Impact of Information and Communication Technology (ICT) on Efficiency: Evidence from the Iranian Banking Industry

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Abstract: The main objectives of this paper are to measure the technical efficiency levels of Iranian banks and to investigate the degree of factors influence on the efficiency in these banks. Stochastic frontier analysis (SFA) methods are applied to bank-level data over 22 years (from 1995 to 2011). We find that publicly-owned banks obtain average technical efficiencies of 0.73, which is lower than privately-owned banks, which achieve average technical efficiencies of 0.83. Our empirical results indicate that components of ICT (Software Investment, IT services, except Hardware Investment) and ownership, bank size have a significant influence on technical efficiency levels. We also found that privately-owned banks due to type of governance structure have successful performance in effective use of ICT components, compared to publicly-owned banks.

Key words: Information and communication technology (ICT) • Efficiency • Banking industry • Electronic banking (E-banking) • IT investment • IT services • Hardware investment • Software investment • Outsourcing • Iranian banks

INTRODUCTION

Today information and communication technology (ICT) as an excellent prospect of technology plays a vital role in efficiency of manufacturing firm or a service industry and through components such as cost reduction, products promotion, cheaper distribution channels, direct savings, reduction in supply time, good customer services, production innovation, entering new markets, increase market share, has led to improvement of competitiveness of enterprises. But implementation and development of such a new technology in industrial manufacturing and services firms requires availability of appropriate set of conditions. Absence of these conditions stands in many countries such as Iran which makes use of the advantages of this new technology very limited. This particularly in capital market and in relation to credit and financial resources is very important. Because transaction costs in market reduce financing costs in investment and ultimately lead to cheaper financing and this considered as a motivation for higher economic growth at macro-level. Due to broad and deep impact of ICT on global market and according to importance of monetary and credit transactions in every economic and commercial activity it requires that the tools and infrastructure of money and exchange are synchronized and consistent with the growth of information technology. Banks in order to attract more customers and diversify and expand their services have not been idle. They synchronized and aligned themselves with ICT rapidly. Studies show that values obtained of investments in ICT depends on several factors such as, governance type, organizational structure, management style and competitive environment. On the other hand information technology has intangible benefits such as knowledge promotion, quality improvement, increased coordination and better accountability, that does not have tangible impact on profitability in the short terms. Commercial value of information technology in banking industry topic has a special feature, because banks investments in information technology due to the nature of banking activities, process, management and strategic use of information have grown increasingly. However increasing competition among banks leading to lose their customers, but information technology by facilitate, service definition and new product (diversity)
and increasing efficiency at all levels of banking industry value chain, not only reduce the risk but create competitive advantages.

Before the Islamic revolution in Iran, there were 36 banks and financial institution operational but only five of them were publicly-owned. After the victory of the Islamic revolution in Iran all banks were incorporated and 10 publicly-owned banks (governmental) were established. And until 2001 only these 10 banks worked and the atmosphere was absolutely non-competitive. In 2000s formulating the five-year plan of economic development, the need for establishment of private banks were considered and approved by the parliament. Until 2000 all Iranian banks were publicly-owned and they worked by similar rules and provisions. The process of privatization of banks in Iran strictly followed where the current banking system of Iran includes 11 privately-owned banks and 6 publicly-owned banks. Due to the increasing of privately-owned banks in Iran, a competitive atmosphere was created and caused large changes in banking system. Use of information technology systems, online systems and advanced methods of banking in fact thriving is due to the presence of the privately-owned banks in Iran and publicly-owned banks to keep in competition with privately-owned banks adapted themselves with a new system.

According to the research conducted, Iranian banks continuously spend substantial investment in ICT to keep their position in the competitive environment of banking industry. But type of ownership and governance at Iran’s banking industry, non-competitive nature due to grammatical rules of the banking system has caused that the banks did not consider the ICT as a competitive advantage. And investments in information technology effectively do not reduce costs and do not increase the efficiency of banks.

The purpose of research is to investigate and compare the impact of ICT on efficiency of both publicly-owned and privately-owned banks according to governance structure of banking industry in Iran. And to answer a question with respect to the governance structure of banking industry in Iran that how is the effectiveness of ICT components on efficiency of the banking industry in Iran?.

Literature Review: According to general theories, attraction power and adaptation of an industrial or service firms with the tools and techniques of modern information technology or diffusion acceleration of this modern technology at the industry’s level depends on factors such as: interest rate forecast (saving input, improved efficiency benefits, greater flexibility, better products quality) implementation restrictions (investment costs and unfavorable financial conditions, labor restriction, management, information access) absorption capacity, spillover effects, competition and competitor conditions, size, longevity, market share [1, 2-6].

Studies on effects of ICT on economic performance can be divided into three parts. Studies have been conducted on the micro-level and industry, focused on macro-level and national of a country and international studies. Investigation at micro-level gives the researcher possibility to achieve important points that may not be possible in macro level. Economic growth improvement at macro-level through investment in ICT necessarily does not mean that firms have benefited from similar interests [7, 8]. Sometimes significant social benefits of investment in ICT obtained that lead to enhance consumer welfare; however the producer is not able to capture the returns from investment. On the other hand firms have specific characteristics which cause absorption the benefits of investment in ICT that be different in different firms [9, 10, 11]. Based on searches in electronic documents and resources available in domestic and foreign research, we have tried to investigate the impact of ICT and some of its applications on performance of an economy and or various subsectors such as industry and services. For example the effect of ICT on national productivity, efficiency, profitability and market share, has been done according to analytical methods in different studies [12]. Total works done at micro level in developed countries is more than developing countries. In this part we will examine some of them.

Brynjolfsson and Hitt [13] worked on the effects of ICT on growth in USA. They have been working on a sample of 527 large firms in USA from 1987 to 1994 by using the production function of Cobb-Douglas, in addition to traditional inputs and traditional labor and investment they also have used computer science investment. Then they have extracted an index for TFP. Based on their results, contribution of computerization on productivity growth is positive and significant [13].

Matteucci and Sterlacchini [14] by using traditional production function framework they have analyzed the contribution of ICT and R&D from TFP growth. They observed sample of 1119 Italian firms and the period of study was 1998 -2000. According to the statistics provided R&D activities of private sector is low compared to USA and Europe major countries, However the ICT gap between the countries of European Union and Italy is less [14].
Imran, Abdul et al., (2012) investigated the role of IT on the efficiency of bank and also explored the existence of relationship between the investment in IT and bank efficiency measures. The result showed that investment in information system is contributing towards increase market share, reducing operating cost, improved customer services and assisting the banks in introducing new products and services. These are the major benefits of investment in IT which are propelling many banks to invest in IT. That is the reason that most of the organizations in Pakistan are using the IT as competitive tool [15].

Tim and Prashant et al., (2011) investigated IT business value, IT capabilities and competitive advantage for the companies. Researchers are calling for a more coherent understanding of the firm-level impacts of IT and how those firm-level impacts can be measured. The purpose of their study was to investigate the multitude of organization-level studies of the impact of IT. Researchers’ findings synthesized into an overarching framework of the impact of IT at the organization level. The framework categorized measures of the impact of IT into productivity, profitability and intangible benefits, while the antecedents of IT impact were categorized into IT resources, IT capabilities, IT/business alignment and external factors [16].

This study was conducted by Eyadat and Kozak [17] and evaluated the effect of IT on gains efficiency and banks cost in American banks between 1992-2000. Study showed a positive relationship between level of IT implementation and profitability of the bank's assets and costs reduction. However efficiency has increased for all American banks but the cost efficiency was less than the benefit. This point reflects the fact that introduction of new banking services lead to increase revenues on the other hand offers new and higher expenses [17]. In following a summary of the research and studies offered.

In most studies, ICT as one of the production inputs, logged into the economic production system then analysis and evaluation of its effectiveness will be discussed. Empirical researches on the supply side are divided into three categories:

- Studies and research that have complementary role in effectiveness of ICT on production system: These studies indicate that the effect of increasing investment in ICT on the economy and its subsectors needs a set of supplementary factors such as: professional workforce, corporate restructure, appropriate communication infrastructure [8, 18, 19-23].
- Research to analyze and estimate the impact of ICT and tools derived from it in economic performance or products (quantity and quality). In this studies methods of mathematical economy, statistical, econometric, have been investigated to measure the impact one of the ICT tools on performance, (productivity, efficiency, import & export scale) of a firm or industry [4, 6, 22, 24-27].
- Research, that to clarify a design for theoretical explanation of factors affecting diffusion and or adapting firms and industries with a modern technology emerged from ICT. In this research following theories has been used: (Diffusion of Innovation’Institutional Theory’Resource-Based Theory ‘E-Readiness Model’T)echology Acceptance Model’T)heory of Reasoned Action’T)heory of Planned Behavior’T)echnology- Organization- Environment Model) [1, 2, 28-34]. Somehow this theory are trying to answer a question that under which conditions a firm or industry decides to changing technology or in other word what factors makes a technology used by a firm or industry.

In some of the studies reviewed and by use of econometric models and techniques impact of ICT components has been measured by using of production function estimate. In this method production function of economy and industry will be estimated and investment in ICT used as one of the explanatory variable. Thus, impact of ICT on efficiency and productivity is measured.

**MATERIALS AND METHODS**

The model used in this study was firstly proposed by Battese and Coelli [35]. This model performs prediction of technical efficiency (economics or cost) by using of stochastic frontier production functions estimation. This model assumes that the inefficiency in terms of explanatory variables, indicating that the specific characteristics of each bank is explainable. In this case assumed that banks’ having structural differences to each other and this specific characteristic of each bank is effective on its efficiency. Stochastic frontier cost function for the panel data for this study defined as follow:
\[ C_{it} = F(y_{it}, P_{it}, z_{it}; \beta) + v_{it} + u_{it}, \quad v_{it} = N(0, \sigma^2_v) \]

where \( c_{it} \) is total firms cost, \( i = 1,2,\ldots,N \) time; \( t = 1,2,\ldots,T \), \( y_{it} \) firm's output, \( i \) on \( t \) time, \( P_{it} \) is input cost, \( j \) used in firm, \( i \) for \( t \) time, \( \beta \) model parameters that must be estimated [35]. Since the banking industries have multi-product nature and the relationship between input and output is not very clear, therefore from the perspective of intermediary approach and parametric method to estimate stochastic frontier production functions (cost), Maximum Likelihood method (ML) is used. Inefficiency component of flexible stochastic frontier cost function (translog) that defined by Battese and Coelli [35] model, considered as follows:

\[ \ln T_{it} = \beta_0 + \sum_{q=1}^{3} \beta_q \ln y_{it} + \sum_{q=1}^{3} \sum_{j=1}^{q} \beta_{qj} \ln y_{it} + \sum_{q=1}^{3} \sum_{j=1}^{q} \sum_{k=1}^{j} \beta_{qjk} \ln y_{it} + \alpha_1 \ln P_{it} + \sum_{q=1}^{3} \beta_q \ln y_{it} + \sum_{q=1}^{3} \sum_{j=1}^{q} \beta_{qj} \ln y_{it} + \sum_{q=1}^{3} \sum_{j=1}^{q} \sum_{k=1}^{j} \beta_{qjk} \ln y_{it} + \beta_1 t + \sum_{j=1}^{3} \beta_{jt} \ln p_{jt} \]  

\[ (1) \]

where \( i \) is bank indicator and \( t \) is time indicator; \( \ln T_{it} \) the natural logarithm of total bank cost of the \( i^{th} \) bank in the time \( t \); \( \ln y_{it} \) is natural logarithm of \( q^{th} \) output; \( \ln P_{it} \) the natural logarithm of the \( j^{th} \) input price; \( \beta \) are the coefficients to be estimated; \( t \) is the year of observation which is a proxy to capture any changes that may have occurred during the period included in the study which are not explicitly controlled for in the model. In accordance with economic theory, costs and input prices in Eq. (2) are normalized using one of the variable input prices \( P_{2_i} \) to impose linear input price homogeneity [36]. The \( v_{it} \) are random variables which are assumed to be iid \( N(0, \sigma^2_v) \) sentences error \( i^{th} \) bank in time \( t \) and consist of normal truncated distribution which is defined as follows:

\[ u_i = z_{i} + \delta + \nu_i = \alpha N(z, \delta, \alpha \sigma^2) \]

where \( z_{i} \) is Vector of firm-specific characteristics which are brought directly into the model; \( \nu_i \) variable random with a normal distribution truncated with average of zero and \( \alpha \) variance. \( u_i \) and \( \nu_i \) are independent from each other and \( \delta \) and \( \alpha \) are parameters of \( z_{i} \) that estimated within a model. The time-squared variable and time interacted with each input variable were included in this model to allow for non-monotonic technical change and non-neutral technical change, respectively. Variance parameters \( \sigma^2_z \) and \( \gamma \) can be expressed by \( \sigma^2 = (\sigma^2_z + \sigma^2_\gamma) \) and \( \gamma = \alpha \sigma^2_z / (\sigma^2_z + \sigma^2_\gamma) \). The parameter, \( \gamma \) must lie between 0 and 1 and thus this range can be searched to provide a good starting value for use in an iterative maximization process such as the Davidon-Fletcher-Powell (DFP) algorithm [35]. The Battese and Coelli 1995 models allow us to estimate simultaneously the parameters of the stochastic frontier and bank-specific determinants of inefficiency in one step using maximum likelihood [37]. Therefore, the inefficiency effects \( (u_i) \) in Eq. (1) are specified as:

\[ u_i = \delta + \delta_{Hard In} + \delta_{SoftIn} + \delta_{ITServices} + \delta_{Ownership} + \delta_{Banksize} + \delta_{Year} + w_i \]

\[ (2) \]

where \( z_1 \) rate of investment in software sector; \( z_2 \) rate of investment in hardware sector; \( z_3 \) purchasing services cost rate and outsourcing in IT sector; \( z_4 \) ownership of a dummy variable, that if it is equal to one means privately-owned and if it is equal to zero means publicly-owned; \( z_5 \) bank size variable that indicate total branches of a bank; \( z_6 \) year represents the year of the observation involved.

Both technical change and time-varying technical inefficiency effects have been modeled in the technical inefficiency effects model. The distributional assumptions on the technical inefficiency effects allow the impacts of technical change and time-varying behavior of the technical inefficiency effects to be identified. Addition input, the year variable in the stochastic frontier model account for possible Hicks-Neutral technological change. However, inclusion of the year variable in the technical inefficiency effects model to account for the changes in the technical inefficiency as time increases. The technical inefficiency effects model discussed above is only useful when the inefficiency effects are stochastic and follow a specific distribution [38].

**Data Collection and Analysis**

**Variables:** According to the research objectives, using of two sets of variables in this study is unavoidable. The first sets of variables that are used to measure the efficiency are definite and certain. Most significant variables are data and outputs that known as computational variables. Second sets are independent variables, in order to the research hypothesis they are used to investigate their relationship with efficiency (as independent variable) and they called statistical variables. Both sets of variables are described briefly as
follows: required data has been extracted from the reports of banks account balance and financial reports of Iran’s central bank for the period of (1990-2011), statistic contained 11 privately-owned banks and 6 publicly-owned banks. Researchers are faced with many problems in measuring banks outputs. In comparison to industrial production units, the nature of banks outputs which includes services, also variety of this services makes the measurement very difficult compared to manufacturing units in industries. For example, banks are responsible to give their customers services such as loans, money transfer services and non-monetary services such as jewelry maintenance, accounting services and managed portfolio of investments for customers. Fees or charges for all services provided to customers not receives directly from the customers therefore in this research, intermediary approach is used. In this approach banks are seen as intermediary institutions. According to Molyneux, Yener [39] banks worked as service provider of intermediary services through collecting deposits, debts and convert them into interest-bearing assets such as loans, bonds and other investments. In this approach outputs are utilized in forms of each country’s currency in computations and models. And also banks total costs include interest payments to mobilize deposits, in other word this approach is considered customers deposits as a data. Thus in intermediary approach the data include: investment, labor and deposits (as payments in form of loan) and outputs include total outstanding loans and participation [40]. On the basis of intermediary approach and definitive method mentioned above, variables of this model are divided into three categories data, outputs and prices, in this study TC is bank’s total cost and include: personnel expenses, interest expenses paid to term deposits, fixed assets depreciation expenses, administrative costs and other expenses and it considered as a dependent variable. And also $Y_i$ total volume of loans given, $Y_2$ stocks and bonds and shares, $Y_3$ non-interest incomes logged as a bank’s output in cost function.

For identifying inputs used by banks after reviewing various studies we found that total volume of investment deposits, number of personnel and fixed assets of banks are used as banks inputs. After extraction of above statistic the prices of different inputs are considered in cost function of banks and calculations of inputs price are as follow (it should be noted that the volume of investment in term deposits, total facilities and personnel cost, were adjusted on the basis of implicit price index).

$P_i$ price of labor was acquired from divide the total payments to employees during a year by the total number of employees to determine, the rate of $P_2$ price of funds (actual interest paid to investment on term deposits), the total interest expenses to term deposits divided by remained term deposits (short term- long term) were considered as interest rate of deposits; $P_3$ depreciation cost, total depreciation costs divided by total book value of fixed assets are considered as depreciation rate [36]. The Following Table 1 briefly shows utilized variables in this study.

### Statistical Variables:
As mentioned above, these variables are the main variables of this study and they are divided into two categories of dependent and independent variables: dependent variable is efficiency calculated by use of statistical variables in a model according to defined efficiency concept in this section. And independent variables are components of using ICT in the country’s banks that they are measuring by criteria, their relationship with the dependent variables are assessed through statistical tests. Obviously, these variables are determined according to the research hypothesis. Thus according to the main hypothesis of this study 6 independent variables have been considered as follows:

**Hardware Investment:** Implementation of electronic banking (E-banking) despite the need of software infrastructure requires technical infrastructures, telecommunication hardware and computer hardware, excommunication equipment includes computer and cell phones utilization of modern technologies in relation to telecommunication and computer by banks and customers as well. This will lead to dynamic electronic banking (E-banking) [41]. Promotion of safe and high-speed telecommunication lines nationally, expansion of mobile telecommunication platforms, increasing of land-line telephone subscribers necessary facilities and encourage people to purchase a computer are significant factors for adoption of electronic banking. Generally in all levels of movement of banks, financial institutions and commercial firms toward electronic banking, develop of modern technologies in the hardware is considered as a necessity to maintain the competitive position [25].

**Software Investment:** Implementation of electronic banking (E-banking) require various infrastructures such as software infrastructures, independence of web
Table 1: Descriptive statistics of the variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Description</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable TC</td>
<td>Total costs: Personnel expenses, interest expenses paid to term deposits, fixed assets depreciation Expenses, administrative costs and other expenses.</td>
<td>65.76</td>
<td>15.36</td>
</tr>
</tbody>
</table>

Independent variable

<table>
<thead>
<tr>
<th>Variable output quantities</th>
<th>Total loans (Rial millions)</th>
<th>y1</th>
<th>Securities (stocks and bonds and shares) (Rial millions)</th>
<th>46.36</th>
<th>52.36</th>
</tr>
</thead>
<tbody>
<tr>
<td>y2</td>
<td>(Rial millions)</td>
<td>y2</td>
<td></td>
<td>25.25</td>
<td>31.25</td>
</tr>
<tr>
<td>y3</td>
<td>Non-interest income(include Services fees received, honorarium) (Rial millions)</td>
<td>y3</td>
<td></td>
<td>15.25</td>
<td>22.14</td>
</tr>
</tbody>
</table>

| Variable input prices     | Price of labor: salaries and benefits divided by number of employees                          | P1     | 1.8                                                     | 1.02    |
|                           | Price of funds: total interest expenses divided by total funds                                | P2     | 0.51                                                    | 0.49    |
|                           | Price of physical capital: occupancy expenses divided by the book value of fixed assets     | P3     | 0.31                                                    | 0.39    |
| T                          | Time trend                                                                                    | T      | 16                                                      | 10     |

Notes: Rial official currency of Iran

Table 2: List of explanatory variables

<table>
<thead>
<tr>
<th>Efficiency determinants</th>
<th>Variable type</th>
<th>Measuremen</th>
<th>Expected sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardware investment</td>
<td>Value</td>
<td>Ratio of hardware acquisition to total acquisition of tangible immobilizations.</td>
<td>Positive</td>
</tr>
<tr>
<td>Software investment</td>
<td>Value</td>
<td>Ratio of Software acquisition to total acquisition of intangible immobilizations.</td>
<td>Positive</td>
</tr>
<tr>
<td>IT services</td>
<td>Value</td>
<td>Ratio of IT services expenses to total expenses on external services</td>
<td>Positive</td>
</tr>
<tr>
<td>Ownership</td>
<td>Dummy</td>
<td>1= privately-owned and 0= otherwise</td>
<td>Positive</td>
</tr>
<tr>
<td>Bank size</td>
<td>Value</td>
<td>Number of branch</td>
<td>Negative</td>
</tr>
<tr>
<td>Year</td>
<td>Value</td>
<td>Year of observation</td>
<td>Positive</td>
</tr>
</tbody>
</table>

RESULTS

Hypotheses Test: Hypotheses test related to stochastic frontier functions, by use of likelihood ratio test is As follows:

\[-2\{\log(L(H_0)/L(H_1))\} = -2\{\log(L(H_0) - L(H_1))\}\]

where in \(\lambda\) test statistic, \(L(H_0)/L(H_1)\) maximum likelihood function value with respect to the restrictions specified by the null hypothesis, \(H_0\) is opposite hypothesis of \(H_1\). \(\lambda\) as a marginal with distribution \(\chi^2\) with freedom degree of number of constraints, if the \(H_0\) hypothesis is correct then above statistic test will be Less than \(\chi^2\) table otherwise we cannot accept \(H_0\). Table 3 presents the results using the generalized likelihood-ratio (LR) tests in evaluating hypotheses for the sufficiency of representation of the cost structure of the banks in the sample.
Table 3: Tests of hypothesis

<table>
<thead>
<tr>
<th>Null hypothesis</th>
<th>LR</th>
<th>Critical value</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test of no inefficiency effects: $H_0: \gamma = 0$</td>
<td>36.84</td>
<td>12.54</td>
<td>Reject H0</td>
</tr>
<tr>
<td>Test for half-normal functional form: $H_0: \mu = 0$</td>
<td>34.51</td>
<td>11.23</td>
<td>Reject H0</td>
</tr>
<tr>
<td>Joint effect of the inefficiency detergents: $H_0: \delta = \alpha, i = 1.6$</td>
<td>68.59</td>
<td>23.04</td>
<td>Reject H0</td>
</tr>
<tr>
<td>Cobb douglas: $H_0: \beta_i = 0$</td>
<td>65.85</td>
<td>14.62</td>
<td>Reject H0</td>
</tr>
</tbody>
</table>

Table 4: Estimated parameters of the Translog SFA production function

<table>
<thead>
<tr>
<th>Technical inefficiency effects model</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>T-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.278</td>
<td>0.02</td>
<td>4.17</td>
</tr>
<tr>
<td>Hardware investment</td>
<td>0.014</td>
<td>0.04</td>
<td>0.30</td>
</tr>
<tr>
<td>Software investment</td>
<td>-0.032</td>
<td>0.03</td>
<td>-0.96</td>
</tr>
<tr>
<td>IT services (science 3)</td>
<td>-0.177</td>
<td>0.05</td>
<td>-2.26</td>
</tr>
<tr>
<td>Ownership</td>
<td>-0.134</td>
<td>0.04</td>
<td>-3.23</td>
</tr>
<tr>
<td>Bank size</td>
<td>-0.016</td>
<td>-0.06</td>
<td>-0.10</td>
</tr>
<tr>
<td>Year</td>
<td>0.459</td>
<td>0.18</td>
<td>2.47</td>
</tr>
</tbody>
</table>

Variance parameter

$\sigma^2 = 0.047$

$\gamma = 0.954$

Log likelihood

103.570

Average technical efficiency

0.790

- First null hypothesis: $H_0: \gamma = 0$ it means there is no inefficiency effects in the model, due to the results strongly rejected.
- Second null hypothesis: $\mu = 0$ it means technical inefficiency effects ($U_i$) have a semi-normal distribution and this strongly rejected.
- Third null hypothesis: $H_0: \delta = 0$ indicates that none of the bank specific explanatory variables are not significant, in other word testing significant of regression of variables affecting inefficiency. Due to computational values above hypothesis is rejected.
- Fourth null hypothesis: $H_0: \beta_i = ... = 0$ states that functional form of Cobb Douglas is more appropriate and due to parameter $\hat{\gamma} = 0.94$ estimation and statistical test (t) related to that, this hypothesis also rejected, it means that Maximum Likelihood (ML) estimations are preferred to estimation of (CLOS).

Model's Estimation Results: To measure economic efficiency (cost) of banks in Iran, estimated cost function (Translog) and Frontier 4.1 software were used and finally economic efficiency average of banks calculated (79%) in forms of Battese and Coelli [35] model. And also maximum likelihood estimations (ML) translog stochastic Frontier cost function parameters by assumption of inefficiency component existence, were calculated through Battese and Coelli [35] model. They represented in following Table 4.

$\gamma$ in fact indicates need of inefficiency existence and is equal to (0.95) we can say that (95%) of errors in the model is due to the inefficiency component existence and this matter according to t statistic of this parameter will be more obvious. And significance of coefficient at (5%) level is accepted, thus we can say due to existence of inefficiency component, ML estimations preferred to OLS method. According to model results, the highest efficiency is related to private-owned banks and publicly-owned banks are less efficient. And also banks performance during the research period was in downturn. The results indicate that the efficiency of private-owned banks is higher than publicly-owned banks. Efficiency average has been calculated (73%) for publicly-owned banks and (81%) for the private-owned banks respectively.

As shown in following diagram Fig. 1 private-owned banks efficiency in early years of establishment, was less than publicly-owned banks. But efficiency process was additive so after the year 2004, private-owned banks efficiency was higher than publicly-owned banks. Performance of banks in the years 2007-2009 because these banks were heavily influenced by government order in regards to interest rate rules, that caused performance of banks decreasing in this period. A few banks in Iran before year 2008 were publicly-owned, then after economic reforms they have been privately-owned. The results of research show that the efficiency of these banks, before and after privatization have a large
difference, so the strategic approach of these banks is different than before. After reformation change, these banks started to reduce costs by reducing the number of branches and optimize business processes by approach to outsourcing, part of the services related to ICT and developing of electronic banking services through different channels. The reasons for difference between publicly-owned and privately-owned banks can be justified as follows:

Privately-owned banks in Iran due to the type of governance structure and also economic size and appropriate infrastructure in information technology, have been able to compete with large publicly-owned banks in the short term. Less branches, infrastructure development of information technology and effective use of information technology caused to reduce additional costs in business.

**Impact of Explanatory Variables on Inefficiency:** One of the main goals of this study is to investigate the impact of information and communication components on efficiency of banks in Iran. The results of the technical efficiency effects model are presented in the Table 4. The results of this study show that the explanatory variables in the model are significant.

The first research hypothesis states that banks investments in hardware has a negative relationship with inefficiency and also is rejected at (5%) significance level. Positive estimate for the coefficient of this explanatory variable indicates that the Iranian banks investments in hardware section has not led to reduce of costs and increase of efficiency. This point reflects that the hardware investment and introduction of new Electronic Services(ES), on the one hand lead to increase customers satisfaction and on the other hand impose higher and new costs to the banks. Although each banking operation requires some of the IT tools but results of studies on issue of relationship between level of hardware utilized and amount of efficiency increase are different all researchers agreed on importance of ICT in the banking industry. But some of them do not accept (reject) the proportionality between increase amount of information technology and increase of banks efficiency [15, 17, 42, 44].

Second research hypothesis that indicates the technical inefficiency has a negative relationship with banks software investment is not rejected (approved) at (1%) significance level. The estimated negative amount in the model shows that banks investments in software section has led to reduce of costs and increase of banks technical efficiency. Iranian banks by development ICT are trying to provide Services based on technology. In this regard heavy expending in software applications by banks. And technology-based services reduce overhead costs and covers banks objectives. The results seem to be consistent with other research [19, 42, 45].

Third research hypothesis states that, by increasing of outsourcing and purchasing of information technology services, efficiency of banks also increase. And also is not rejected (approved) at (1%) significance level. Outsourcing is one of the ways of using information technology and recognized as a way to reduce information technology costs. Banks by focusing on information technology issues, are not able to create high value added, because their real business is nothing but information technology. Outsourcing of information technology in banks will cause reduced of associated costs and each units of banks regardless of information and technology associated issues accomplish their business [31].
The results of the fourth research hypothesis is also not rejected at (1%) significance level. This hypothesis states that ownerships of banks are associated with technical efficiency. Estimated negative value for this parameter shows that the privately-owned has a positive impact on banks efficiency. And privately-owned banks more efficient than publicly-owned banks. This finding is in agreement with those of other studies [20, 28, 46, 47].

The fifth research hypothesis also is not rejected (approved) at (5%) level. Bank’s size parameter, that in this study number of banks branches are considered states that bank’s size has a positive relationship with bank inefficiency. Estimated positive value for this parameter shows that excessive banks branches will cause increase of proportional costs and reduce the banks efficiency.

The sixth null hypothesis specifies that technical efficiency is not related to the time period. This hypothesis was rejected at the (%5) level of significance. The positive coefficient for year variable shows that the technical efficiencies of Iranian banks are likely to move in the negative direction as time increases. This suggests that the inefficient banks are falling further behind their efficient counterparts [38].

CONCLUSION AND SUGGESTIONS

This is the first comprehensive experimental study about investigation the impacts of information technology on efficiency of Iran’s banks for a period of 22 years from (1990 to 2011) by using SFA model. Results of the study have shown the technical efficiency average of Iranian banks during the study is (79%) and technical efficiency of privately-owned banks in Iran is higher than publicly-owned banks. Technical efficiency average for a period from 2001 to 2011 is (81%) for privately-owned banks and (73%) for publicly-owned.

According to the results, impact of information technology components (software and outsourcing of information technology services) had a positive effect on efficiency of banks. And by increasing of optimal investment in application software section and also outsourcing of information technology services, operational costs in banks reduced and services have been provided to the customers through multi-channels with lower costs and speed. But it should be noted that the effects of these components on publicly-owned and privately-owned banks are not same. Type of ownership, governance in publicly-owned banks and imposed grammatical rules, caused that publicly-owned banks do not focus on necessity of using ICT in their business environment as a strategic tool to gain competitive advantages. Indiscriminate increase of investment in information technology will not necessarily lead to increase of efficiency. The accuracy and sensitivity of investment decision-making process in information technology is essential to avoid wasting time and money in this process. The alignment of information technology with business strategies should be controlled and all activities that can be done through outsourcing should be determined till focus on main activities of banks increase.

Generally create of products in form of new services through various channels with lowest cost and higher speed is important for privately-owned banks. But since all banks offering new services, it is difficult to differentiate between products. So multiplicity and quality of financial services is very important for the privately-owned banks. For this reason the management of privately-owned banks investing in information technology and due to the publicly-owned banks large scale and geographical expansion, investment in ICT can be a competitive advantage for privately-owned banks. The main reason of this issue is governance in privately-owned banks that by adaptation of information technology strategies with business strategies has led to costs reduction, increase outputs and ultimately increase of technical efficiency. Privately-owned banks by the opportunity of using electronic services and internet can maintain their position in electronic banking and also they can reduce costs, therefore achieving maximum profitability.

Fortunately, privately-owned banks since their formation have tried to invest in information technology. But unfortunately legal, social and technical infrastructures for development and effective use of electronic banking are not available in Iran. Development of internet banking and achieving of two parameters are important for the Iranian banks: First, firms by use of powerful, reliable and systematic financial structures should be able to providing various services to the customers and attract their satisfaction. And second should be able to produce a different services in form of focused set, to reduce costs, increase safety and increase of flexibility power. Therefore create of such structures and systems can be one of the most important factors to increase abilities of Iranian banks in providing banking services.
REFERENCES


