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The effect of information technology on public and private sector: Evidence from the Banking Industry

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Abstract: 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. 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.

Keywords:Information and communication technology (ICT), Efficiency, Banking industry, Electronic banking (E-banking),IT investment, IT services, Hardware investment, Software investment, outsourcing, Iranian banks

1.   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. 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

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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. 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?

2.   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[e.g.,1, 2-4].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 [5, 6]. 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 [e.g.,7, 8]. 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[9]. Total works done at micro level in developed countries is more than developing countries .In this part we will examine some of them. 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:

1- 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 [e.g.,10, 11-13].

2- 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[e.g.,4, 14, 15].

3-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 ‹Technology Acceptance Model‹Theory of Reasoned Action‹Theory of Planned Behavior‹Technology- Organization-Environment Model)[16-18]. 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.

3.   METHODOLOGY

The model used in this study was firstly proposed by Battese and Coelli [19] . 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:

$$C_{it} = F(y_{ir}, P_{jit}, z_i; \beta) + v_{it} + u_{it}, \qquad v_{it} \approx N(o, \sigma_v^2) \tag{1}$$

Where c_{it} is total firms cost , i (i=1,2,….N) time: t (t=1,2,….T), y_{it} firm's output, i on t time , P_{jit} is input cost, j used in firm , i for t time, β model parameters that must be estimated[19]. 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 [19]model, considered as follows :

$$\ln Tc_{it} = \beta_o + \sum_{q=1}^{3} \beta_q \ln y_{qit} + \sum_{j=1}^{3} \beta_j \ln P_{jit} + \frac{1}{2} \sum_{q=1}^{3} \sum_{l=1}^{3} \beta_{ql} \ln y_{qit} \ln y_{lit}$$

$$+ \frac{1}{2} \sum_{j=1}^{3} \sum_{k=1}^{3} {}_{jk} \ln P_{jit} \ln P_{kit} + \sum_{q=1}^{3} \sum_{j=1}^{3} \beta_{qj} \ln y_{qit} \ln p_{jit} + \beta_s t + \sum_{j=1}^{3} \beta_{qs} \ln p_{jit} t \tag{2}$$

$$+ \sum_{q=1}^{3} \beta_{js} \ln y_{qit} t + \frac{1}{2} \beta_{ss} (t)^2 + u_{it} + v_{it}$$

Where i is bank indicator and t is time indicator ; $\ln Tc_{it}$ the natural logarithm of total bank cost of the *ith* bank in the time t ; $\ln y_{it}$ is natural logarithm of *qth* output ; $\ln P_{jit}$ the natural logarithm of the *jth* input price ; β 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_{2it} to impose linear input price homogeneity[20]. 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[21] .Therefore, the inefficiency effects (u_{it}) in Eq. (1) are specified as:

$$u_{it} = \delta_0 + \delta_1 Hard\ In_{it} + \delta_2 SoftIn_{it} + \delta_3 ITServices_{it} +$$
$$\delta_4 Ownershipe_{it} + \delta_5 Bank\ size_{it} + \delta_6 year_{it} + w_{it} \tag{3}$$

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.

4.   DATA COLLECTION AND ANALYSIS

4.1   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. 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_1 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.

Table 1. Descriptive statistics of the variables

variables	Description	Mean	Standard deviation
Dependent variable TC	total costs :Personnel expenses, interest expenses paid to term deposits, fixed assets depreciation Expenses, administrative costs and other expenses.	65.76	15.36
Independent variable Variable output quantities			
y1	total loans(Rial millions)	46.36	52.36
y2	Securities (stocks and bonds and shares) (Rial millions)	25.25	31.25
y3	Non-interest income(include Services fees received, honorarium)(Rial millions)	15.25	22.14
Variable input prices			
P1	Price of labor: salaries and benefits divided by number of employees	1.8	1.02
P2		0.51	0.49
P3	Price of funds: total interest expenses divided by total funds Price of physical capital: occupancy expenses divided by the book value of fixed assets	0.31	0.39
T	time trend	16	10

Notes: Rial official currency of Iran

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_1 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 [20].The Following Table 1 briefly shows utilized variables in this study.

4.2 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 following Table 2 .

Table 2.   List of explanatory variables

efficiency determinants	Variable type	Measurement	Expected sign
hardware investment	Value	Ratio of hardware acquisition to total acquisition of tangible immobilizations.	Positive
Software investment	Value	Ratio of Software acquisition to total acquisition of intangible immobilizations.	Positive
IT services	Value	Ratio of IT services expenses to total expenses on external services	Positive
ownership	Dummy	1= privately-owned and 0= otherwise	Positive
Bank size	Value	Number of branch	Negative
Year	Value	Year of observation	Positive

5.   RESULTS

5.1   Hypotheses test

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

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

Where in λ test statistic, $L(H_1)$ و $L(H_0)$ maximum likelihood function value with respect to the restrictions specified by the null hypothesis , (H_0) is opposite hypothesis of (H_1). λ 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

Null hypothesis		LR	Critical value	Decision
Test of no inefficiency effects:	$H_0 : \gamma = 0$	36,84	12,54	Reject H0
Test for half-normal functional form:	$H_0 : \mu = 0$	34,51	11,23	Reject H0
Joint effect of the inefficiency detergents:	$H_0 : \delta_i = o, i = 1..6$	68,59	23,04	Reject H0
Cobb douglas:	$H_0 = \beta_{ij} = \beta_{qy} = \beta_{ss} = \beta_{ys} = \beta_{yj} = \beta_{sj} = 0$	65,85	14,62	Rejet H0

1. First null hypothesis: $H_0 : \gamma = 0$ it means there is no inefficiency effects in the model, due to the results strongly rejected.

2. Second null hypothesis: $\mu = 0$ it means   technical inefficiency effects (U_i) Have a semi-normal distribution, and this strongly rejected.

3. Third null hypothesis: $H_0 : \delta_i = 0$ 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 χ2 computational values above hypothesis is rejected.

4. Fourth null hypothesis: $H_0 : \beta_{ij} = ... = 0$ states that functional form of Cobb Douglas is more appropriate, and due to parameter $\hat{\gamma} = \%94$ 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).

5.2   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 [19] 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 [19] model. They represented in following Table 4.

γ 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 Fig1 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.
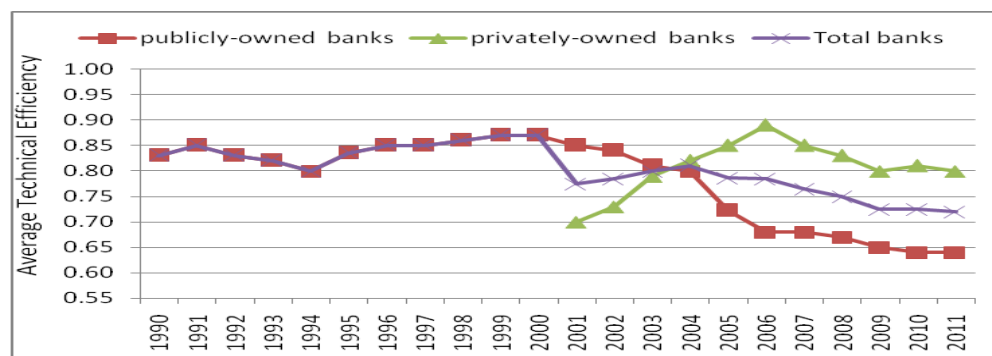

Fig. 1. Average technical efficiency of publicly-owned and privately-owned banks

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.

5.3   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.

Table 4. Estimated parameters of the Translog SFA production function

Technical inefficiency effects model	coefficient	Standard error	T-statistic
Constant	0.278	0.02	4.17
Hardware investment	0.014	0.04	0.30
Software investment	-0.032	0.03	-0.96
IT services(science3)	-0.177	0.05	-2.26
Ownershipe	-0.134	0.04	-3.23
Bank size	-0.016	-0.06	-0.10
Year	0.459	0.18	2.47
Variance parameter			
σ^2	0.047		
γ	0.954		
Log likelihood	103.57		
Average technical efficiency	0.79		

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. But some of them do not accept (reject) the proportionality between increase amount of information technology and increase of banks efficiency [e.g.,22, 23].

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 [11, 24, 25].

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. 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 [12, 26].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[27].

6.   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. 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.

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