Iran. Econ. Rev. Vol.17, No.2, 2013.

A Differential Oligopoly Game with Sticky Prices and Environmental Externality

Amir Mansour Tehranchian*
Samad Yadollahpour Arabi**

Received: 2012/012/10 Accepted: 2012/04/16

Abstract

We investigate a differential oligopoly games with sticky prices and environmental externality. The external effect is determined by sales. We compute the socially optimal allocation, where a benevolent planner sets production plans so as to maximize the discounted social welfare, in both existence and non-existence environmental externality, and show that the latter equilibrium entails a larger level of steady state production as compared to the former.

Keywords: Price Stickiness, Differential Games, Environmental Externality, Social Welfare.

1- Introduction

In this age, efficiency should be the managers' highest purpose and the most valuable destination of all organizations. An effort to increase efficiency level is a new battle facing management at the threshold of twenty-first century. In a simple look, efficiency is the output to used resources ratio. So if with the same cost more products are produced or a certain amount of product is produced with less cost, community benefits and can provide a better life for its people. In recent years, a proper approach to efficiency was used in intellectual, social and cultural areas. In fact today efficiency is not an unfamiliar and strange issue, at least in community's subjective beliefs. But the objectivity of productivity meaning the rational use of available resources and achieve the highest goal and the most valuable

*Department of Economics, University of Mazandaran, Babolsar, Mazandaran, Iran(Corresponding Author).

** Department of Economics, Allameh Mohaddes Noori Institute of Higher Education, Noor, Iran.

target in all organizations, needs scientific thinking and dealing with the issue of efficiency, so that efficiency cycle establishes in the four stages of measurement, analysis, planning and execution in organizations.

Organizations need transformational management, prospective strategic thinking and avoidance from daily thinking. The fundamental step for such a stable management method requires an efficient scientific-practical approach, to balance the organizational inputs and outputs, and with continuously functional evaluation, institutionalize the quality and efficiency (Eliza, 2007, p 14). Obviously achieving these demands and requirements and access to what this study is looking for, by activity measurement and application of scientific and quantifiable models and finally design and establish a performance evaluation system will be possible. The importance of this measurement is to the extent that based on experiments conducted in industrialized countries, simply by announcement, establishment and implementation of a performance evaluation system, and even without any change in organization or investment, productivity increases 5 to 10 percent. (Supachet, 2008, p 120). Research on how to obtain maximum results from limited resources is the nature of economics and limited resource allocation is its purpose. Efficiency in the most simple expression is the maximize result in micro and macroeconomic scale. Thus, research concerning efficiency, including in institution level, is considered as one of the most important economical researches. Any move to improve the efficiency of the banking system will make the savings, investment and resource allocation process improve and, potential facilities lies all over the country will be used for development and general welfare. The most important issues in banking industry are performance and risk issues. Where the future is unknown, there is risk. Hence, those who can secure a future for themselves and their organizations are those who can increase their knowledge with proper planning and analysis. So today when risk management is discussed, the goal is not to eliminate the risk, but is to identify and determine its due costs. On the other hand risk management does not bear any meaning itself, because risk is a parameter that can Influence other conditions in firm such as profit, efficiency, etc. Therefore, this study sought to examine this impact on bank performance. To calculate efficiency in the banking system two major methods will be used: DEA and SFA. But today another method which is developed from DEA is also used. In this study to calculate efficiency, MEA

and SFA methods will be used. After analyzing the extracted results by each of these methods and ranking the studied banks according to efficiency scores, the optimal method will be chosen and introduced. So far several studies have been conducted to evaluate bank efficiency using these two mentioned methods, both inside and outside Iran borders. But researches rarely have studied and compared the impact of various risks on efficiency. So the present study sought to answer this question: which of these two efficiency evaluation models, i.e. multi-directional efficiency analysis (MEA) and stochastic frontier analysis (SFA), are more effective to analysis the effect of risk on banking system efficiency? And, how is the impact of each credit, operational, market and liquidity risks on banking system efficiency? So at first, to determine this subject, efficiency and types of risk are explained.

2- Theoretical Basis

2-1-Efficiency:

From economic theory point of view, efficiency is the result of optimized production and resource allocation. In other words, in a production unit managers and workforce, according to the desired goals of the firm and the available technological ability, are trying to determine their production amount, in a way that while using the maximum resources and possibilities, and optimal cost allocation, make optimal use of productive factors (capital and workforce). Efficiency is a relative concept and to measure it and to understand the distance between efficiency and expected and ideal levels, we should compare the performance of economic units with efficiency in potential production circumstances. (Surrey, Garshasbi, Oryani 2007).

2-2-Credit Risk:

Although banks and institutions are as an intermediary between saving consumers, investors and shareholders and credit facilities applicants, but the most important operation of these institutions is granting facilities and loans to applicants. Credit risk is the risk resulting from non-payment of all or part of the initial granted facilities and their profit, or the risk resulting from failure to return the profits of bank investment, in other words credit risk is the risk of not receiving timely cash flow from bank granted facilities (Christophe, 2004, p 93).

2-3- Operational Risk:

Can be defined as risks related to business strategy, internal systems and operations, technology and mismanagement (Lei Sun, 2010, p 55). The Basel Committee defines operational risk as "Risk resulted from operation of personnel, systems and internal processes and external events." However, the Committee believes that banks should not rely on this general definition, but each bank according to the size, nature and complexity of its activities should have a unique definition of operational risk. Basel Committee believes that shortage in understanding and managing operational risk – which almost exists in all bank activities and transactions - to a large extent might decrease the possibility of identifying and controlling some of the risks. In this study to evaluate the relationship between operational risk and bank efficiency, the three indicators are used: return of assets volatility (ROA), stock return volatility and stockholders' equity to asset ratio (Luc Leaven, 1999, p 20).

2-4- Liquidity Risk:

Despite intense competition, inability to predict economic conditions and the promise to shareholders for maximize profit, and the promise to depositors for capital return at any time, banks have to multiply their efforts to balance between risk and efficiency and satisfy both shareholder and the depositor groups as the main sources to provide their needed funds. Thus one of the main concerns of private banks is to increase efficiency at a certain level of risk. In banking industry, in the absence of proper management, one of the risks which directly lead to bank losses is liquidity risk. Liquidity risk comes from lack of necessary liquidity to cover the short term obligations and unexpected outflow of funds. Consider for example the period in which due to increased interest rate of deposits by a rival bank, most of the depositors withdraw their deposits from the bank. In the same period bank cash funds cannot meet such a sudden exit. In such circumstances, the bank has to absorb expensive resources (such as inter-bank loan market) or cash its other assets in less time and very low price than the market price (Luke Leaven, 1999, p. 20).

2-5- Market Risk:

This risk comes from adverse fluctuations in market variables. For example, increase in inflation rate influences on the banks future income and

makes it difficult to predict the future state of bank's balance sheet (Maria Psillak, 2010, p 19). In this research, efficiency indicators of daily exchange rate return, monthly interest ratio, changes of exchange rate and interest rates from t-1 to t are used.

Various risks, affect banking system's performance and efficiency severely. One of the most important reasons that bank performance influences from various risks is that risks are related to each other and also it is impossible to completely separate different types of risk. If one of the market parameters such as inflation rate increases, this change reduces the value of bank portfolio assets (due to effect of future income of paid loans) and creates the market risk. However, higher inflation rate reduces the value of bank cash assets and market risk will rise. Lower exchange rate reduces the value of exchange cash assets which creates changes of exchange ratio risk, and on the other hand reduces the income from exports for a facility receiver customer, reduces his expected income and thus reduces his repayment ability and therefore credit risk is created. On the other hand, this reduces banks' fund inputs and creates liquidity risk (Chiu, 2009, p 460). This way one of the risks creates and strengthens other risks and series of hazards and risks, affects on profitability and efficiency of banks.

3- Research Background

Non-parametric method in productivity evaluation was founded in 1957 by Farrell. This method was developed in 1978 by the Charnz, Cooper and Rhodes, based on mathematical programming models and was entitled as data envelopment analysis and was introduced as an efficient method to evaluate decision making units function (DMUs). Following the development of data envelopment analysis, in 1984 a very important concept of returns to scale was considered by the Banker, Charnz and Cooper in DEA models. Following this start, in the last two decades special reports and also numerous successful applications of this method have been reported and published in worldwide prestigious journals in a way that nowadays data envelopment analysis is regarded as an efficient tool for evaluation of decision making units serving managers. In this regard, the DEA website has been designed at the University of Warwick in England. This site contains comprehensive information from Data Envelopment Analysis (Bonn Wachtel, 2005).

DEA model development is based on Rhodes PHD thesis topic with the guidance of Dr. Cooper which evaluated the efficiency of America's public schools. This study led to publication of the first article about the general introduction of DEA in 1978. In this year the comprehensive data analysis method, by 3 researchers called Chanz, Cooper and Rhodes, known as the CCR group, universalized Farrell method in a way that includes manufacturing process features with multiple manufacture and production and it was added to economic literature (Adel, 2003, p7).

Parallel to non-parametric approach for performance measurment, parametric approach was started by Aigner and chu in 1968 to estimate the frontier production function. They introduced Cobb-Douglas linear production function. In this model, the disruption component of the function is considered as an inefficiency component and there are no uncontrollable factors and measurement errors impact. That is why this method is called "definitive". Overall thereafter for some reasons, this approach was better encountered to solve noise problem. This method is known as stochastic frontier approach (SFA). Stochastic frontier production function was proposed by Aigner, Lowell, and Schmidt (1977) and was independently presented by Van den Brook and Miozen, based on the idea that deviations from production line cannot be controlled completely by the firm (Adel, 2004, p. 8).But one of the areas that frequently used parametric and nonparametric methods, is the performance evaluation area in the banking industry. Below are a number of studies on bank efficiency comparison using several different methods, and following is presented a summary of results of studies. So far many studies have been conducted about the efficiency of banking industry using both parametric and nonparametric methods; some of these studies can be mentioned as follow:

Nassiri, "Efficiency measurement and ranking of Keshavarzi Bank branches, using DEA method" a project in 2001, using DEA method examined 172 Keshavarzi Bank branches in the East and West Azarbaijan and Ardebil provinces. He calculated branches' efficiency with assumptions of fixed and variable returns to scale with respect to certain features such as performance areas, scope and size of branches, and computed the levels of technical efficiency and scale and ultimately introduced some of the branches as inefficient units for reference and model. One of the results of his study is that the average technical efficiency of rural branches of

Keshavarzi Bank is closer to the border of its group efficiency and only 31 percent of the studied units had technical efficiency and scale.

Akbarpour Shirazi, Tahmasebi and Javadian in an article called “Using data envelopment analysis for evaluating banks' marketing efficiency” in 2006. They argue that banks increasing competition, need for knowledge and information on bank services, urban sprawl, need to cover broad audience, reflection of customers evaluation of bank services, keeping existing customers and attract new customers, are factors that make bank marketing important. In this paper, to evaluate the bank marketing a mathematical model based on data envelopment analysis (DEA) is presented. The proposed model is a BCC input-oriented model with two inputs and two outputs.

Hijazi et al. in a study called “Total productivity analysis of Export Development Bank of Iran and its branches productivity growth using data envelopment analysis (DEA)" in 2008. They used SBM model to analyze the total efficiency of this bank during 1994 to 2003, and used DEA model and Malmquist productivity index to measure productivity growth in its branches during 2004 to 2005. In DEA model, number of employees, received interest and fees, and administrative and personnel costs were served as inputs variables; and granted facilities, received fees and deposits with and without cost are used as output variables. Results show that the average productivity in 2004 grew by one percent and in 2005 by two percent. Also ranking branches based on productivity and DEA method, have a significant correlation with their current ranking with 99% confidence level.

Fallah Shamsi and Tehrani, in an article entitled "Design and explanation of credit risk model in domestic banking system" in 2005. They examined efficiency of possible linear, logistic, and artificial neural networks models to predict the credit risk of customers in domestic banking system. Predictor variables in these models are financial ratios of loan receivers that their significant correlation with credit risk has been approved by appropriate statistical tests. Using credit and financial data of 316 legal clients in domestic banks, mentioned models were designed and were tested by efficiency test. The article includes assumptions, statistical and sampling techniques based on research findings to establish a measurement system and risk management in domestic banking system. Results obtained in this paper indicate that the correlation between variables in the credit risk predict

model was not linear, and exponential and sigmoid functions are considered as the most appropriate models to predict credit risk, and the most efficient models to predict credit risk respectively are artificial neural networks and logistic models.

Elena Beccalli et al. in an article titled "Productivity and performance of stocks in European banking" in 2002, wanted to introduce fuller reasons in the bank efficiency, by defining an alternative productivity rate and evaluating the correlation between this rate and market performance in financial institutions. In this study, using data envelopment analysis (DEA) and SFA model they evaluated cases in the European index banks in 2000. Results especially from DEA model, show that the percentage of changes in stock prices, is a reflection of the productivity rate, while the DEA model is more efficient than SFA model. Then it was expressed that these changes lead to a negative process in cross-border transactions to achieve a better performance.

Gonzalez in 2005 in an article titled "Bank regulation and risk regarding causative factors: an international comparison of bank risk" considering the number of bank branches and number of personnel as input, and investments and volume of deposits as output, efficiency of banks was obtained with influencing credit risk and total risk variables using DEA model, and accordingly ranked the banks. This article ultimately concluded that there is a significant correlation between risk and finance.

Ricardo and Calves in an article titled "Application of data envelopment analysis method to estimate bank performance in Brazil" in 2006, considered the 50 top banks in Brazil and using bank balance sheet variables, evaluated and compared these banks performance. The survey results indicate the efficiency and superiority of the DEA method in ranking and rating of banks, compared to traditional method of ranking.

Pasiouras in 2008 in an article entitled "Estimating technical and scale efficiency of Greek commercial banks: the impact of credit risk, off-balance sheet activities, and international operations" by taking into account variables and indicators that explain banking risks such as default loans as input variables in the DEA, tried to explain the correlation between risk and efficiency in banking industry and found a significant correlation between these two categories.

Elizabetta Fiorentino et al. in a paper titled "Efficiency in German banks: a comparison between DEA and SFA" in 2006, evaluated the coordination between efficiency results obtained by these reciprocal methods in the financial economics literature, namely the DEA and SFA methods. They reviewed 34192 samples of all banks in Germany between 1993 and 2004 and analyzed the coordination rate between the results and five criteria (input and output variables): levels, rankings, identifying the precise anchors, stability over time and correlation to the level of accounting standards based on performance. The survey results indicate that non-parametric methods are sensitive to measurement errors. Moreover, taking into account systematic differences between commercial, savings and loan banks in order to avoid incorrect interpretations about the overall efficiency of banks is important. Another achievement of this research is that despite the fundamental changes taking place in the banking system in Europe, short term productivity rates is highly stabile.

Chiu and Chen in 2009 in an article titled "Taiwanese bank efficiency analysis: a combination of both external and internal risks", studied the correlation between credit, market and operational performance risk with bank efficiency. Using and results obtained by DEA and SFA methods they calculated performance and risk of banks and at the end found a significant correlation between risk and performance.

Stephen Karanu in 2010 in an article titled "Ghana's banking system efficiency and performance using DEA and SFA models" evaluated the level of performance and efficiency of Ghana banks in a 10-year period between 1997 and 2006 using two DEA and SFA models. He studied the different assumptions from DEA and SFA models to compare both models, and then used both of them to obtain the banks' efficiency. This article shows the difference between the results obtained by both models using chart graph.

Sun and Chang in 2010, during a relatively comprehensive survey in an article titled "Comprehensive analysis of the effects of risk on bank performance: evidence from emerging countries in Asia," studied the correlation between operational, credit and markets risk of banks in Thailand and performance of sample bank branches; evaluated the performance of branched using DEA and SFA methods and resulted a significant correlation between risk and performance.

4- Statistical Society

The research statistical society includes 15 banks (Melli, Tejarat, Saderat, Mellat, Sepah, Refah, Maskan, Keshavarzi, Industry and Mine, Export Development, Parsian, Pasargad, Karafarin, Eghtesad Novin, and Saman). The research variables for these 15 The Banks has been collected for the past six years.

4-1- Research Questions

The main questions

1. How is the performance of domestic banks and their ranking based on MEA method?
2. How is the performance of domestic banks and their ranking based on SFA method?
3. Is there any significant difference between performance evaluation and ranking of banks based on the MEA and the SFA methods?
4. How and how much is the impact of important risk measures in the banking industry on banks' performance?

Subsidiary questions

1. What are the efficient and inefficient units in domestic banks based on MEA method?
2. How is the ranking of banks according to the average performance rate based on MEA?
3. How much is the inefficiency of banks based on SFA method?
4. How is the ranking of studied branches according the average performance rate based on the SFA method?
5. How and how much is the impact of credit risk measures in banking industry on banks' performance?
6. How and how much is the impact of operational risk measures in banking industry on banks' performance?
7. How and how much is the impact of market risk measures in banking industry on banks' performance?
8. How and how much is the impact of liquidity risk measures in banking industry on banks' performance?

4-2- Research Variables

Variables to estimate the efficiency with MEA

The MEA model using data from input and output variables compares options or branches in pairs, and thus each bank's ranking compared to other

banks and according different types of performance is calculated and provided. Input variables, often are considered as a production factor for the product or service provided in the studied firms (Chansarn, 2008). In this research, after reviewing studies conducted on input variables of MEA model in the banking industry and most of the theories in this field, input variables for all 15 desired banks were collected for the past six years 2005-2011 including: (the number of branches, volume of bank deposits and collection costs). The volume of bank deposits include: (demand deposits, cooperative and saving deposits, durable deposits, and other deposits). These variables are the most important parameters that their size change and optimization can directly affect on units' performance and efficiency improvement; also their statistics are available for all banks. Considering these three variables as input variables in bank's performance evaluation, covers and uses all of the variables and parameters involved in the topic. Large numbers of unused bank branches and additional costs can affect technical performance and ultimately the total performance of the bank and impose additional and overload costs to the organization. Thus calculate the optimal values of these variables and estimate the model based on minimizing these factors, provides a basis to improve bank's efficiency and improvement the performance of the entire set. Also output variables were selected with regard to the nature of the bank profession (granted facilities, investment category, and income category). The entire bank's granted facilities include all of the bank granted facilities and bank demands minus the storage of questionable receivable demands, and investments include short-term and long-term investment and participation bonds.

The performance estimation variables with SFA method

To estimate efficiency with SFA method, we need to introduce input and output. The model introduced in this study to estimate the performance is as follows and its variables are obvious.

$$\ln(TC_{it}/P_{1_{it}}E_{it}) = \alpha_0 + \sum_{i=1}^{3}\alpha_i \ln(Q_{it}/E_{it}) + \sum_{j=2}^{3}\beta_j \ln(P_{j_{it}}/P_{1_{it}}) + \gamma \ln R_{it} + u_{it} + \upsilon_{it}$$

$$i = 1,2,....,N, t = 1,....,$$

TC_{it} is the total cost of the i[th] bank in year t, Q_{it} output (including

investments Q_1, granted facilities Q_2, deposits with other banks Q_3 and off-balance sheet activities (Q_4), $P_{j_{it}}$ inputs price (including labor cost P_3, capital cost P_2 and total cost P_1), E_{it} Equity of bank depositors, R_{it} the non-revenue loans ratio (deferred), υ_{it} random error, u_{it} effect of cost inefficiency.

Variables to study the effect of risk on performance

To estimate the impact of risk on performance, we select indicators for each risk, and then based on these indicators, we estimate the model. Credit risk indicators are variables for granted facilities to assets ratio, deferred demands to facilities and capital adequacy ratio. Also for operational risk, variables are selected for asset return volatility, stock return volatility. For market risk, the two variables for changes of interest rate and changes of exchange rate, and for liquidity risk, the three variables for facility to deposit ratio, long-term facilities to long-term deposits ratio and cash to deposit ratio are selected.

4-3- Method and Model

In this study, to achieve the performance of studied banks, MEA and SFA methods will be used. In this regard at the first step of calculating efficiency, using the MEA method, Deap software will be used considering input and output variables and after obtaining the efficiency values, banks are ranked. After this step based on output and input variables, the values of sample banks' performance will be calculated and presented using the SFA method by Frontier software version 4.1. Finally based on achieved performance values, the sample banks are ranked. In the next step performance values obtained from the two methods are compared. After calculating the obtained performance values, to study the effect of different types of studied risks on performance, the geometric average of performance values obtained from the two MEA and SFA methods are considered as efficiency value. In this step for each of the studied risks, 3 top indicator are selected and based on

available data for these indicators and available performance levels, the impact of each one on performance is decided by Eviewse software.

5- Results

To calculate efficiency with MEA method, two methods can be used. About these two methods we should have in mind that to calculate efficiency, variable to scale method is more accurate than stable to scale method, and also know that using stable to scale method will produce only one type of efficiency by the software. To answer the research questions the performance of banks with MEA and SFA methods were calculated, and the results are according to Table 1.

To answer the first question of the research and first and second subsidiary questions of the research, the performance of banks is calculated as shown in the above table. Given the above table, except banks No. 6, 9, 10, 11, 13 and 15 that are classified as fully efficient banks with the average efficiency of 100%, the remaining banks are classified as inefficient banks. Considering that in MEA method, efficiency is calculated and measured, thus it seems that designing a ranking system using this method is more scientific and efficient than other existing methods, but this is only a hypothesis and we will test it using survey results.

Table 1: Results of Calculating the Efficiency of banks with the two MEA and the SFA methods

Row	Name of the Bank	Average Efficiency by MEA Method	Average Efficiency by SFA Method
1	Melli	0.53	1.08
2	Tejarat	0.82	0.888
3	Saderat	0.4	1.099
4	Mellat	0.61	1.252
5	Sepah	0.99	0.906
6	Refah	1	0.701
7	Maskan	0.59	0.75
8	Keshavarzi	0.5	0.699
9	Industry & Mine	1	0.843
10	Export Development	1	0.804
11	Parsian	1	1.027
12	Pasargad	0.94	0.858
13	Karafarin	1	0.96
14	Eghtesad Novin	0.84	1.314
15	Saman	1	1.236

Source: Researcher Computation

Results from calculation performance with Anderson – Pearson method by win-dea software show that Parsian Bank with average performance of 1.695 won the first rank. Next ranks respectively belong to Saman Bank, Karafarin, Industry and Mine, Refah, Export Development, Pasargad, the Eghtesad Novin, Tejarat, Mellat, Maskan, Melli, Keshavarzi, and Saderat. In ranking by SFA method the studied banks can be ranked as follows: Eghtesad Novin Bank with an average efficiency of 1.314 wins the first rank and other ranks respectively belong to Mellat, Saman, Saderat, Melli, Parsian , Karafarin, Sepah, Tejarat, Pasargad, Industry and Mine, Export Development, Maskan, Refah and Keshavarzi.

To answer the third research question, Pearson correlation test in SPSS software will be used. According to the software output the correlation coefficient by two methods is zero. In other words there is a significant difference of ranking between these two SFA and MEA methods and according to the std. deviation rate for rankings between the two methods - which in the SFA method is equivalent to 2/0 and in the MEA method is equivalent to 4/0 - it can be concluded that SFA method in branches performance evaluating was more accurate and had less error levels. To answer the fourth research question, i.e. how is the impact of various risks (credit, operational, market and liquidity) on the performance,

indicators were selected for each risk and by Eviews software the regression model was estimated for them. But before model estimation and coefficients interpretation, reliability or stability of variables should be evaluated and this was performed by Eviews software by two auto-correlation function (ACF) and Dicke Fuller's unit root test. Results show that the research data are in good reliability and stability level. The estimated models are as follows.

5-1-Credit Risk

To estimate the impact of credit risk on efficiency, three indicators of credit risk were used, including granted facilities to assets ratio, deferred demands to facilities and capital adequacy ratio. By OLS method and Eviews software, for the last six years' data, three indicators and also the average performance value obtained from SFA and MEA methods was used. Table 2 shows the results estimated for the impact of risk on performance.

Table 2: Complementary Results from Estimation of Credit Risk and Performance Models

Independent variables		**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Granted facilities to assets ratio	x1	0.446	0.381	3.718	0.0042
Deferred demands to facilities ratio	x2	-0.124	0.190	3.295	0.0067
Capital adequacy	x3	0.272	0.009	3.514	0.0108
Constant	C	1.116	0.294	3.440	0.0055
R-squared		0.927	Mean dependent var		0.871
Adjusted R-squared		0.006	S.D. dependent var		0.149
S.E. of regression		0.149	Akaike info criterion		-0.752
Sum squared resid		0.243	Schwarz criterion		-0.563
Log likelihood		9.641	F-statistic		8.47
Durbin-Watson stat		1.923	Prob(F-statistic)		0.04

Resource: The researcher's calculations.

Table 2 can be summarized as the following equation:

$$Y_i = 1.116 + 0.446\ X_1 - 0.124\ X_2 + 0.272\ X_3$$

In this correlation y_i is the average performance of SFA, MEA methods. Also independent variable X_1 is granted facilities to asset ratio, X_2 is deferred demand to facilities ratio and X_3 is capital adequacy.

The results from model estimation and other calculations and tests indicate that:

1- t-statistic and its associated probability (Prob) indicate significant correlations between variables of granted facilities to assets ratio, deferred demands to facilities ratio, capital adequacy with 95% confidence level (because t-statistics is higher than 96/1).
2- R^2 statistics indicate that 0.927% of dependant variability changes can be explained by expository variable of the model.
3- High statistic of F model (8.47) indicates the significance of the whole regression.
4- Statistics of Durbin - Watson in the model equal to 1.92 reject the correlation between model components.
5- Explanatory coefficients variable Indicate that:

- there is a significant correlation between granted facility to assets ratio and efficiency. With one unit increase in variable of granted facilities to assets ratio, efficiency will increase as much as 0.4.
- with one unit increase in variable of deferred demands to facilities ratio, efficiency will decrease as much as 0.124.
- with one unit increase in variable of capital adequacy, efficiency will increase as much as 0.27.

5-2- Operational Risk

To estimate the impact of operational risk, similar to credit risk, three indicators of return of asset volatility, stock return volatility and stockholders' equity are used and results are shown in table three.

Table 3: Complementary Results of Performance and Operational Risk Estimation Model

Independent variables		Coefficient	Std. Error	t-Statistic	Prob.
return of asset volatility	x1	-0.0201	0.074	2.274	0.0789
stock return volatility	x2	-0.0005	0.002	2.271	0.0791
stockholders' equity	x3	0.5769	0.051	3.126	0.0284
Constant	c	0.7573	0.073	10.847	0.0000
R-squared		0.876	Mean dependent var		0.871
Adjusted R-squared		0.039	S.D. dependent var		0.149
S.E. of regression		0.146	Akaike info criterion		-0.786
Sum squared resid		0.235	Schwarz criterion		-0.597
Log likelihood		9.893	F-statistic		٨.840
Durbin-Watson stat		1.894	Prob(F-statistic)		0.004

Resource: The researcher's calculations.

Table 3 can be summarized as the following equation:

$$Y_i = 0.7573 - 0.0201\ X_1 - 0.0005\ X_2 + 0.57\ X_3$$

Independent variables are X_1 assets returns volatility, X_2 stock returns volatility and X_3 equity of shareholders in each Bank.

The results from estimation of model and other calculations and tests indicate that:

1- t-statistic and its associated probability (Prob) indicate significant variable of assets returns volatility, stock returns volatility and equity of shareholders in 95% confidence level.

2- R^2 statistics indicate that 0.87% of dependant variability changes can be explained by expository variable of the model.

3- High statistic of F model (8.84) indicates the significance of the whole regression.

4- Statistics of Durbin - Watson in the model equal to 1.894 reject the correlation between model components.

5- Explanatory coefficients variable Indicate that:

- with one unit increase in variable of assets returns volatility, efficiency will increase as much as 0.0201.
- with one unit increase in variable of stock returns volatility; efficiency will decrease as much as 0.0005.
- with one unit increase in variable of stockholders equity, efficiency will increase as much as 0.057.

5-3- Market Risk

For market risk, circumstances were a little different, because market risk is independent from type of the bank due to nature of Iran financial market, Melli Bank was selected as the sample bank and two indicators of market risk include changes in interest rate and changes in exchange rate, and bank efficiency was estimated for the past 6 years which is shown in Table 4.

Table 4: Subsidiary Results from Estimation of Market Risk and Efficiency

Independent variables		Coefficient	Std. Error	t-Statistic	Prob.
Changes of interest rate	x1	-0.171	0.06415	3.241	0.000681
Changes of exchange rate	x2	0.00035	0.00016	2.983	0.075946
Constant	c	1.051	0.071503	9.431	0.011652
R-squared		0.834	Mean dependent var		0.79261
Adjusted R-squared		0.0023	S.D. dependent var		0.13559
S.E. of regression		0.132	Akaike info criterion		-0.71526
Sum squared resid		0.032	Schwarz criterion		-0.54327
Log likelihood		8.321	F-statistic		8.8432
Durbin-Watson stat		2.132	Prob(F-statistic)		0.00364

Resource: The researcher's calculations.

Table 4 can be summarized as the following equation:
$Y_i = 1.051 - 0.171\ X_1 + 0.00035\ X_2$

Independent variables are: X_1 changes of interest rate, X_2 changes of exchange rate.
The results from estimation of model and other calculations and tests indicate that:
1- t-statistic and its associated probability (Prob) indicate significant variable of changes of interest rate, and changes of currency in 95% confidence level.
2- R^2 statistics indicate that 0.83% of dependant variability changes can be explained by expository variable of the model.
3- High statistic of F model (8.843) indicates the significance of the whole regression.
4- Statistics of Durbin - Watson in the model equal to 2.132 reject the correlation between model components.
5- Explanatory coefficients variable Indicate that:

- with one unit increase in variable of change of interest rate, efficiency will increase as much as 0.171.
- with one unit increase in variable of change of exchange rate, efficiency will decrease as much as 0.00035.

5-4- Liquidity risk

To examine the impact of the credit risk on bank performance three indicators of facility to deposit ratio, long-term facilities to long-term

deposits ratio, and cash to deposits ratio was used, and results were similar to Table 5.

Table 5: Subsidiary Results of Estimation Liquidity Risk Model and Performance

Independent variables		Coefficient	Std. Error	t-Statistic	Prob.
Facility to deposit ratio	x1	-0.0028	0.002	2.145	0.2669
Long term facilities to long term deposit ratio	x2	-0.0034	0.002	2.317	0.0909
Cash to deposit ratio	x3	0.2340	0.002	3.142	0.3072
Constant	c	1.2408	0.266	4.664	0.0007
R-squared		0.910	Mean dependent var		0.931
Adjusted R-squared		0.050	S.D. dependent var		0.149
S.E. of regression		0.145	Akaike info criterion		-0.797
Sum squared resid		0.232	Schwarz criterion		-0.608
Log likelihood		9.980	F-statistic		8.310
Durbin-Watson stat		1.940	Prob(F-statistic)		0.003

Resource: The researcher's calculations.

Table 5 can be summarized as the following equation:

$$Y_i = 1.2408 - 0.0028\ X_1 - 0.0034\ X_2 + 0.234\ X_3$$

Independent variables are: X_1 facilities to deposit ratio, X_2 long term facilities to long term deposits ratio X_3 cash to deposit ratio.

The results from estimation of model and other calculations and tests indicate that:

1- t-statistic and its associated probability (Prob) indicate significant explanatory variable of facilities to deposit ratio, long term facilities to long term deposits ratio and cash to deposit ratio in 95% confidence level.

2- R^2 statistics indicate that 0.91% of dependant variability changes can be explained by explanatory variable of the model.

3- High statistic of F model (8.31) indicates the significance of the whole regression.

4- Statistics of Durbin - Watson in the model equal to 1.94 reject the correlation between model components.

5- Explanatory coefficients variable Indicate that:

- With one unit increase in variable of facilities to deposit ratio, efficiency will increase as much as 0.0028.
- With one unit increase in variable of long term facilities to long term deposit ratio, efficiency will decrease as much as 0.0034.

● With one unit increase in variable of cash to deposit ratio, efficiency will increase as much as 0.234.

After specifying models and receiving desired results from research, the need to review the accuracy of models is of high importance. In this research to study the accuracy of obtained models, five tests including: (regression reality test, linear assumption test, White test to diagnose heteroscedasticity, LM test to diagnose serial correlation test and Ramsey test) were used and the results showed that estimation models are not only highly accurate but also are validated for the time period above research time (i.e. the studied six years).

6- Conclusion

The results show that:

▪ With one unit increase in variable of granted facilities to asset ratio, efficiency will increase as much as 0.4.

▪ With one unit increase in variable of deferred demands to facility ratio, efficiency will increase as much as 0.124.

▪ With one unit increase in variable of capital adequacy, efficiency will increase as much as 0.27.

▪ With one unit increase in variable of asset return volatility, efficiency will increase as much as 0.0201.

▪ With one unit increase in variable of stock return volatility, efficiency will increase as much as 0.0005.

▪ With one unit increase in variable of equity of shareholders, efficiency will increase as much as 0.057.

▪ With one unit increase in variable of change of interest rate, efficiency will increase as much as 0.171.

▪ With one unit increase in variable of change of exchange rate, efficiency will increase as much as 0.00035.

▪ With one unit increase in variable of facilities to deposit ratio, efficiency will increase as much as 0.0028.

▪ With one unit increase in variable of long-term facilities to long-term deposit ratio, efficiency will increase as much as 0.0034.

▪ With one unit increase in variable of cash to deposit ratio, efficiency will increase as much as 0.234.

It is needed to mention that long term lack of credit risk management can impose these challenges for banks:

▪ disregarding needed capital adequacy specially when granting facilities to risky tasks.

▪ Impossibility of correct evaluation of bank assets quality.

▪ Liquidity shortage and impossibility of correct evaluation from sources, assumptions, incomes and costs.

▪ Imposing unexpected costs such as deferred demands.

▪ Impossibility of competition with the banks with proper risk management

▪ Impossibility of cash evaluation due to risks and inability of making needed decisions to reduce risks.

▪ Deviation of information needed for managers which lead to non-optimum decisions.

▪ Reduce in interests from non-recognition and receiving incomes.

Also disregarding market risk, optimize combination of exchange portfolio or the state of each exchange in international markets, financial institutes, will impose huge losses for banks. Thus calculating exchange rate risks by banks can decrease the losses from exchange rate volatility. Therefore risk and efficiency in investments have a key role and whenever future events are not fully predictable and some of the events are preferable to other events, risk factor exists. The impact of risk factor on financial status of banks and financial institutes is undeniable and for this reason it potentially can affect on financial decisions.

Liquidity risk in banks can have these outcomes:

▪ Increase of debts to the central bank, in a way that banks have to receive facilities from the national bank to cover the needed liquidity.

▪ Decrease in the value of bank stock market, when banks face liquidity problem, they sell their assets with a lower price than market price to solve the problem, thus with the decrease of assets value, bank stock value will decrease.

▪ Debt to other banks, although currently there is no interbank market in Iran and interbank facility granting is not much common, but this variable can be mentioned as one of the affects of liquidity risk.

▪ Financial security costs, facing liquidity risk make banks to receive higher costs than common market rates to provide financial security. Sometimes interests paid to deposits increase, to increase activity level and

increase the volume of granted facilities or to preserve deposits and prevent their outgo and increase the cost of financial security. This increase in financial security cost from deposits while received profit rate for facilities is stabile or decreased, results to decreases in bank's operational profit.

Furthermore the disadvantage of operational risks that involves different institutes - including banks due to growing usage of technology and increase of relationship between customers and assess markets - is mostly due to internal rubbery, external robbery, institute's process in recruitment and work place security, processes related to customers, products and profession, damages of physical assets and etc.

Using the research results to study the existence or nonexistence of a significant correlation between the presented rankings by both methods, using Pearson correlation coefficient, it is concluded that without considering their calculation advantages in each of SAF and MEA models, using SAF method in efficiency evaluation is relatively superior to MEA method.

7- Suggestions

Regarding the importance of efficiency of banks and also the impact of risk on bank efficiency, these suggestions are offered for future researches:

- Study of the impact of exchange rate risk and other risks such as electronic banking and … on bank efficiency
- Using the more number of input and output for more accuracy in banks efficiency evaluation
- Using other methods and models to calculate efficiency and compare their calculation results
- Study the impact of different risk parameters on efficiency in a more expanded time period to achieve a better accuracy

References

1- Akbarpoor Shirazi, Mohsen. Tahmasebi, Somayeh. Javadian, Nikbakhsh. "Using Data Envelopment Analysis to Evaluate Banks Marketing Efficiency", The First International Marketing Management Conference, 2006.

2- Hejazi, Rezvan. Anvari Rostami, Ali Asghar. Moghadasi, Mina. "Analyzing the total efficiency of Iran Export Development and its Branches Efficiency growth, Using Data Envelopment Analysis (DEA)", Management Journal, Tehran University, Number 1. Autumn and Winter 2010.

3- Sori, Amir Reza, Garshasebi, Alireza, Oryani. Adaptive Comparison of Iran Commercial Banks Using DEA and SFA Methods. Seasonal Journal of New Economy and Commerce. No.8, P 33-60. Spring 2008.

4- Adel, Azar. "Designing the Mathematical Efficiency Evaluation Model Using Data Envelopment Analysis, Journal of "Modare Olom Ensani", Set 6, No. 3, 2004.

5- Fallah Shamsi, Mirfaize. Tehrani, Reza. "Designing and Explanation of Credit risk Model in domestic banking system", "Olom Ejtemaee Va Ensani" journal of Shiraz University. No. 43. Summer 2006.

6- Nassiri, Nasser "Studying banking system efficiency using data envelopment analysis (case study of Keshavarzi Bank", Sientific-Research seasonal journal of economic researches, Economy research department of Tarbiat Modares University, third year, No. 9 & 10, autumn and winter 2004.

7- Beccalli, Elena. "Cross-country comparisons of efficiency:Evidence from the UK and Italian investment firms". Journal of Banking and Finance. 2004.

8- Bonin,John. Wachtel, Paul. Hasan Iftekhar . Banking In Transition Economies, Oxford Encyclopedia of Banking, A. Berger, ... World Scientific Publishing Company, Singapore, 2005.

9- Charnes, A., W.W. Copper and E Rhodes. "Measuring the efficiency" of European journal of Operations Research, 2. 1978.

10- Chiu, Y.-H., Chen, Y.C., "The analysis of Taiwanese bank efficiency: Incorporating both external environment risk and internal risk". Economic Modelling.2009. 26, 456-463.

11- Christoph j. "Express Credit And Bank Default Risk An Application Of Default Predictions Models To Banks From Emerging Market Economics",

International Conference On Emerging Market And Global Risk Management, University Of Westminster, London, UK. 2004.
12- Elisa Luciano and Luca Regis, "Bank efficiency and Banking sector development the case of Italy", Applied mathematics, working paper series, working paper No. 5/2007, February 2007.
13- Fiorentino. Elisabetta. Karmann, A. The cost efficiency of German banks:a comparison of SFA and DEA. Series 2: Banking and Financial StudiesNo 10 .Available at SSRN: http://ssrn.com/abstract=947340 . 2006.
14- González, F. "Bank regulation and risk-taking incentives: An international comparison of bank risk." Journal of Banking and Finance 29, 1153-1184. 2005.
15- Karanu, Stephen, Productivity & Efficiency in the Ghanaian Banking Sector (Using DEA & SFA) (November 24, 2010). Available at SSRN: http://ssrn.com/abstract= 1714293.
16- Lei Sun, Tzu-Pu Chang. "A comprehensive analysis of the effects of risk measures on bank efficiency: Evidence from emerging Asian countries" 2010.
17- Luc Laeven. "Risk and Efficiency in East Asian Banks", POLICY RESEARCH WORKING PAPER, The World Bank Financial Sector Strategy and Policy Department. 1999.
18- Maria Psillaki , Ioannis E. Tsolas, Dimitris Margaritis." Evaluation of credit risk based on firm performance, European Journal of Operational Research 201. 873–881. 2010.
19- Pasiouras, F. Estimating the Technical and Scale Efficiency of Greek Commercial Banks: The Impact of Credit risk, off-Balance Sheet Activities, and International Operations. Research in International Business and Finance 22, 301-318. 2008.
20- Supachet Chansarn "The Relative Efficiency of Commercial Banks in Thailand, DEA Approach" International Research Journal of Finance, 2008.