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Financial Sanctions and Iranian Banks' Performance

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Abstract

In this study, we use Stochastic Frontier analysis approach to estimate cost efficiency, economies of scale, and technological progress among Iranian banks from 1999 to 2012. The results show that there is a marked difference in cost efficiency before and after the recent financial sanctions against Iranian banking industry. Moreover, the results indicate that specialized government-owned banks are less efficient than commercial government owned banks and non-government owned banks after the imposed financial sanctions. Furthermore, we could not find a logical relationship between cost efficiency and Iranian banks' size. Cost reductions attributed to technological progress and economies of scale were greater prior to recent financial sanctions.

Key words: *Cost efficiency, Technological progress, Banking, Sanctions, Iran.*

JEL Classification: *G21.*

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1. Introduction

Researchers and policy makers around the world have devoted a great deal of attention to the financial sectors of both advanced and developing countries over the past two decades. Banking is one of the most important sections of each economy. As the intermediaries of monetary funds, banks are considered as one of the fundamental parts of financial markets along with the stock exchange market and insurance industry (Maleki Nia et al., 2012).

Banking has greater importance in the economy of Iran in comparison with other economies. Because of the inefficiency of capital market in practice, these banks carry the burden of providing long term financial capital. Also, in the process of the releasing of financial markets in order to join the global market, efficiency is a fundamental condition. The Iranian banking sector has undergone significant transformation since deregulation and through the financial banking sanctions sent by US and EU. The United States has tried to shot out Iran banks from international banking system. These efforts have been implemented by the Treasury Department through preventing Iran from accessing the U.S. financial system (on November 6, 2008 the Treasury Department barred U.S. banks from handling any indirect transactions with Iranian banks) and also using punishments to pressure firms to cease doing business with Iran (Katzman, 2012).

The EU financial sanctions exclude Iran from the worldwide messaging system (SWIFT) used to arrange international money transfers, which made international payments very difficult and also constrained other bilateral economic flows (Dizaji & Bergeijk, 2013). Despite these important changes in the banking system, to the best of our knowledge, there has not been any empirical research in relation to the effect of the sanctions on the efficiency and productivity of the Iranian banking industry. However, there exists vast literature examining bank performance in general, and also in countries other than Iran. Moreover, studies concerning the Iranian banking sector have not

been of a comprehensive nature. Most of the researches focused on banking system efficiency have used parametric and nonparametric approaches. Data Envelope Analysis (DEA) is a nonparametric approach that measures efficiency and assumes that there are no random fluctuations present. The Stochastic Frontier Analysis (SFA) methodology is a parametric approach that estimates efficiency and allows for random error to be present. This paper employs stochastic cost frontier productions function using data for a relatively longer time period over 1999-2012.

According to Berger and Humphery (1997), very little of the interbank differences of efficiency scores are correlated with size, market concentration and organizational form. On the other hand, Hermalin and Wallace (1994), Kaparakis et al. (1994), De Young and Nolle (1996) found significant negative relationship between size and efficiency. Other studies, however, report no significant relationship between size and efficiency, such as Cebenoyan et al. (1993), Mester (1993), Berger and Hannan (1995), Berger and Mester (1997). Another purpose of this study is to test the whether bank efficiency scores in the Iranian banking system are correlated with bank size.

In this paper, we estimate cost efficiency among Iranian banks using SFA. In addition, economies of scale and technological progress (TP) are also estimated. This study will add to the literature in three ways: First, it is comprehensive in that we study cost efficiency, technological progress, and economies of scale for the entire Iranian banking sector in both before and after the recent strong financial sanctions. Second, it considers the performance of different categories of Iranian banks by their size and type of ownership before and after the resentment of US and EU sanctions. Comparing cost efficiency, technological progress, and economies of scale by bank ownership class, and asset size, both before and after the recent

banking sanctions will shed some light on how the Iranian banking sector was affected by financial sanctions.

Additionally, we will also shed some light on economies of scale and TP of non-government owned banks versus the commercial government owned banks and specialized government owned banks; and the economies of scale and TP of larger banks versus small and medium size banks. Each of these hypotheses will be analyzed before and after the recent financial sanctions in 2008[1].Third, according to Margono et al. (2010), we employ a flexible Fourier form to obtain a better approximation of the unknown bank cost function for Iranian banks.

In summary, our results show that the strong financial sanctions which have been imposed on Iranian banking system have damaged the Iranian banking system in terms of bank cost efficiency, scale of economies and technological progress. The estimation reveals that the commercial government owned banks display greater cost efficiency than both specialized government owned banks and non-government owned banks almost in every year of the study. Moreover, we also note that there is not a

1. Over the years, sanctions have taken a serious toll on Iran's economy and people. Numerous governments and multinational entities have imposed sanctions against Iran. Following the Iranian Revolution of 1979, the United States imposed sanctions against Iran and expanded them in 1995 to include firms dealing with the Iranian government. The United States has led international efforts to use sanctions to influence Iran's policies, including Iran's uranium enrichment program, which Western governments fear is intended for developing the capability to produce nuclear weapons. In recent years and when nuclear talks between Iran and Western governments were stalled and seen as a failure, they were cited as a reason to enforce stronger sanctions on Iran’s oil exports and financial system. Therefore, it seems that the effects of recent financial sanctions have been more significant than previous ones on Iranian banking system. So the aim of this study is to consider the effects of recent international sanctions on Iranian banking system although the history of sanctions on Iranian economy includes a few decades. So we have divided the time period of this study to two sub-periods namely before the recent strong financial sanctions (1999-2007) and after the recent strong financial sanctions (2008-2012).

logical relationship between the bank size and efficiency in Iranian banking system. Our results further indicate the presence of increasing returns to scale in all types of banks by their ownership before the sanctions but constant returns to scale for specialized government owned in post sanctions period.

Technological progress suggests that on average, Iranian banks benefited from technology in reducing average cost in the pre-sanctions period, but this has changed to be reversing in post sanctions period.

This study is organized as follows: Section 2 includes a brief review of the literature related to the bank efficiencies. Section 3 presents a brief historical discussion of Iranian banking system. Section 4 presents the SFA methodology as applied to our study. Section 5 introduces the data. Empirical results of efficiency, economies of scale, and technological progress estimations are presented in Section 6, and, finally, Section 7 concludes this study.

2. Literature Review

Koopmans (1951) and Debreu (1951) did the initial studies to evaluate the efficiency and performance of units. The fundamental and practical work to recognize the efficiency was done by Farrell in 1957. For the first time, he considered the evaluation of efficiency with parametric method and instead of guessing the production function, viewed the amount of inputs and outputs and considered a frontier for units that is the frontier production function which is considered as an index to measure the efficiency and in fact, it was exhibiting the performance of the best institute in the industry where the other institutes' performance are compared with them. He divided the total (economic) efficiency of production into two subdivision of technical efficiency and allocation (price) efficiency where the technical efficiency indicates the ability of the institute at maximizing production due

to the determined production factors, and the allocation efficiency shows the ability of the institute to use the optimum composition of the production factors due to their prices (Maleki Nia et al., 2012).

Charnes, Cooper and Rhodes (1978) extended the primary evaluation of single input and output to multiple inputs and outputs for the purpose of completing the Farrell's method. This method was developed by them, based on mathematical programming models and was entitled as data envelopment analysis (DEA) and was introduced as an efficient method to evaluate decision making units function (DMUs). After that, CCR method is accomplished and then Banker, Charnes and Cooper (1984) introduce BCC method. This model is used to measure and appoint efficiency of units and also correction of inputs and outputs to upraise the amount of efficiency with regard to variable return to scale.

After Farrell, due to limiting assumption he considered in the production function, the econometrics method was used for evaluating the efficiency, which is known as statistical frontier analysis (SFA).

Stochastic frontier production function was proposed by Aigner, Lowell, and Schmidt. The majority of the studies in the area of efficiency analysis of financial institutions are confined to the banking sector in the United States. However, during the last 10 years, many studies have also been conducted on efficiency of European and Asian banks. The empirical studies using stochastic frontier analysis approach for US banks include Elyasiani and Mehdian (1990), Bauer, Berger, and Humphrey (1993), Kaparkis, Miller, and Noulas (1994), Mester (1996), Berger and Mester (1997), Berger and DeYoung (2001) and Akhigbe and McNulty (2003), among others. Bauer et al. (1993) estimated technical efficiency using two approaches, i.e., stochastic frontier and thick frontier for a panel of 697 US banks from 1977 to 1988. They noted that the average technical efficiency was greater than 80%. Berger and Mester (1997) used a sample of nearly 6000 US banks over the period 1990–1995 and estimated cost and profit efficiencies to be 86% and 50%, respectively. Berger and DeYoung (2001) studied the effects of

geographical expansion on the US bank efficiencies and observed that the small banks would be less efficient when they operated nationally. Akhigbe and McNulty (2003) concluded that from 1990 to 1996 small banks were more profitable than larger banks.

Among the efficiency studies of European banks, Fiyoritino et al. (2006) examine a sample of 34192 German banks between 1993 and 2004. They conclude that non-parametric methods are sensitive to measurement errors. By taking into account variables and indicators that explain banking risks such as default loans as input variables in the DEA, Pasiouras (2008) tried to explain the correlation between risk and efficiency in Greek banking industry and found a significant correlation between these two categories. Ayranci (2010) examined private sector commercial banks in Turkey. The results indicate that foreign banks have displayed greater efficiency compared to domestic banks when financial efficiency is considered alone; domestic and foreign banks have the same efficiency level when the data for general managers are considered; and the annual relative efficiency figures for the sector demonstrate vast amounts of fluctuation during periods of economic crisis, again with or without the data for general managers. Weil (2003) compared the cost performance of Eastern European banks with Western European banks using the average cost ratio measured by total costs divided by total assets. He investigated 640 banks for 1996 and 2000 to analyze the related evolution of banks' performance. Using Fourier-Flexible cost function based on Seemingly Unrelated Regression (SUR) technique, the author concluded that western banks are more cost efficient than eastern banks: the median cost efficiency score is 68.9% for western banks and 54.4% for eastern banks. Moreover, he comes to the conclusion that the efficiency gap between the western and eastern countries is neither explained by differences in environmental variables, nor by differences in risk preferences, but attributable to weak managerial performance in eastern

countries. However, the reduction of the gap during the time suggests that managerial performance of the eastern banks is improving due to foreign involvement in bank ownership.

There have been banking sector efficiency studies for Asian countries as well. Ketkar, Noulas, and Agarwal (2003) investigated 39 Indian banks using DEA methodology (using data from 1990 to 1995) and observed that the overall average efficiency was 64%. Shanmugam and Das (2004) used SFA methodology to estimate efficiency of Indian banks from 1992 to 1999 and noted that efficiency ranged from 30% to 76%. The efficiency of the banking system in Jordan, Egypt, Saudi Arabia and Bahrain has been investigated by Al-Jarrah and Molyneux (2003). Their sample comprised 82 banks over the period 1992-2000. They used the stochastic frontier and Fourier-Flexible (FF) form, based on intermediation approach to estimate profit and cost efficiency levels in the countries under investigation. The banks in each country are divided into four categories; commercial, investment, Islamic, and other financial institutions. Their results indicate that larger banks seem to be more profit efficient in general and the efficiency scores ranged from 56% for investment banks to 75% for Islamic banks. Indeed, based on specialization, Islamic banks are the most profit efficient while investment banks are the least efficient ones. The results show that profit efficiency of Arabic banking system not only has not witnessed significant changes over 1993-99 but also has experienced a fall in 2000.

Hosseini and Soury (2008), evaluated the efficiency of the industrial banking in Iran. They used the facts and figure of 10 government banks; including six commercial banks and four specialized banks. Their results indicate that the industrial banking efficiency in Iran is 76/87 percent. Hijazi et al. (2008), use SBM model to analyze the total efficiency of Export Development Bank of Iran and its branches during 1994 to 2003. They also 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 input variables; and granted facilities, received fees and deposits with and without cost are used as output variables. Their results indicate 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 has a significant correlation with their current ranking with 99% confidence level.

3. The Banking System of Iran

Iran has one of the most highly state dominated banking systems in the world. Rigid controls and government ownership of the financial institutions make Iran one of the few remaining examples of the financial repression. The Central Bank of the Islamic Republic of Iran (CBI) is responsible for the design and implementation of monetary and credit policies concerning the general economic policy of the country. Iranian government-owned banks have been among the largest Islamic banks in the world, comprising seven of the top 10 (Asian Banker Research, 2008).

The direct controls of the central bank over the commercial banks have removed most of their autonomy. Indeed, banks are subject to interest (profit) rate ceilings for both deposits and loans and to direct controls on the allocation of loans among different sectors and to public enterprises according to the yearly budget laws and the related notes. Since these regulatory inefficiencies prevent banks from pricing their financing facilities efficiently, they have not developed risk management and credit appraisal expertise appropriately and because of the administrative allocations, Iranian banks have faced with rampant loan defaults which have increased the vulnerability of the system to potential banking panics. The defects of the current regulatory arrangement have raised the operating costs and inhibited innovation and proper risk management. The system has not been able to

keep up with international standards and suffers from the lack of diversified portfolio and instruments. The clearing system introduced in 2001 has made worse interbank credit risks by building in automatic interbank overdraft facilities from banks that are net creditors to those that lack the liquidity to meet their clearing obligations. Government-owned banks are notoriously liable to make bad loans, partly due to difficulties for their managers to resist political pressures to lend at low interest rates to interest groups and partly because of the fact that projects are not chosen based on cost-benefit analysis, but according to the budget law (Kalbasi Anaraki and Hasanzadeh , 2003). After the victory of the Islamic revolution in Iran all banks were incorporated and 10 publicly-owned banks (governmental) were established. Until 2001, only these 10 banks worked and the atmosphere was not competitive. In 2000s formulating the five-year plan of economic development, the parliament considered and approved the need for establishment of private banks. Until 2000 all Iranian banks were publicly-owned and they worked by similar rules and provisions (Safari and Zhen Yu, 2014).

During the last decade, the industry has undergone extensive changes due to factors such as increased government regulation and technological advances. Changes in policy have affected both government-owned and private banks. Generally, it appears that government-owned banks have been more noticeably affected by the Iranian government's regulatory initiatives launched in 2005, which obliged all banks to markedly reduce deposit and loan interest rates. The government also imposed different interest rates and conditions on government-owned versus non-government owned banks. For instance, government-owned banks were obliged to assign higher priority in their lending operations to areas such as advanced technology projects, small and medium-sized enterprises and housing projects for low-income earners. As a result, government-owned banks raised their loans and advances to the private sector by 30 percent and 29 percent in 2006 and 2007, respectively. According to CBI (2008) the share of the private sector in total loans and

advances increased from 90 percent in 2005 to 93 and 94 percent in 2006 and 2007, respectively. However, the level of non-performing loans (NPLs) of government-owned banks increased considerably in the same period. According to CBI (2005, 2007), the ratio of government owned banks' NPLs to their total loans was approximately 5 percent in 2005, but this number increased to 10.4 and 9.7 percent in 2006 and 2007, respectively. Hence, it seems that government control of the government-owned banks has tended to limit the ability of managers to allocate their resources efficiently and to operate at an efficient scale (Arjomandi et al., 2012).

The most recent challenge for Iranian commercial and financial system consists of the US and UN sanctions in an effort to promote policy change in Iran regarding its nuclear program. Several major Iranian banks are under U.S. and U.N. sanctions. On October 25, 2007, the U.S. Treasury designated Bank Saderat, a major Iranian government-owned financial institution, for terrorism support[1]. On January 9th, 2007, the Treasury sanctioned Bank Sepah, a major Iranian financial enterprise. U.N. Security Council Resolution 1747 named Bank Sepah and Bank Sepah International as financial institutions involved in financing nuclear or ballistic missile activities. On October 25th, 2007, the Treasury sanctioned Bank Melli Iran and Bank Mellat, other major Iranian financial institutions, as WMD proliferators or supporters. In June 2008, the European Union also decided to sanction Bank Melli Iran. On March 12, 2008, Treasury sanctioned the Bahraini Future Bank B.S.C. for reportedly assisting in Iran's nuclear and missile programs. The United States contends that Future Bank B.S.C. is controlled by the embargoed Bank Melli Iran. On October 22, 2008, Treasury designated the Export Development Bank of Iran (EDBI) for providing or attempting to provide financial services to Iran's Ministry of

1. Iranian authorities contend that two external audits of Bank Saderat conducted in Lebanon and London found no evidence of such allegations (Ilias, 2010).

Defense and Armed Forces Logistics (MODAFL). The EDBI is a specialized government-owned financial institution that supports Iran's trade community. Treasury also sanctioned three financial institutions associated with EDBI, two of which are located in Iran and one located in Venezuela. In a move to further restrict Iran's access to the U.S. financial system, the Treasury revoked the "U-turn" license for U.S. financial institutions on November 6, 2008[1] (Ilias, 2010). The United States and some European countries assert that certain Iranian banks and their branches are attempting to circumvent international financial sanctions in order to engage in proliferation-related activity and terrorism financing. Iranian government officials have denied these claims. Financial sanctions reportedly have affected the profitability of Iranian banks and damaged Iran's credit ratings.

4. Methodology

To minimize cost of production, management must decide the appropriate quantities of various inputs that are employed to achieve a given level of output. In terms of output, banks can be viewed as either a producer, or an intermediary. The producer view treats banks as firms that provide services to consumers such as account holders. This approach considers only labor and physical capital as inputs necessary to conduct banking transactions. The intermediary view interprets the bank's role as an agent providing intermediation between borrowers and lenders. This approach treats deposits and borrowed funds in addition to labor and physical capital as inputs used to produce earning assets. Elyasiani and Mehdian (1990) argue that the intermediary approach is more inclusive of total banking cost because the interest expenses associated with deposits are not excluded and because it

1. With respect to Iran, "U-turn" fund transfers are financial transactions that pass through the U.S. financial system only en route from one offshore non-Iranian financial institution for another, conducted for the direct or indirect benefit of the Iranian government, banks, or individuals (Ilias, 2010).

appropriately categorizes deposits as inputs. Therefore, recognizing this advantage, the intermediation approach is applied in this paper.

We need to specify a functional form in order to apply the stochastic frontier approach for estimating the cost efficiency. Choosing the appropriate functional form to estimate bank efficiency is crucial in the face of heterogeneous data. To estimate bank efficiencies many studies have used the Trans log function to represent the technology of production. However, others including Mitchell and Onvural (1996), Berger, Leusner, and Mingo (1997), Altunbas, Evans, and Molyneux (2001), Vennet (2002) and Carbo et al. (2002) have noted that an augmented Trans log function, or a flexible Fourier (FF) form offers a better approximation to the unknown functional form for banks. They indicate that adding trigonometric terms to the Trans log function and forming the flexible function is very effective in mitigating problems of misspecification in an unknown multivariate function (Morgano et al., 2010). In this study we use a flexible Fourier form to represent the cost function for estimation. The flexible Fourier form of the cost function for two output quantities and three input prices used in this study can be presented as follows (Gallant, 1981):

$$
\begin{aligned}
\ln TC = {} & \alpha_0 + \sum_{j=1}^{2} \alpha_{y_j} \ln y_j + \sum_{k=1}^{3} \alpha_{pk} \ln P_k + \alpha_\tau t \\
& + \frac{1}{2}\left\{ \sum_{j=1}^{2}\sum_{l=1}^{2} \alpha_{jl} \ln y_j \ln y_1 + \sum_{k=1}^{3}\sum_{m=1}^{3} \alpha_{Pkm} \ln p_k \ln p_m + \alpha_{\tau\tau} t^2 \right\} \\
& + \sum_{j=1}^{2}\sum_{k=1}^{3} \alpha_{yjpk} \ln y_j \ln p_k + \sum_{j=1}^{2} \alpha_{\tau yj} t \ln y_j + \sum_{k=1}^{3} \alpha_{\tau pk} t \ln p_k \\
& + \sum_{j=1}^{2} \left\{ \beta_j \cos z_j + \delta_j \sin z_j \right\} \\
& + \sum_{j=1}^{2}\sum_{l=1}^{2} \left\{ \beta_{jl} \cos(z_j + z_l) + \delta_{jl} \sin(z_j + z_l) \right\} \\
& + \sum_{j=1}^{2}\sum_{l\geq j}^{2}\sum_{\substack{m\geq l \\ m\neq j}}^{2} \left\{ \beta_{jlm} \cos(z_j + z_l + z_m) + \delta_{jlm} \sin(z_j + z_l + z_m) \right\} + \varepsilon
\end{aligned}
\tag{1}
$$

Where $\ln TC$ stands for the natural logarithm of total cost, $\ln y_j$ is the natural logarithm of j[th] output, j, j = 1, 2; $\ln p_k$ is the natural logarithm of k[th] input price, k, m = 1, 2, 3, and t = 1, 2, 3, . . ., T. z_j are adjusted values of output y_j such that their interval is between 0 and 2π. To avoid end point estimation problems around these limits, Gallant (1981) suggested restricting the span of z_j in the interval of $[0.1\times 2\pi, 0.9\times 2\pi]$. z_j which is calculated by $z_j = 0.2 - \theta_j a + \theta_j \ln y_j$ where

$$\theta_j = 0.9\times 2\pi - 0.1\times 2\pi/(a_j - b_j),$$

a_j and b_j are the maximum and minimum values of $\ln y_j$ respectively. Linear restrictions on Eq. (1) are imposed to satisfy linear homogeneity in input prices:

$$\sum_{k=1}^{3}\alpha_{p_k} = 1, \qquad \sum_{k=1}^{3}\alpha_{p_{km}} = 0 \quad for \quad all \quad m \quad and \quad \sum_{j=1}^{3}\alpha_{y_j p_k} = 0 \quad for \quad all \quad k.$$

These restrictions are carried out by normalizing total cost and two of the input prices by the other input price. In addition to the above restrictions, standard symmetry of the function is also imposed, i.e., $\alpha_{y_{jl}} = \alpha_{y_{lj}} \quad for \quad all \quad j,l \quad , \quad \alpha_{p_{km}} = \alpha_{p_{mk}} \quad for \quad all \quad k,m..$

The error term, ε_{it}, in Eq. (1) is decomposed as $\varepsilon_{it} = u_{it} + v_{it}$ where v_{it} is the random component and u_{it} is the inefficiency component. Following Aigner, Lovell, and Schmidt (1977), it is assumed that v_{it} and u_{it} are independently distributed, v_{it} is distributed as a two-sided normal distribution with zero mean and variance, σ_v^2, while u_{it} is assumed to follow a one-sided distribution. In this paper we assume that u_{it} follows a truncated normal distribution, with mode = μ and variance = σ_u^2. We use Maximum likelihood method to estimate the model in Eq. (1).

Battese and Coelli (1992) extended time invariant efficiency estimation to allow efficiency changes over time. Using time varying cost efficiency in

the cost function is essentially the same as time varying technical efficiency in the production function. However, the error tem in production function estimation is decomposed as $\varepsilon_{it} = v_{it} - u_{it}$ compared to $\varepsilon_{it} = v_{it} + u_{it}$ in cost function estimation. One of the time varying formulations proposed by Battese and Coelli (1992) is $u_{it} = \eta_t u_i$, where $\eta_{it} = \exp\{-\delta(t-T)\}$. Behavior of cost efficiency over time can be summarized from the parameter estimate δ. If $\delta > 0$, cost efficiency increases at a decreasing rate; if $\delta < 0$ cost efficiency decreases at an increasing rate; and if $\delta = 0$ cost efficiency remains constant. Cost efficiency estimates under the time varying assumption can be obtained by the minimum mean square- error predictor (Kumbhakar & Lovell, 2000: p. 170):

(2)

$$CE_{it} = E\left[\exp(-u_{it}) \mid \varepsilon_i\right] = \left[\frac{1-\phi(\eta_t\sigma_* - (\mu_{*i}/\sigma_*))}{1-\phi(-(\mu_{*i}/\sigma_*))}\right]\exp\left\{-\eta_t\mu_{*i} + 0.5\eta_t^2\sigma_*^2\right\}$$

Where

$$\mu_{*i} = -(\mu\sigma_v^2 - \eta'\varepsilon_i\sigma_u^2)/(\sigma_v^2 + \eta'\eta\sigma_u^2)$$
$$\sigma_*^2 = \sigma_u^2\sigma_v^2/(\sigma_v^2 + \eta'\eta\sigma_u^2)$$
$$\eta' = (\eta_1\eta_2\eta_3\eta_4 ... \eta_T)$$

and $\phi(.)$ stands for standard normal cumulative distribution function.

The economy of scale measure is used to gain information concerning how banks manage their average costs related to proportional change in their outputs. We can estimate the scale economies (SE) by summing the partial derivatives of total cost with respect to each output quantities.

Note that if SE is greater than 1, banks exhibit decreasing returns to scale; if SE is equal to 1, banks exhibit constant returns to scale; finally if SE

is less than 1, banks exhibit increasing returns to scale. Economies of scale exist if a proportional increase in all outputs leads to a less than equal proportional increase in average cost. From the cost function in (1), technological progress can also be estimated. The rate of technical progress is provided by:

$$
\begin{aligned}
SE &= \sum_{j=1}^{2} \frac{\partial \ln TC}{\partial \ln y_j} \\
&= \sum_{j=1}^{2} \alpha_{y_j} + \sum_{j=1}^{2}\sum_{l=1}^{2} \alpha_{y_{jl}} \ln y_j + \sum_{j=1}^{2}\sum_{k=1}^{3} \alpha_{y_j p_k} \ln p_k + \sum_{j=1}^{2} \alpha_{\tau y_j} t \\
&+ \sum_{j=1}^{2} \theta_j \left\{ -\beta_j \sin z_j + \delta_j \cos z_j \right\} \\
&+ \sum_{j=1}^{2}\sum_{l=1}^{2} \theta_j \left\{ -\beta_{jl} \sin(z_j + z_l) + \delta_{jl} \cos(z_j + z_l) \right\} \\
&+ \sum_{j=1}^{2}\sum_{l\geq j}^{2}\sum_{\substack{m\geq l \\ m\neq j}}^{2} \theta_j \left\{ -\beta_{jlm} \sin(z_j + z_l + z_m) + \delta_{jlm} \cos(z_j + z_l + z_m) \right\}
\end{aligned}
\tag{3}
$$

$$
TP = \frac{\partial \ln TC}{\partial t} = \alpha_\tau + t\alpha_{\tau\tau} + \sum_{j=1}^{2} \alpha_{\tau y_j} \ln y_j + \sum_{k=1}^{3} \alpha_{\tau p_k} \ln p_k \tag{4}
$$

Following Baltagi and Griffin (1988), technological progress (TP) exists when TP is negative and technological regress is implied by positive TP. The major components contribute to technological progress are: pure technological progress $\alpha_\tau + t\alpha_{\tau\tau}$; scale augmenting technological change, $\sum_{j=1}^{2} \alpha_{\tau y_j} \ln y_j$, which represents change due to modifications of production scale; and non-neutral technological change $\sum_{k=1}^{3} \alpha_{\tau p_k} \ln p_k$.

5. Data

Statistical population of this study is the banking system of Iran during 1999 to 2012. Required data has been extracted from the reports of banks' balance-sheets and financial reports from Central Bank of Iran. We use unbalanced panel data for 21 Iranian banks (Melli Iran, Tejarat, Saderat, Mellat, Sepah, Refah, Maskan, Keshavarzi, Industry and Mine, Export Development, Parsian, Pasargad, Karafarin, Eghtesad Novin, Saman, Ansar, Post Bank, Day, Sarmayeh, Sina, and Shahr Bank) with 3 different types of ownership including commercial government-owned banks, specialized government-owned banks and non-government owned banks[1]. Total cost incurred by a bank is the dependent variable (TC) in the cost function model to be estimated. Outputs y_1 and y_2 are the values of loans and the values of investments respectively. Price of labor (p_1) is total labor expense divided by the number of persons employed by the bank. Price of capital (p_2) is equal to the total depreciation divided by total fixed assets. Price of funds (p_3) is interests paid to deposits divided by volume of deposits.

6. Empirical Results

The strong financial sanctions against Iranian banking system almost after 2008 have caused the years of relatively poor performance in Iranian banking sector. Severe depreciation of Iranian currency in combination with several bank closures was significant among the events leading to a loss of confidence in the banking industry. There has been overwhelming

1. Parsian, Pasargad, Karafarin, Eghtesad Novin, Saman, Ansar, Post Bank, Day, Sarmayeh, Sina, and Shahr banks have been considered as non-government owned banks. Moreover some of the previously commercial government owned banks, such as Tejarat, Saderat, Mellat and Refah has started the privatization in recent years. We take into account this point in our estimations as well. Maskan, Keshavarzi, Industry and Mine and Export Development banks are specialized government owned banks.

difficulties encountered by the Iranian financial sector after 2008, hence it is quite appropriate to fit separate cost frontiers before and after 2008. We use Frontier 4.1 software (Coelli, 1996) to estimate the modified trans-log cost frontier depicted in Eq. (1). Parameter estimates for the cost frontier from each time period considered (1999–2007, 2008–2012 and 1999-2012) are presented in Table 1.

Table 1: Parameter estimates for flexible Fourier cost function

Variable	Parameter	1999-2007 (estimate)	2008-2012 (estimate)	1999-2012 (estimate)
Intercept	α_0	3.068**	12.262**	3.61**
$\ln y_1$	α_{y_1}	0.294*	-1.947**	-0.184
$\ln y_2$	α_{y_2}	0.339**	0.293	0.536**
$\ln p_1$	α_{p_1}	1.570**	0.334	1.152**
$\ln p_2$	α_{p_2}	-0.658*	1.469**	-0.219
t	α_t	-0.352*	1.453**	0.145
$0.5\ln y_1 \ln y_1$	$\alpha_{y_{11}}$	0.095**	0.345**	0.093**
$0.5\ln y_2 \ln y_2$	$\alpha_{y_{22}}$	0.083**	0.077	0.037
$\ln y_1 \ln y_2$	$\alpha_{y_{12}}$	-0.087**	-0.079	-0.078**
$0.5\ln p_1 \ln p_1$	$\alpha_{p_{11}}$	-0.018	0.206	0.030
$0.5\ln p_2 \ln p_2$	$\alpha_{p_{22}}$	-0.095	0.292	0.073
$\ln p_1 \ln p_2$	$\alpha_{p_{12}}$	-0.002	-0.221	-0.122**
$0.5t^2$	α_{tt}	0.126**	0.042	-0.031**
$\ln y_1 \ln p_1$	$\alpha_{y_1p_1}$	0.031	0.251**	-0.055
$\ln y_1 \ln p_2$	$\alpha_{y_1p_2}$	-0.061	-0.216**	0.004
$\ln y_2 \ln p_1$	$\alpha_{y_2p_1}$	-0.093**	-0.347**	0.038
$\ln y_2 \ln p_2$	$\alpha_{y_2p_2}$	0.123**	0.167	-0.026
$t\ln y_1$	α_{ty_1}	-0.053*	-0.234**	0.029
$t\ln y_2$	α_{ty_2}	0.029**	0.115**	0.005
$t\ln p_1$	α_{tp_1}	-0.091**	0.083	-0.045**
$t\ln p_2$	α_{tp_2}	0.062**	0.077	0.052**
$\cos(z_1)$	β_1	-0.009**	0.007	-0.012
$\sin(z_1)$	δ_1	-0.020	-0.071*	-0.085**
$\cos(z_2)$	β_2	0.095*	0.075	0.087**

Variable	Parameter	1999-2007 (estimate)	2008-2012 (estimate)	1999-2012 (estimate)
$\sin(z_2)$	δ_2	0.010	-0.025	0.062
$\cos(z_1+z_1)$	β_{11}	0.053	-0.018	0.051
$\sin(z_1+z_1)$	δ_{11}	-0.009	-0.066	0.033
$\cos(z_2+z_2)$	β_{22}	-0.023	0.109**	-0.021
$\sin(z_2+z_2)$	δ_{22}	0.076	0.034	0.041
$\cos(z_1+z_2)$	β_{12}	-0.049	-0.056	-0.059
$\sin(z_1+z_2)$	δ_{12}	0.060	0.020	0.042
$\cos(z_1+z_1+z_2)$	β_{112}	-0.022	0.021	-0.04
$\sin(z_1+z_1+z_2)$	δ_{112}	-0.086*	0.026	-0.049

Note: The estimates of the flexible Fourier cost function model given in Eq. (1) are obtained by the maximum likelihood method, using Frontier 4.1 software.
* Marginally significance at 5% levels.
** Strongly significance at 5% levels.

6.1. Efficiency analysis

To save space, the analysis presented here is based on annual averages across the Iranian banking sector. Table 2 reports cost efficiency for all banks by type of ownership for both the pre-sanctions period and the post-sanctions period, while Table 3 presents cost efficiencies by bank asset size for the mentioned periods. In the pre-sanctions period, the average cost efficiency is 34.524, while in the post-sanctions period it is 1.9. This indicates that Iranian banks were operating much closer to the frontier prior to the disruption which accompanied the recent financial sanctions.

Cost efficiency of the Iranian banks decreased at an annual average rate of 1.3% during the pre-sanctions period. In 2003 the cost efficiency improved by 45.24% but by 2007 the annual rate decreased by 4.6%. In the post-sanctions period, the cost efficiency of banks is much lower than the pre-sanctions period. Moreover, the reductions in efficiency after 2008 even at an upper average annual rate of 3.6% are apparent. Decreases in efficiency averaged to 3.6% from 2008 through 2012.

Table 2: Cost efficiency of banks by type of ownership.

Year	All banks	Commercial government-owned banks	Specialized government-owned banks	Non-government owned banks
1999	38.306	50.375	20.204	-
2000	36.696	48.181	19.469	-
2001	29.823	46.106	18.770	3.079
2002	28.614	44.144	18.105	3.041
2003	41.560	77.003	17.472	3.622
2004	39.538	73.045	16.869	3.570
2005	33.606	69.337	16.190	3.462
2006	32.029	65.863	15.746	3.412
2007	30.547	62.605	15.149	3.363
Average (pre-sanctions)	34.524	59.628	17.552	3.364
2008	2.107	2.134	2.686	1.691
2009	1.876	1.957	1.143	1.586
2010	1.871	1.925	1.139	1.721
2011	1.839	1.895	1.136	1.888
2012	1.810	1.865	1.132	1.856
Average (post-sanctions)	1.900	1.955	1.447	1.748

Note: This table compares the average cost efficiencies of commercial government-owned banks, specialized government-owned banks, non-government owned banks among themselves and with all banks before and after the sanctions [Eq. (2)].

Commercial government-owned banks display greater cost efficiency than both specialized government-owned and non-government owned banks in every year of the study (the exception is for 2008 which specialized government owned banks have the greatest cost efficiency). Non-government owned banks show the lowest cost efficiency of all three bank types over the entire pre sanctions time period considered here.

Comparing cost efficiency among ownership types before and after the sanctions provides some insight concerning the degree of damage sustained. In the pre-sanctions period, average cost efficiency was 59.62, 17.55 and

3.64 for commercial government-owned, specialized government-owned, and non-government owned banks respectively while the average for all banks was 34.52. After the sanctions, average cost efficiency was 1.95, 1.44 and 1.74 for commercial government-owned, specialized government-owned, and non-government owned banks respectively. All bank ownership types exhibit decreased efficiency in the post-sanctions period. Cost efficiency gaps between the two periods are 57.67 for commercial government-owned banks, 16.1 for specialized government-owned banks, and 1.61% for non-government owned banks. It is apparent that non-government owned banks maintained cost efficiency through the sanctions to greater degree than government-owned banks. By comparing the cost efficiency among specialized government owned banks, we note that these banks are relatively less cost efficient in the post-sanctions period. Prior to the sanctions, non-government banks have the lowest cost efficiency while in the post-sanctions period, their position improved and their average performance in terms of cost efficiency is better than specialized banks. The commercial government owned banks show the highest cost efficiency both before and after the sanctions on average. These observations support the notion that commercial government owned banks are relatively efficient compared to specialized government-owned and non-government owned banks. This is comparable to the Altunbas et al. (2001) study of German banks, which found no evidence that private banks are more efficient than public banks.

Estimates of cost efficiency by bank size are presented in Table 3. Banks are divided into five categories based on their annual average total fixed assets over the last 8 years of this study[1]. These categories are defined as follows: less than 1500 billion Rials; from 1500 to 6500 billion Rials; from 6500 to 11500 billion Rials; from 11500 to 16500 billion Rials; and greater

1. There is a more consistent data for this variable over this time period.

than 16500 billion Rials in fixed assets. On average, banks with assets less than 1500 billion Rials are most efficient in pre sanctions period.

Table 3: Cost efficiency of banks by asset size

Year	<1500*	1500-6500*	6500-11500*	11500-16500*	>16500*
1999	7.666	13.327	54.023	28.225	61.416
2000	7.497	12.941	51.710	27.161	58.614
2001	7.333	7.824	49.52	26.15	55.97
2002	7.174	7.627	47.445	25.187	53.474
2003	99.105	6.646	45.479	24.270	51.117
2004	93.308	6.491	43.615	23.397	48.889
2005	87.911	5.485	41.846	22.565	46.783
2006	82.892	5.367	40.167	21.772	44.790
2007	78.214	5.253	38.573	21.016	42.904
Average (pre-anctions)	52.344	7.884	45.819	24.415	51.550
2008	1.553	1.538	4.272	1.605	2.884
2009	1.311	1.568	2.651	1.239	2.806
2010	1.390	1.745	2.593	1.233	2.733
2011	1.379	1.719	2.538	1.227	2.664
2012	1.369	1.694	2.485	1.222	2.599
Average (post-sanctions)	1.400	1.652	2.907	1.305	2.737

Note: This table compares the average cost efficiencies among different bank sizes before and after the sanctions. Banks are divided into five categories based on their assets in billion Rials [Eq. (2)].

*Billion Rials

This may help to explain low efficiency among small banks. On average, banks with annual assets from 6500 to 11500 billion Rials are the most efficient in the post-sanctions period at 2.907. In both the pre and post-sanctions periods, banks with annual fixed assets more than 16500 billion Rials at 51.55 and 2.73 respectively are the second most efficient banks.

Bank efficiency studies for other countries, e.g., Turkish banks (Kasman, 2002), German banks (Altunbas et al., 2001), European banks (Carbo et al., 2002), and Italian banks (Girardone et al., 2004) present little evidence of relationship between cost efficiency and bank size. However, our results indicate that although smaller and larger banks are more cost efficient than

mid-size banks in Iran during the pre-sanctions period, middle sized banks with assets between 6500 and 11500 billion Rials show better performance during the post sanctions period in comparison with other categories.

6. Economies of scale

Iranian banks revealed evidence of increasing returns to scale from 1999 to 2012. As reported in Table 4, for all banks on average, the scale economies (SE) are less than one almost in every year of the study (the exception is 2009 which its related amount is 1.074). Note that scale economies are interpreted as the percentage change in cost associated with a 1% change in bank output. The economies of scale for all banks varied from 0.21 to 0.46 before the sanctions and from 0.37 to 1.07 after the sanctions. The average SE factor was 0.36 and 0.67 in the pre- and post-sanctions periods respectively. Prior to the sanctions, a 1% increase in output would raise predicted cost by 0.36%. After the sanctions, predicted cost would increase 0.67% in response to 1% increase in output.

For commercial government-owned banks, specialized government-owned banks, and non-government owned banks the SE in the pre-sanctions period averaged 0.29, 0.63, and 0.13, respectively. In the post-sanctions period estimates of SE averaged 0.68 for commercial government-owned banks, 0.99 for specialized government-owned banks, and 0.61 for non-government owned banks. These results indicate the presence of increasing returns to scale in commercial government owned banks and non-government owned banks but near constant returns to scale for specialized government-owned banks. Comparing SE before and after the sanctions, we are able to determine that increases in output add more to the cost in the post-sanctions period for both government and non-government owned banks. Over the post-sanctions period, SE for commercial government-owned banks and non-government owned banks were 0.68 and 0.61

respectively. Therefore, during this period, a 1.0% increase in outputs would raise predicted average cost by 0.68% for commercial government-owned banks, and by 0.61% for non-government owned banks. Furthermore, specialized government owned banks, on average, exhibit constant returns to scale in post-sanctions period. Perhaps this can be explained by the notion that specialized banks adhere to more stringent business practices than other types of banks, leading to higher costs.

Table 4: Economies of scale of banks by type of ownership

Year	All banks	Commercial government-owned-banks	Specialized government-owned-banks	Non-government owned banks
1999	0.443	0.235	0.755	-
2000	0.301	0.375	0.191	-
2001	0.216	-0.134	0.762	0.178
2002	0.462	0.570	0.794	-0.522
2003	0.390	0.422	0.898	-0.172
2004	0.386	0.320	0.158	0.730
2005	0.360	0.114	0.699	0.421
2006	0.287	0.110	0.747	0.187
2007	0.454	0.613	0.685	0.115
Average (pre-sanctions)	0.366	0.291	0.632	0.133
2008	0.563	0.543	0.703	0.494
2009	1.074	1.482	1.864	0.822
2010	0.374	1.531	-0.537	0.142
2011	0.811	0.007	0.728	1.037
2012	0.538	-0.150	2.231	0.572
Average (post-sanctions)	0.672	0.682	0.997	0.613

Estimates of SE are presented by bank size in Table 5. On average, the banks in all five categories show economies of scale before the sanctions period. After 2008, banks with assets between 6500 and 11500 billion Rials operated under diseconomies of scale on average while banks in other categories exhibited economies of scale. Economies of scale among smaller and larger banks are evident both before and after the economic sanctions.

The economies of scale factor for banks with assets less than 6500 billion Rials averaged 0.411 and 0.59 in the pre-sanctions and post-sanctions periods respectively. Similarly, the SE factor for banks with assets more than 11500 billion Rials in the pre-sanctions and post-sanctions periods averaged 0.27 and 0.82, respectively. This indicates that the smaller banks had a better performance in terms of returns to scale during the sanctions period.

Table 5: Economies of scale of banks by asset size

Year	<1500*	1500-6500*	6500-11500*	11500-16500*	>16500*
1999	0.980	0.314	1.363	-1.113	0.775
2000	-0.893	1.172	-0.596	0.339	0.693
2001	0.864	0.445	0.933	-0.212	-0.497
2002	-0.083	0.432	1.450	1.151	-0.431
2003	0.835	-0.274	-0.215	0.938	1.095
2004	0.428	0.937	-0.289	-0.650	0.568
2005	0.562	0.438	0.249	0.819	-0.254
2006	-0.123	0.402	0.171	0.113	0.622
2007	0.942	0.037	1.227	0.830	0.174
Average (pre-sanctions)	0.390	0.433	0.477	0.246	0.305
2008	0.314	0.42	1.335	-0.076	1.061
2009	1.290	0.994	1.195	0.689	1.054
2010	0.070	-0.095	1.265	1.835	0.938
2011	1.067	0.754	0.693	1.600	0.358
2012	0.588	0.566	0.772	0.427	0.373
Average (post-sanctions)	0.665	0.527	1.052	0.895	0.756

6.3. Technological progress

Estimates of technological progress (TP) (reported in Tables 6 and 7) indicate that during the pre-sanctions period Iranian banks on average recorded advancing technological progress. From 1999 to 2007, technological progress resulted in a reduction of average cost by 3.4%. On

the other hand, technological progress in the post-sanctions period was in regress. From 2008 to 2012, this technological regress resulted in a 21.1% increase of total cost. During this period Iranian banks could not benefit from technological progress. The yearly TP estimates suggest the maximum reduction in total cost on average due to technological progress occurred in the first year of this study. In 1999, total cost in the banking sector was reduced 42.9% due to technology advances. Contrarily, technological regress in the post-sanctions period resulted in a 31.5% increase of banking sector total cost in 2011.

Estimates of technological progress among bank ownership types are presented in Table 6. Technological progress among the three types suggests that government-owned (both commercial and specialized) banks benefited from technology in reducing average cost in the pre-sanctions period. The impact of technological progress on cost reduction was 6.4% for commercial government-owned banks, and 19% for specialized government-owned banks during this period. In the post-sanctions period, only specialized government owned banks were able to realize cost reductions from technological progress. Over this time frame, commercial government-owned banks, and non-government owned banks faced increased average costs by 26.9%.

Table 6: Technological progress of banks by type of ownership

Year	All banks	Commercial government-owned banks	Specialized government-owned banks	Non-government owned banks
1999	-0.429	-0.448	-0.400	-
2000	-0.357	-0.366	-0.343	-
2001	-0.200	-0.265	-0.230	0.055
2002	-0.107	-0.147	-0.096	-0.014
2003	-0.056	-0.138	-0.004	0.036
2004	0.092	0.095	0.058	0.120
2005	0.175	0.221	0.166	0.126
2006	0.232	0.177	0.283	0.263
2007	0.336	0.288	0.391	0.355
Average (pre-sanctions)	-0.034	-0.064	-0.19	0.134
2008	0.097	0.072	0.008	0.187
2009	0.105	0.238	-0.424	0.121
2010	0.259	0.274	-0.367	0.313
2011	0.315	0.409	-0.587	0.371
2012	0.281	0.353	-0.748	0.355
Average (post-sanctions)	0.211	0.269	-0.423	0.269

Note: This table compares the technological progress (TP) estimates of commercial government owned banks, specialized government owned banks and non-government owned banks among themselves and with all banks before and after the sanctions [Eq. (4)].

Table 7: Technological progress of banks by asset size

Year	<1500*	1500-6500*	6500-11500*	11500-16500*	>16500*
1999	-0.397	-0.337	-0.462	-0.466	-0.454
2000	-0.349	-0.276	-0.351	-0.401	-0.388
2001	-0.223	-0.053	-0.286	-0.289	-0.272
2002	-0.122	-0.044	-0.207	-0.104	-0.122
2003	-0.128	0.035	-0.271	0.005	-0.035
2004	0.064	0.106	0.143	0.027	0.107
2005	0.193	0.139	0.232	0.159	0.212
2006	0.313	0.265	0.134	0.167	0.183
2007	0.390	0.374	0.261	0.252	0.299
Average (pre-sanctions)	-0.028	0.023	-0.089	-0.072	-0.052
2008	0.265	0.109	0.085	-0.096	0.039
2009	0.328	-0.019	0.131	-0.038	0.087
2010	0.493	0.184	0.216	0.089	0.170
2011	0.556	0.236	0.257	0.133	0.231
2012	0.527	0.204	0.231	0.118	0.180
Average (post-sanctions)	0.433	0.142	0.184	0.041	0.141

Note: This table compares the technological progress (TP) estimates among these five different bank sizes before and after the sanctions (estimates based on Eq. (4)).

*Billion Rials

Examining technological progress (TP) by bank size reveals that TP existed almost for all categories (exception is for the banks with assets between 1500 and 6500 billion Rials) prior to the economic sanctions. TP estimates for each bank size category are presented in Table 7. The biggest reduction in cost in terms of TP stands for the middle size banks (with assets

between 6500 and 11500 billion Rials) prior to the sanctions. Larger banks (with assets more than 11500 billion Rrials) reduced cost more as the result of TP than smaller banks (with assets less than 6500 billion Rials) in the pre sanctions period. In the post-sanctions period, there is an absence of cost reduction due to TP among Iranian banks in all size categories. This lack of TP or technological regress is also associated with bank size. Smaller banks (with assets less than 6500 billion Rials) exhibit more technological regress than larger banks (with assets more than 11500 billion Rials) during the post-sanctions period. Banks with assets less than 1500 billion Rials faced increased cost by 43.3% on average during the period after the economic sanctions while banks with more than 16500 billion Rials and between 11500 and 16500 billion Rials in assets faced increased cost by 14.1% and 4.1% respectively during the same period.

7. Summary and Conclusion

In this study we investigated cost efficiency, economies of scale, and technological progress among Iranian banks before and after the recent financial sanctions in 2008 in order to consider the effects of sanctions on the performance of Iranian financial institutes. To the best of our knowledge there has not been any empirical research in relation to the effect of the sanctions on the efficiency and productivity of the Iranian banking industry. Moreover, this study has a comprehensive nature in that we study cost efficiency, technological progress, and economies of scale for the entire Iranian banking sector in both before and after the recent strong financial sanctions.

The results show that generally in the post-sanctions period, the cost efficiency of banks is much lower than the pre-sanctions period. Commercial government-owned banks display the greatest cost efficiency among Iranian banks both before and after the sanctions. While the non-government owned

banks have the lowest cost efficiency prior to the sanctions period this position stands for specialized government-owned banks in the post sanctions period. Estimates of cost efficiency by bank size show that although the banks with smallest size exhibit the highest cost efficiency before the financial sanctions but the banks with middle size show better performance than smallest and largest banks during the sanctions period.

Also in terms of scale economies our empirical results show that the Iranian banks have better performance before the sanctions and sanctions have affected the Iranian banks by lowering their scale economies. While all types of banks show increasing return to scale in pre sanctions period, specialized government owned banks have lost this advantage during the sanctions period and exhibit constant returns to scale. Estimates of SE by bank size also encourage our findings. The banks in different categories by their size show better performance in terms of SE before imposition of financial sanctions. While the banks with different sizes show increasing return to scale during the pre-sanctions period, this change for the banks with middle size and these banks exhibit decreasing return to scale in post sanctions period.

The Iranian banking sector benefited from technological progress in the period between 1999 and 2007. Cost reduction due to technological innovation averaged to 3.4% in the pre-sanctions period. This technological progress was consistent among bank ownership types and size categories. In the post-sanctions period from 2008 to 2012, there has been no cost reduction attributable to technological progress. All in all, the results of this study indicates that the financial sanctions have considerable effects on Iranian banking system so that they have worsened the performance of them respecting their cost efficiency, technological progress and scale of economies.

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