critical conditions is essential. Therefore, concerning the negative impact of the two categories of

the ratio of non-performing loan liabilities and the ratio of loans to deposits on the efficiency of banks, this paper recommends that the macroeconomic management of the banks and the supervision section of the banks (the central bank) take appropriate steps to reduce the operational risks of the banking system through the proportion of non-performing loans, as well as to determine the optimal level for the loans/deposits ratio. To do so, the formation of asset management companies and the use of new mechanisms and standard customer ratings can help reduce non-performing loans. On the other hand, expanding liquidity risk monitoring to achieve the optimal combination of bank assets can lead to the effective management of the loans to deposits ratio.

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Appendix A: Banks under the study

The sample used in the estimations of 16 private and state banks of the country for 8 years from 2010 to 2017 is as follows: Mellat, Kar Afarin, Refah, Iran zamin, Sina, Tosee saderat, Gardeshgari, Tosee Taavon, Saman, Maskan, Tejarat, Ansar, San'at O Ma'dan, Saderat, Pasargad, Keshavarzi.