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Common Factors of CPI Sub-aggregates and Forecast of Inflation

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Abstract

In this paper, we investigate whether incorporating common factors of CPI sub-aggregates into forecasting models increases the accuracy of forecasts of inflation. We extract factors by both static and dynamic factor models and then embed them in ARMA and VAR models. Using quarterly data of Iran's CPI and its sub-aggregates, the models are estimated over 1990:2 to 2008:2 and out of sample forecasts are produced for 2008:3 to 2012:1. The results show that in most cases the performance of the models containing common factors of CPI sub-aggregates is better than the Autoregressive, as one of the benchmark models. But, only for the horizon of two-step ahead, the performance of the factor models are significantly better than that of benchmark. Also, the FAVAR performs better than the other factor models in forecasting inflation.

Keywords: *Forecasting, Inflation, CPI Sub-aggregates, Factor Models, ARMAX, FAVAR*

JEL Classification: *C32, C53, E31*

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1. Introduction

Since there are lags in transmission of monetary policy into the economy, the policy should be based on projections of the future of macro variables and particularly the future of inflation. Therefore, central banks around the globe employ inflation forecasting as a tool when setting monetary policy. Moreover, many economic decisions, made by firms, investors, or consumers, are often based on inflation forecasts. The accuracy of these forecasts can thus have important repercussions in the economy.

When forecasting aggregate economic variables consisting of several sub-aggregates, such as inflation, we face the question of, whether using information contained in sub-aggregates can improve the forecast accuracy of the aggregate variable. This is frequently encountered when forecasting inflation, where data are commonly available for components of CPI in addition to the CPI as an aggregate index (for more details, see Bermingham and D'Agostino, 2011).

There are three ways for disaggregating CPI; we can disaggregate it (1) in terms of components of CPI (i.e. groups of goods and services), (2) in terms of regions or states, and (3) in terms of time (for more details, see Hendry and Hubrich, 2006). In this paper, we focus on the first one, i.e. disaggregating through components of CPI. When using information of components of CPI, we can consider three alternative approaches. The first one is modeling and forecasting components of CPI separately and then combining those forecasts to produce the forecast of CPI inflation (see Duarte and Rua, 2005, Espasa *et al*, 2002, Hubrich, 2005, Bayat and Barakchian, 2013). In the second approach, introduced by Hendry and Hubrich (2006, 2011), some or all components are incorporated directly into the inflation forecasting model. Theoretically, including CPI sub-aggregates as exogenous variables in the forecasting model should improve forecast accuracy, but entering a great number of sub-aggregates in the model violates parsimony of the model, and because of generating estimation and

specification errors, results in loss of efficiency (Lutkepohl, 2011). The third approach is based on using factor models to summarize information contained in CPI sub-aggregates. Since the factors extracted from CPI sub-aggregates have an effective role in explaining inflation (see, for example, Granger, 1987), it is plausible that those factors can improve forecast accuracy of inflation, while it does not violate the parsimony principle by adding too many parameters to the model. These factors can be embedded as exogenous variables in a vector (X), and then be added to AR and ARMA models, resulting in ARX and ARMAX models, respectively. Mendez and Kapetanios (2005) used this approach for forecasting inflation of some countries in Euro-zone, and Duarte and Rua (2005) for forecasting inflation of Portugal. Factors can also be used in a Factor Augmented Vector Auto Regression (FAVAR) model to forecast inflation. The idea behind FAVAR is to combine the standard VAR analysis with the recent advances in dynamic factor models, and thus, to estimate a joint VAR including some variables of interest (here, inflation) plus factors extracted from a large panel of time series (here, CPI sub-aggregates). One of the advantages of the FAVAR model is that in a FAVAR, all variables are treated as endogenous, whereas in econometric modeling one generally needs to classify variables as exogenous and endogenous. The FAVAR model has been used frequently in academia and central banks for forecasting inflation (see, for example, Akdogan *et al.* 2012, Barnett *et al.* 2012, Faust and Wright, 2007, 2011, Pang, 2010, and Norman and Richard, 2010).

In this paper, we examine whether incorporating common factors of CPI sub-aggregates into a forecasting model improves its performance in forecasting inflation, and specifically, if such a model can outperform the autoregressive model as our simple but powerful benchmark model. To the best of our knowledge, no other study has yet examined performance of factor models in forecasting inflation in Iran. Moreover, this is the first study

in which the information contained in CPI sub-aggregates is used to forecast inflation in Iran. (Bayat and Barakchian (2013) also use CPI sub-aggregates, however, the approach they follow is totally different from the one followed in this paper). In these respects, our study is perceived to be new. To compare the forecasting performance of different models, we use Root Mean Squared Forecast Error (RMSFE) as the measure. Our results show that in most cases the performance of models containing common factors of CPI sub-aggregates is better than that of the benchmark model. In addition, in the horizon of two-quarters ahead, the forecasts generated by the factor models are significantly more accurate than those generated by the benchmark model.

The remainder of this paper is organized as follows. Section 2 explains the factor models used in the paper. Section 3 presents the data and results, and finally, Section 4 concludes.

2. Factor Models

Common factors can be extracted from CPI components either by static or dynamic factor models. In this paper, the factors extracted by static factor models will be used in the class of ARMAX models and those extracted by dynamic factor models will be used in FAVAR models. The reason why factors in FAVAR models are extracted by dynamic factor models is that the setup of a FAVAR allows factors to be determined dynamically by their lags. This setup is compatible with 'state-space representation' on which dynamic factor models are based.

a. Static factor models

The standard formulation of a *static factor model* is

$$H_t = \Lambda F_t + e_t \tag{1}$$

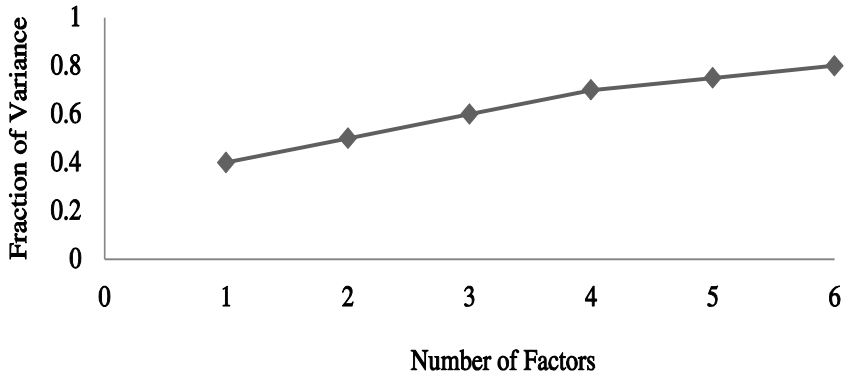
Where H_t is a $(N \times 1)$ vector of (the growth rates of) CPI sub-aggregates and F_t is a $K \times 1$ vector of unobserved factors where K is "small" relative to

N. Λ is a $(N \times K)$ factor loading matrix, e_t is a $(N \times 1)$ vector of errors following a multivariate normal distribution with zero mean and $(N \times N)$ covariance matrix. For estimating factors, we use the method of maximum likelihood (MLE) which involves minimizing a discrepancy function. Let S represent the observed dispersion matrix of H (CPI sub-aggregates) and let the fitted dispersion matrix of H be $\sum(\Lambda, \psi)$. Then the discrepancy function, to be minimized by MLE, is

$$D_{MLE}(S, \Sigma) = tr\left|\Sigma^{-1} S\right| - \ln\left|\Sigma^{-1} S\right| - N.$$

But first we need to determine the number of factors before estimating them. Figure 1 shows the cumulative percentage of the total variation of (the growth rates of) the CPI sub-aggregates explained by the first 6 factors. As can be seen, with only 3 factors we are able to explain about 60% of the variation of (the growth rates of) the twelve CPI sub-aggregates (for the list of twelve CPI sub-aggregates, see footnote 1). So we assume that the number of factors is 3.

Figure 1: Cumulative fraction of variance of CPI sub-aggregates explained by the factors



Another rule for choosing the number of factors is called the Kaiser-Guttman rule. This rule, which is commonly termed "eigenvalues greater than 1", is the most commonly used method. According to this rule, one computes the eigenvalues of the unreduced dispersion matrix (H) and the number of eigenvalues that exceed the average (of the eigenvalues) determines the number of factors. For a correlation matrix, the average eigenvalue is 1; hence the term "eigenvalues greater than 1" has been commonly used in the literature. By the Kaiser-Guttman rule, the number of factors is also determined to be 3.

b. Dynamic factor models

Dynamic factor models are based on the state-space representation such that factors are considered as unobserved variables in the measurement equation. Assume H_t is a $(N \times 1)$ vector containing CPI sub-aggregates and F_t is the matrix of factors extracted from H_t. A *dynamic factor model* can be presented by equations (2) and (3),

$$H_t = \Lambda F_t + e_t \tag{2}$$

$$F_t = \sum_{l=1}^{L} B_l F_{t-l} + v_t \tag{3}$$

Where Λ is a $(N \times K)$ factor loading matrix, e_t is a $(N \times 1)$ vector of errors following a multivariate normal distribution with zero mean and $(N \times N)$ covariance matrix, B_l is a $(K \times K)$ matrix of the autoregressive and cross-regressive coefficients, and v_t is a $(K \times 1)$ vector of random shocks following a multivariate normal distribution with zero mean and $(K \times K)$ covariance matrix. In a *dynamic factor model*, the common factors have an autoregressive structure and a possible cross-regressive structure. Although the factors at any given time have no direct impact on future values of

observed variables, they have an indirect impact as they influence future values of the factors, which, in turn, influence the observed variables concurrently. As before, the number of factors is estimated to be 3 based on the Kaiser-Guttman rule, and the *dynamic factor model* is estimated using MLE.

Figure 2 shows the time series of the factors of CPI sub-aggregates derived by the static and dynamic factor models. As the figure shows, their trends are very similar, but their volatilities are very different; the factor derived by the static model is much more volatile than the one derived by the dynamic model.

Figure 2: The first factors extracted from CPI sub-aggregates by the static and dynamic factor models

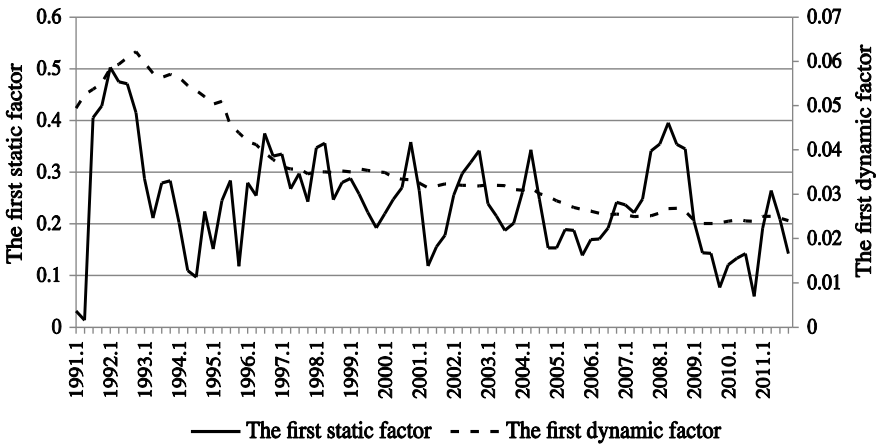


Table 1 shows correlations between the inflation rate, and the factors extracted from CPI sub-aggregates by the static and dynamic models. Correlations between the inflation rate and all static and the first two dynamic factors are positive, but correlation between the inflation rate and the third dynamic factor is negative. The inflation rate has highest

correlation with the third factor of the static factors (0.66) and with the first factor of the dynamic factors (0.52).

Table1: Correlations between the inflation rate, static and dynamic factors of CPI sub-aggregates

	Inflation	$\mathbf{F_1^S}$	$\mathbf{F_2^S}$	$\mathbf{F_3^S}$	$\mathbf{F_1^D}$	$\mathbf{F_2^D}$	$\mathbf{F_3^D}$
Inflation	1						
F_1^S	0.2	1					
F_2^S	0.26	-0.14	1				
F_3^S	0.66	0.35	-0.15	1			
F_1^D	0.52	0.47	0.16	0.46	1		
F_2^D	0.46	0.57	-0.12	0.66	0.61	1	
F_3^D	-0.14	-0.79	0.27	-0.35	-0.48	-0.85	1

Notes: Static factors (F_1^S, F_2^S, F_3^S) and dynamic factors (F_1^D, F_2^D, F_3^D) are extracted from CPI sub-aggregates using the method of MLE and Kalman filter respectively (See section 2 for more details).The estimation period is 1990:2-2012:1.

2.1. Forecasting Models

ARX(p) model is presented by equation (4),

$$\pi_t = \alpha + \sum_{i=1}^{p} \emptyset_i \, \pi_{t-i} + \sum_{j=1}^{n} \beta_j \, F_{j,t} + \varepsilon_t \qquad (4)$$

Where $\pi_t$is CPI inflation, p is the number of inflation lags ($0 \leq p \leq 4$), n is the number of factors (here n=3), and $\emptyset$ and β are the coefficients of the inflation lags and the factor loadings, respectively. The forecasts of π_{t+h} are produced iteratively as:

$$\hat{\pi}_{t+h} = \hat{\alpha} + \sum_{i=1}^{p} \hat{\emptyset}_i \, \hat{\pi}_{t-i+h} + \sum_{j=1}^{n} \hat{\beta}_j \, F_{j,t} \qquad (5)$$

Dynamic ARX(p) is constructed by adding lags of the factors to equation (4):

$$\pi_t = \alpha + \sum_{i=1}^{p} \emptyset_i \, \pi_{t-i} + \sum_{j=1}^{n} \sum_{m=0}^{v} \beta_{jm} \, F_{j,t-m} + \varepsilon_t \qquad (6)$$

Where *v* is the number of lags of the factors, and $0 \leq v \leq 4$.

The forecasts of π_{t+h} are generated iteratively based on (6) as:

$$\hat{\pi}_{t+h} = \hat{\alpha} + \sum_{i=1}^{p} \widehat{\emptyset}_i \, \hat{\pi}_{t-i+h} + \sum_{j=1}^{n} \sum_{m=0}^{v} \hat{\beta}_{jm} \, F_{j,t-m} \qquad (7)$$

ARMAX(p, q) and Dynamic ARMAX(p, q) models are constructed by adding moving average (MA) terms to the ARX(P) and Dynamic ARX(P), respectively. The number of the lags of MA terms can take each integer number between 1 and 4.

FAVAR model can be presented by equation (8),

$$\begin{bmatrix} \mathrm{F_t} \\ \pi_t \end{bmatrix} = \Theta(\mathrm{L}) \begin{bmatrix} \mathrm{F_{t-1}} \\ \pi_{t-1} \end{bmatrix} + \mathrm{v_t} \qquad (8)$$

Where F_t contains the factors extracted from CPI sub-aggregates, and $\Theta(L)$ is a conformable lag polynomial of finite order *d*. The error term v_t has zero mean with covariance matrix Q. After estimating factors, $\hat{F}_t$, we estimate equation (8) and forecast *h*-step ahead inflation iteratively following equation (9):

$$\begin{bmatrix} \hat{F}_{t+h} \\ \hat{\pi}_{t+h} \end{bmatrix} = \widehat{\Theta}(L) \begin{bmatrix} \hat{F}_{t-1+h} \\ \hat{\pi}_{t-1+h} \end{bmatrix} \qquad (9)$$

In all ARMAX and FAVAR models the optimal number of the lags of the variables and also the lags of moving average terms are selected based on the Schwartz criterion.

Our benchmarks in this paper are Auto Regressive (AR) and single exponential smoothing (SES) models. Quite often such simple models are found hard to beat compared to large complex models. The form of AR is as below,

$$\pi_{t+1} = \alpha + \sum_{i=1}^{p} \beta_i \, \pi_{t+1-i} + \varepsilon_t \tag{10}$$

The forecasts of π_{t+h} are constructed recursively as:

$$\hat{\pi}_{t+h|t} = \hat{\alpha} + \sum_{i=1}^{p} \hat{\beta}_i \, \hat{\pi}_{t+h-i} \tag{11}$$

where $\hat{\pi}_{j|t} = \pi_j$ for $j \leq t$,
and the specific formula for simple exponential smoothing is:

$$S_t = \alpha \pi_{t-1} + (1-\alpha) S_{t-1} \tag{12}$$

There are many ways of setting the initial value of S_t, such as setting it to π_1. Another possibility, that we use it, would be to average the first four observation.[1]

The forecasts of π_{t+h} are produced as:

$$\hat{\pi}_{t+h} = S_{t+1} = \alpha \pi_t + (1-\alpha) S_t \tag{13}$$

1. For each of the alpha value between 0.01 and 0.99, we produce out of sample forecasting, then, the alpha corresponding to the lowest RMSFE is selected.

3. Data and Results

Our sample quarterly data spans from 1990:2 to 2012:1 including CPI and its 12 sub-aggregates. [1] All forecasts are computed using out-of-sample forecasting framework. For this, we split the sample into two parts: estimation period (1990:2 until 2008:2), and forecast evaluation period (2008:3 until 2012:1). When estimating models we use expanding windows, i.e. first we estimate models using data up to 2008:2 and produce 1 to 4 step ahead forecasts for 2008:3-2012:1. Then we expand the window by one observation and estimate the models using data up to 2008:3 and produce forecasts for 2008:4-2012:1. This procedure is continued until we reach 2011:4.

The data is used in logarithmic, X-12 seasonally adjusted form. Diebold and Kilian (2000) show that when a model includes variables in their stationary form, it generates more accurate forecasts compared to the alternative that it includes variables in their I(1) form. We, therefore, carry out the Augmented Dickey-Fuller (ADF) test for logarithmic CPI and its components, and then, for modeling and forecasting, we use the first difference of those series found to be I(1) by the ADF test.

We showed that the optimum number of factors is 3. However, in order to examine the sensitivity of the results to the number of factors, out-of-sample forecasts for each factor model have been produced when the number of factors is considered to be 1, 2 or 3. For each class of factor models, we report the results for the models with least RMSFEs.

1. Sub-aggregates of the Iranian CPI basket are Food and Beverage; Tobacco; Clothing and Footwear; Housing, Water, Electricity, Gas and other Fuels; Furnishings, Household Equipment and Routine-Household Maintenance; Health; Transport; Communication; Recreation and Culture; Education; Restaurant and Hotels; Miscellaneous Goods and Services.

Table 2: Relative RMSFEs

	Forecast Horizon							
	h=1		*h=2*		*h=3*		*h=4*	
Factor Models	AR	SES	AR	SES	AR	SES	AR	SES
ARX	0.895	0.885	0.928	1.037	0.942	1.095	1.060	1.233
	(0.21)	(0.41)	(0.01**)	(0.86)	(0.57)	(0.63)	(0.52)	(0.44)
	(F_1^S)		(F_1^S)		(F_1^S, F_2^S)		(F_1^S)	
Dynamic ARX	0.974	0.964	0.895	1.000	1.018	1.183	0.998	1.160
	(0.37)	(0.87)	(0.21)	(1.00)	(0.46)	(0.47)	(0.98)	(0.38)
	(F_1^S)		(F_1^S, F_2^S, F_3^S)		(F_1^S, F_2^S)		(F_1^S, F_2^S)	
ARMAX	0.880	0.871	0.940	1.050	0.944	1.097	1.044	1.214
	(0.28)	(0.31)	(0.03**)	(0.79)	(0.58)	(0.62)	(0.69)	(0.50)
	(F_1^S, F_2^S, F_3^S)		(F_1^S, F_2^S, F_3^S)		(F_1^S, F_2^S)		(F_1^S)	
Dynamic ARMAX	1.061	1.050	1.045	1.167	1.035	1.203	0.998	1.160
	(0.64)	(0.79)	(0.52)	(0.47)	(0.42)	(0.42)	(0.95)	(0.44)
	(F_1^S, F_2^S, F_3^S)		(F_1^S, F_2^S, F_3^S)		(F_1^S)		(F_1^S)	
FAVAR	0.867	0.858	0.882	0.985	0.893	1.038	0.908	1.055
	(0.22)	(0.22)	(0.44)	(0.87)	(0.54)	(0.72)	(0.67)	(0.49)
	(F_1^D, F_2^D, F_3^D)		(F_1^D, F_2^D, F_3^D)		(F_1^D, F_2^D)		(F_1^D, F_2^D)	

Notes: This table reports the Relative RMSFEs (the RMSFEs of factor models relative to the RMSFEs of two benchmark models) for *h*-steps ahead forecasts. For each class of factor models, the results for the models with the least RMSFE are reported. The second row of this table for each class of factor models is the factor(s) name(s) which produce the most accurate forecast. The third row for each model represents the P-value of Modified Diebold Mariano test. 5 percent significance level is denoted by two asterisks. The estimation period is 1990:2-2008:2 and the forecast evaluation period is 2008:3-2012:1.

In Table 2, the relative RMSFEs, calculated as the RMSFE of a factor model divided by the RMSFEs of the AR and SES models, and the results of the Modified Diebold-Mariano test[1] are shown. The results show that in most cases the performance of the factor models is better than the AR model, but is not better than the SES model, based on relative RMSFEs. For all horizons, the FAVAR model is the most accurate one. Based on Diebold Mariano test, only for the horizon of two-step ahead, the performance of the ARX and ARMAX models are significantly better than the AR model (at 5% significance level). In the horizons of one, three and four-step ahead, the performance of factor models are not significantly better than AR model. Also, in all horizons, there is no significant difference between the forecast accuracy of factor models and SES benchmark model.

Figure 3 shows the performance of the most accurate factor model (FAVAR) at each forecast horizon. Also, in each forecast horizon, the best benchmark model is shown.

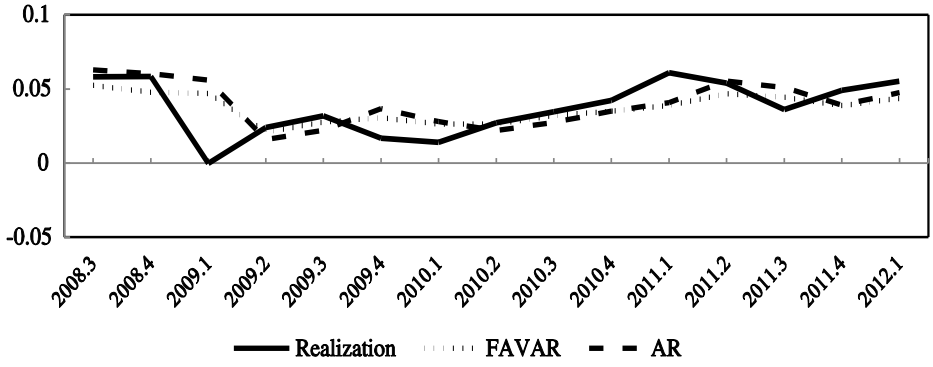
4. Conclusion

In this paper, we examined whether incorporating the information of CPI sub-aggregates into forecasting models increases the accuracy of forecasts of inflation. The results show that, in general, the factor models, where the factors are extracted from CPI sub-aggregates, outperform the AR model, as one of the benchmark models. Therefore, we can conclude that the information of CPI sub-aggregates has value-added in improving the accuracy of forecasts of inflation.

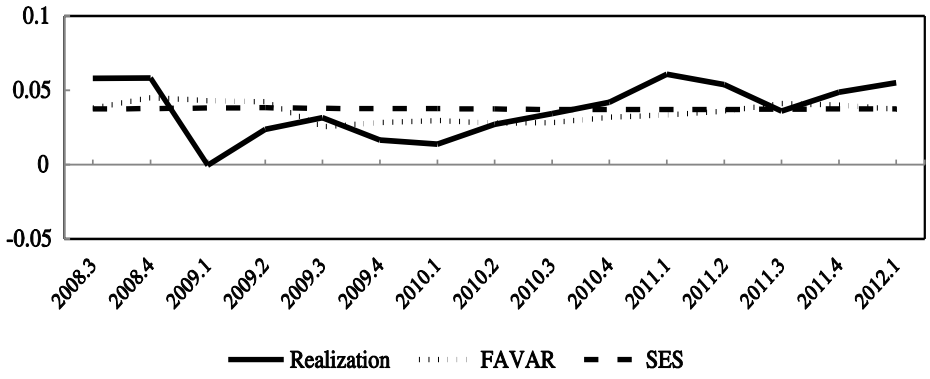
1. The Modified Diebold-Mariano test examines if model A significantly outperforms model B in terms of forecast accuracy. For more information, see Harvey *et al* (1997).

Figure 3: Out of sample forecasts by the factor models

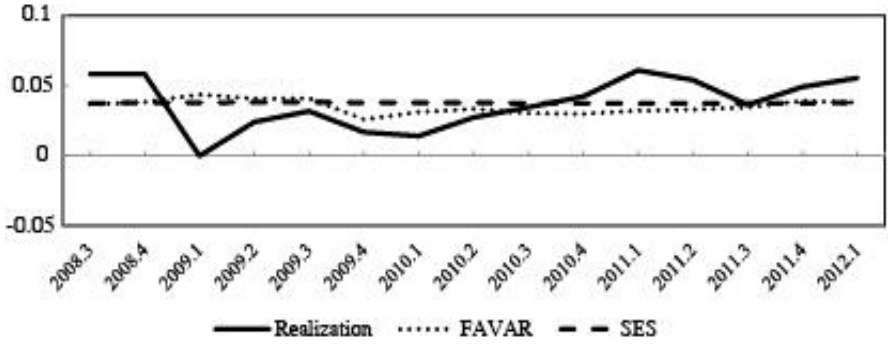
a. One-quarter ahead horizon



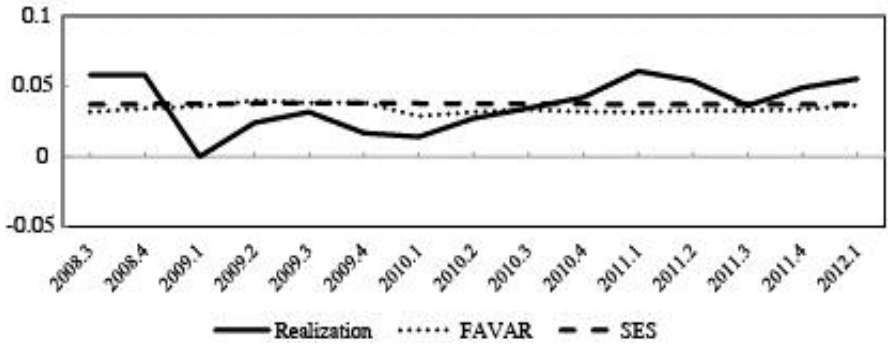
b. Two-quarter ahead horizon



c. Three-quarter ahead horizon



d. Four-quarter ahead horizon



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A Model of Financial Shocks at Bank and Interbank of Iran (DSGE)

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Abstract

This paper proposes a fully micro-founded framework that incorporates optimizing banks into a DSGE model, and evaluates the role of banks and financial shocks in the Iranian business cycles. We consider banks that offer different banking services and interact in an interbank market. Loans are produced using interbank borrowing and deposits. Banks have monopoly power, but cannot set nominal deposit and prime lending rates. The model also includes financial and unconventional monetary policy shocks. The main findings are: (1) Capturing the key features of the economy of Iran; (2) bank behavior substantially affects credit supply conditions and the transmission of different shocks; (3) financial shocks have significant effects on the Iranian business cycle fluctuations.

Key words: *Banks, Interbank market, Financial shocks, Monetary policy*
JEL Classification*: E12, E32, E37, E44, G21, G33*

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1. Introduction

The ongoing global financial crisis underscores the need to develop DSGE models with real financial linkages and an active banking sector. Such a model would allow an empirical evaluation of banks' role and behavior in the transmission and propagation of supply and demand shocks, and an assessment of the importance of financial shocks as a source of business cycles. The banking sector, however, has been ignored in most DSGE models used for policy purposes. Moreover, in the literature, financial frictions are usually modeled on the demand side of the credit market using either the Bernanke, Gertler and Gilchrist (1999) financial accelerator mechanism (BGG, hereafter) or the Lacovello (2005) framework. In light of the ongoing financial crisis, real financial linkages have become the focus of attention.

This paper proposes a micro founded framework that incorporates an active banking sector and a credit market into a DSGE model with a financial accelerator a la BGG (1999). The model is calibrated to the economy of Iran and is used to evaluate the role of profit-maximizing banks in business cycles and in the transmission and propagation of shocks to the real economy, to assess the importance of financial shocks in explaining macroeconomic fluctuations, and to examine the potential role of unconventional monetary policies (quantitative and qualitative monetary easing) in offsetting the real impacts of the financial crisis.

The paper is related to the following studies: Lacoviello (2005, 2011), Gerali et al. (2010), Smits and Wouters (2007), Dib (2012) De Walque (2010) and Giri (2014). Our basic model is based on BGG (1999). The key additions to this model are the supply side of the credit market and an active banking sector.

This paper explains two phenomena. First, banks confront with various risks because they play an important role in financing. These risks include

the risk of mismatch between assets and liabilities which leads to shortage of liquidity and liquidity risk. When banks confront with liquidity shortage they can borrow from the central bank through the credit lines or other banks that have excess fund. Borrowing from the central bank has inflationary effects while the transfer of surplus funds from institutions with excess liquidity to institutions with liquidity shortage will have not an inflationary effect. Banks also have credit risks, because firms default on their borrowings from banks.

Interbank market is one component of money market where banks and other credit institutions engage in transactions with each other for short-term financing. This market plays two vital roles in new financial systems. The first and most important role is the central bank leading to intervene actively and effectively in the implementation of monetary policy through interest rates. Second, efficient interbank markets, transfer liquidity from financial institutions with surplus funds to institutions with deficit funds.

This paper assumes defaults on banking credit and interbank borrowing. Because of relationship with the banks in interbank market and the real economy, a bank can also transfer any kind of risk to other banks and to the real sector. If borrowing from the interbank market, which is a type of short-term financing, is defaulted, it will reduce the bank's credit rating and its credit strength.

Therefore, in this article, the default of banking credit and interbank borrowings is designed in the context of a dynamic stochastic general equilibrium model to study and analyze the real effects. The overall structure of the paper is as follows. Section 2 presents methodology. Section 3 gives literature review. Section 4 presents the model. The parameter estimation is represented in section 5. Section 6 presents Impulse-response Function. Conclusion is described in section 7.

2. Methodology

2.1. Banks and Interbank Markets

Banks are a particular type of economic entity, characterized by the provision of maturity transformation to other agents within the economy. This brings with it a particular kind of risk to which any bank is necessarily exposed. This risk consists of the different maturity profiles of the assets and liabilities in its portfolio, since it is usually not possible to match any sudden outflows from deposits with inflows from a portfolio of loans.

The management of this phenomenon is a major part of a bank's business. In order to meet expected withdrawals, some proportion of total deposits is kept in the form of reserves (for example as deposits with the central bank) and a stock of liquid short term assets is generally kept on the balance sheet. Since reserves generally earn a much lower return than funds invested in other financial assets or loans, there exists a trade-off between safety and profitability.

Reserves are also used by banks to settle transactions between each other as part of normal business. When a depositor of one bank withdraws funds and uses them in a transaction, a different individual will ultimately deposit them at a (potentially) different bank. This requires a transfer of reserve funds from one bank to another. This type of transfer, of which millions occur on any given day, will affect the reserve holdings of individual banks, but would not affect the aggregate stock of reserves. Apart from transactions between the treasury and the central bank, there are only two forces which may change this aggregate. The first is obvious: if the depositor withdrew the funds and held them in the form of cash without depositing them, there would be a debit from his banks' reserve account, but no credit to any other bank. The total stock would thus have decreased. Of course, the converse process also occurs on a daily basis.

However, the total stock of reserves does not generally change a great deal, since the popular requirement for physical cash is relatively stable. The

other force which may change reserve holding, namely the central bank itself, may be more important in that sense. Modern central banks have three different means of injecting or withdrawing reserves from the system. By far the most commonly used are their open market operations, which are in effect auctions aimed at buying or selling reserve funds in order to change the aggregate.

When a bank finds itself in the difficult position of facing liquidity shock large enough to prompt an immediate requirement for additional reserves, it may also access discount lending facilities. Since these programs charge interest rate some margin above policy rates and need for their signals, some failure in liquidity management occur, these emergency facilities are used more rarely.

It should be noted then that the interbank market in which banks trade reserve funds do not affect the aggregate stock of reserves. Instead, they can only serve to help banks in their individual reserve management. This implies that there are two sides to any trade in this market. On one hand, those banks which believe that their depositor's liquidity needs will be low for a given period, may choose to reduce their holding of reserves without fully committing to lending the funds as illiquid loans into the real economy. On the other, should a bank's estimation turn out to be incorrect, the difference can be made up quickly within the market by borrowing or lending funds and thus balancing the books. Interbank markets are then credit markets, in structure somewhat similar to any other market. Although they are of particular importance to the functioning of the monetary system, in principle lending banks face credit risks not dissimilar to those they face when lending to other types of agents in the economy. Although such risks were previously considered to be very low, the financial crisis of 2007/2008 highlighted that their management can be critical to the funding strategy and indeed the survival of a large financial institution [Weltewitz (2009)].

2.2. Recent Theoretical Developments in the Analysis of Interbank Term Structures

Perhaps the closest paper in relation with this paper is developed by Heider, Hoerova & Holthausen (2009), who present a model of an interbank market under adverse selection. In keeping with much of the modeling of banks, some proportion of the market in their model suffers a liquidity shock as impatient consumers withdraw their endowments. Banks must decide whether to invest those endowments in a liquid short-term or asset or a risky, illiquid long term alternative. When they face withdrawals, they must then choose whether to liquidate some of their long-term assets or keep them until maturity and instead secure funding for the meantime from other banks. Due to the difference in riskiness between long-term assets (the precise knowledge of which is private), some banks will be willing to lend, while others become borrowers.

Since those banks with a safer asset are assumed to be able to liquidate it at a lower cost, they will be the first ones to do so if the interbank interest rate increases beyond a critical value. This gives rise to an adverse selection problem. The authors derive a risk premium, which increases unequivocally as adverse selection becomes a bigger problem, which occurs when the expected riskiness of long-term assets increases. Indeed, the authors show that it is possible that the interbank market breaks down entirely, given sufficiently risky assets.

Although this analysis is close in spirit to the one proposed here, its approach is fundamentally different. In Heider et al.'s (2009) paper, interbank markets are defined to have only one maturity. By using the methodology of game theory, it is proposed in this thesis that asymmetric information and perceived increased riskiness does in fact have an impact across the entire term structure of contracts traded between banks.

One of the more recent applications of screening methods is presented by Acharya & Viswanathan (2008), who introduce asset pricing in their bi-dimensional loan contract model in which firms pledge collateral to

counteract a moral hazard situation in a credit market. Since the authors introduce a delay in asset liquidation when firms fail to repay loans, liquidity shocks can have a contagion effect in their model. As in Bester (1987), credit rationing would occur in a pooling equilibrium and as a result, pledging cash collateral is an optimal strategy, requiring sales of assets by the borrower. By modeling a market for asset sales, the authors establish that by posting collateral, not only is rationing weakened, but asset prices are actually more stable than what would have been the case otherwise. The relationship between asset pricing and credit markets is obviously a direct link with the proposed research.

Another model of immediate significance to the research question is presented in Freixas & Jorge (2008), which focuses on modeling interbank markets. In particular, it makes use of a screening game to explain why a lending channel of monetary transmission may exist. As such, it is a model of the interbank market at the core of the broader term structure. In their model, Freixas & Jorge demonstrate a situation in which banks in interbank markets can be rationed, and thus are unable to provide funds to positive NPV projects in the real economy. The authors produce this result by referring to a chance that banks suffering large liquidity shocks may borrow in order to finance a private benefits project. In the ensuing screening game (in which contracts are defined in terms of an interest rate and loan size), borrowing banks that are undertaking this gamble want to maximize the loan they take out. Indeed it is shown that there exists a loan size above which only such bad banks would be attracted and lenders would thus have an incentive to decrease the size, resulting in Type I credit rationing.

3. Literature Review

After the banking crisis in 2007, the importance of relationship of banking sector with the real sector was more than ever before. Therefore, modeling

the transmission of shocks from the banking sector to the real sector was entered into the DSGE models. In the literature on closed economy models, the two main ways in which an active banking system is incorporated into DSGE models with financial friction, is through the external finance premium proposed in Bernanke, Gertler and Gilchrist (BGG, 1999) or through Collateral constraint tied to real estate values for entrepreneurs proposed in Lacoviello (2005). Gerali and et al. (2010), Smits and Wouters (2007) designed DSGE models based on the framework of the banking sector, households and firms. While the banking sector and financial intermediaries receive deposits from households and supply credit to firms, Lacoviello (2011) introduces a banking sector with one bank and focuses on how financial shocks (repayment shocks) affect an economy with patient and impatient households. This group of studies has not addressed the role of the interbank market at the balance sheet shocks transmitted to the real economy. But the effect of shocks as banks default shocks on the real sector has been discussed. The results represent reduced credit supply and thus, reduced economic growth.

Another group of studies have entered interbank issue at DSGE model. Giri (2014) has considered two types of banks. Banks facing with liquidity shortage for credit supply and thus borrow from the interbank market and give credit to the real sector; the second group of banks that have excess funds, lend to interbank and invest in less risky assets such as bonds. Results suggest that credit shocks in the interbank market, has reduced the supply of loans from the banking sector to the real sector of the economy, and then, has reduced investment and economic growth. On another hand, the credit shock in the interbank market raises the interest rates of credit at the interbank market.

While modeling the interbank market, Dib (2010) has assumed that banks are related together through the interbank market. Banks are financed through borrowing from the interbank and capital market. Banks have monopoly power to set interest rates on deposits and loans. Combined

portfolio and leverage ratios are determined exclusively. They may default the borrowings from other banks. In addition, shocks starting from the banking system are also investigated as monetary policy shocks. The main findings of the paper show that default at the interbank market reduces the bank's capital and has a negative effect on production. Deposits and borrowings from the interbank market affect the supply of credit and production. Increased default of borrowing from other banks in the interbank market will increase inflation and policy interest rate.

De Walque et al. (2010) have considered interbank market and regulatory sectors in DSGE. This model has considered the interaction between the banking system and the real sector of the economy and the importance of stabilizing the financial sector and regulatory policy. In this model, three assumptions have been made. First, firms face default regarding to banks. Second, banks in the interbank market confront with nonperforming loans. Third, lack of liquidity at interbank is compensated with liquidity injection from the central bank. Results indicate that nonperforming at firms causes nonperforming at interbank, then reduces the credit supply and growth but increases inflation. NPLs appear with a lag of several years from decreasing of growth rate.

4. The Relationship between the Banking System and Business Cycle in Iran

To understand the relationship between the variables of the banking sector and business cycle, we analyze the amount and direction of correlations between bank variables, including deposits, credit facilities, the NPL and business cycle. We use HP filter to extract cyclical components of these variables.

Variables of banks such as deposit and loans change direction with the business cycle, as the boom have ascended and descended during the

recession. This situation, confirms the correlation coefficient that shows the magnitude of correlation between variables and GDP volatility. Correlation between domestic production and deposit is 0.33 and correlation between domestic production and loan is 0.51, which indicate that there is a positive correlation between GDP and banking variables. Loans are more volatile than GDP but deposit swings.

Figure 1: Cycle component of deposit, loan and GDP

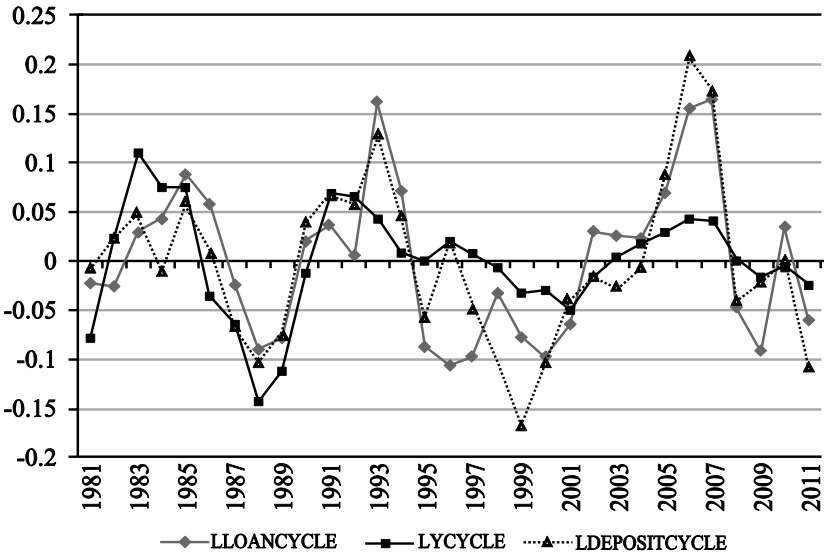


Figure 2 shows NPL and GDP move in opposite directions. Even in the boom period, NPL dropped and in the recession increased. So GDP and NPL have a negative correlation.

Figure 2: Cycle component of GDP and NPL

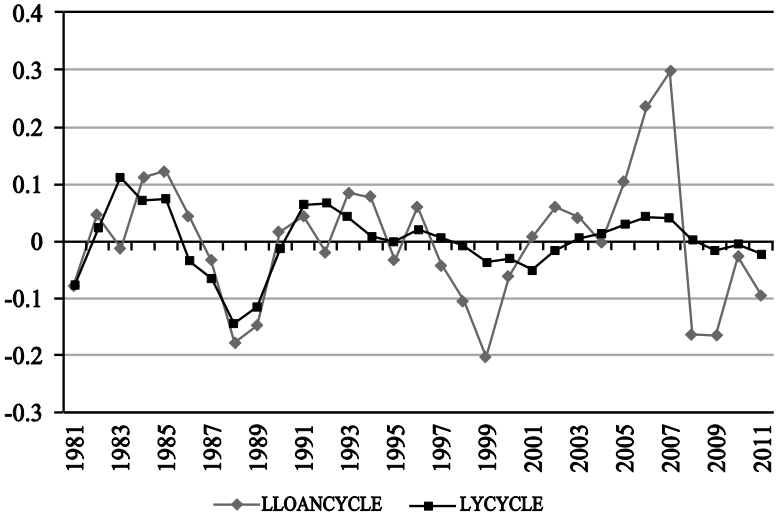
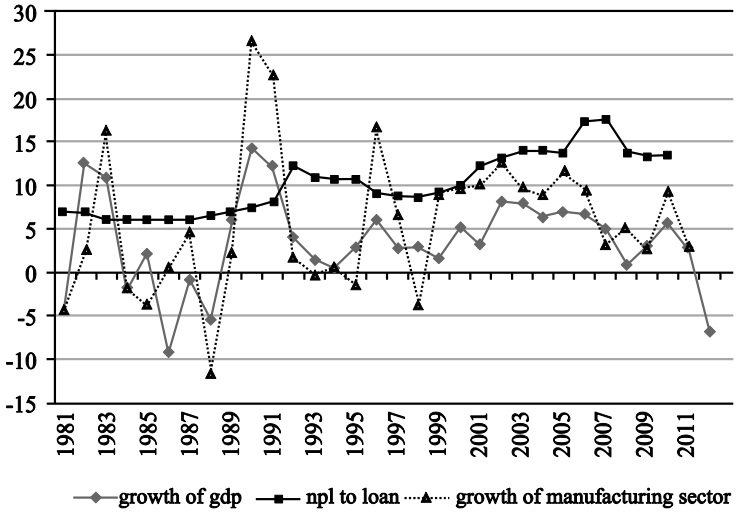


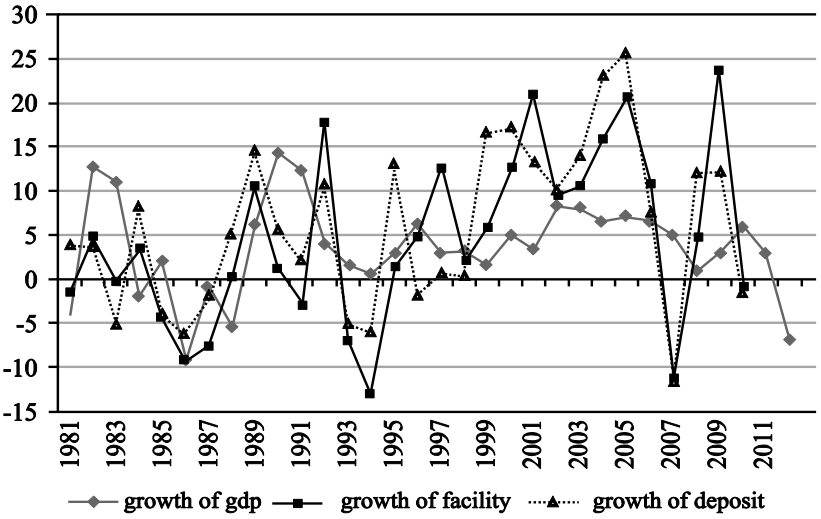
Figure 3: Growth of GDP, growth of manufacturing sector and NPL to loan



As Figure 3 shows, when economic growth and the growth of industrial sector was negative, NPL to total loans increased after two lags. For example, in 1986, 1988 and 1998 when the growth of the manufacturing sector was negative, economic growth has been negative. NPL to total loans has positive growth in the years 1991 and 1992. The economic slowdown and reduced growth of the manufacturing sector reduce manufacturing sector's ability to repay loans from the banking network.

As in Figure 4, it is observed that deposit and facilities of banks have similar fluctuation. In other words, increase of bank liabilities increases lending power. But economic growth follows the behavior of liabilities, with a lag period. With reduced resources, and consequently the cost of the bank in each period, economic growth is decreased in the postwar period. For example, despite the reduction in growth of deposits and funds starting in 1996, the economic slowdown started in 1996.

Figure 4: Growth of facility, deposit and GDP



Note: Economic growth is specified at right axis and deposit and facilities on the left axis.

5. Structure of the Model

As pointed out by Giri (2014), we assume banking sector confronts with shortage of liquidity and borrows from interbank. Like De Walque et al. (2010), it is assumed that banks borrow from interbank, but they don't pay off on time. We suppose nonperforming loan at interbank, because in recent years some banks have not reimbursed their borrowing from interbank on time. Furthermore, interbank market can confront with risk of non-repay fund and due to the significant role of the banking system in financial markets; it will have deleterious effects on macroeconomic variables such as output and inflation.

5.1. Households

Households have constraints and decide the amount of consumption, the amount of labor they wish to supply to the production sector and the amount of liquidity according to the following utility function:

$$\sum_{s=0}^{\infty}(\beta^h)^s E_t\left[\frac{(c_t)^{1-\sigma_c}}{1-\sigma_c}-\frac{N_t{}^{1+\sigma_n}{}_t}{1+\sigma_n}+\frac{1}{1-\vartheta}\left(\frac{M_t{}^h{}_t}{P_t}\right)^{1-\vartheta}\right] \tag{1}$$

Where β is the inter-temporal discount factor, c_t denotes real consumption, N_t is supply of labor in goods sector, $M_t{}^h$ is the liquidity at households. σ_c denotes inverse of the elasticity of inter-temporal substitution of consumption, σ_l is inverse of elasticity of inter-temporal substitution of labor, and ϑ is elasticity of liquidity of household. They are subject to the budget constraint:

(2)

$$m_t^h+c_t+d_t+i_t=w_tN_t+(1+r_{t-1}^d)\frac{d_{t-1}}{\pi_t}+r_t^k k_t+\frac{m^h{}_{t-1}}{\pi_t}+t_t+\frac{\pi_t^f}{p_t}+\frac{\pi_t^b}{p_t}$$

Where w_t is the real wage, t_t is tax, $1+r_t^d$ is the interest rate that households receive from bank, $D_t = \int_0^1 D_{jt} d_t$ is the deposit, π_t^f is profit of production sector and π_t^b is banking profit, π_t is inflation, k_t is quantity of capital, and i_t is investment. Investment is added to capital stock at the beginning of the period and creates future capital stock. k_{t+1} is obtained:

$$k_{t+1} = (1-\delta)k_t + i_t \tag{3}$$

Where δ is depreciation rate. Let's obtain first order conditions with respect to c_t , N_t , d_t , m_t^h , k_t .

5.2. Final Good Producer

Final good producer buys intermediate goods that are shown with j, and produces final goods by using Dxit- Stieglitz.

$$Y_t = \left(\int_0^1 Y_{jt}^{\left(\frac{\theta-1}{\theta}\right)} d_j \right)^{\frac{\theta}{\theta-1}} \qquad \theta \succ 1 \tag{4}$$

Where Y_{jt} is intermediate goods, θ is constant elasticity of substitution between intermediate goods. Final good producers try to determine their purchases of intermediate goods according to different prices to obtain maximum profit. Demand function for each product by any intermediate producer can be obtained:

$$Y_{jt} = \left(\frac{P_{jt}}{P_t} \right)^{-\theta} Y_t \tag{5}$$

Price for final goods is:

$$P_t = (\int_0^1 P_{jt}^{1-\theta} d_j)^{\frac{1}{1-\theta}} \quad (6)$$

5.3. Intermediate Producer

Production sector, characterized by monopolistic competition and Rotenberg pricing, adopts a standard Cobb-Douglas production function with capital k_t , and labor N_t subject to productivity shocks.

$$Y_{jt} = A_t N_{jt}^{1-\alpha} K_{jt}^{\alpha} \quad (7)$$

Where $\alpha \in (0,1)$ is elasticity of production with respect to capital.

$$A_t = \rho_A A_{t-1} + (1-\rho_A)\bar{A} + \varepsilon_{A,t} \qquad \varepsilon_{t,A} \approx N\left(0, \sigma_{\varepsilon_{t,A}}\right) \text{ و } \rho_A \in (0,1) \quad (8)$$

A_t is technology shock. At the beginning of every period, each firm j receives l_{jt} from the bank and is financing γ_t proportion with cost of capital stock and labor. γ_t is:

$$\gamma_t = (1-\rho_\gamma)\bar{\gamma} + \rho_\gamma \gamma_{t-1} + \varepsilon_{\gamma,t} \qquad \varepsilon_{t,\gamma} \approx N\left(0, \sigma_{\varepsilon_{t,\gamma}}\right) \text{ و.} \quad \rho_\gamma \in (0,1) \quad (9)$$

l_{jt} is:

$$L_{jt} = \gamma_t \left(P_{jt} r_t^k K_{jt} + P_{jt} W_t N_{jt}\right) \quad (10)$$

They pay r_{jt}^l which is the interest rate of loan. Adjustment cost confronted by firms is:

$$PAC_t^j = \frac{\varphi_f}{2}\left(\frac{P_{jt}}{(\bar{\pi})P_{jt-1}} - 1\right)^2 Y_t \tag{11}$$

Where $\varphi_f \geq 0$ is adjusted cost parameter, $1+\pi_t$ is inflation rate, Y_t is total production. The marginal cost is:

$$mc_{jt} = \frac{\left[\gamma_t (1+r_t^l) w_t\right]^{1-\alpha} \left(\gamma_t (1+r_t^l) r_t^k\right)^{\alpha}}{\alpha^{\alpha}(1-\alpha)^{1-\alpha} A_t} \tag{12}$$

Firms wish to maximize profit:

$$\pi_{jt}^f = P_{jt}Y_{jt} - P_t mc_t Y_{jt} - PAC_t^j \tag{13}$$

Then obtain first order conditions with respect to, k_{jt}, N_{jt} and P_{jt}.

5.4. Commercial Banks

This paper models banks by introducing monopolistic competition, but interest rates of deposit and loan are determined by the central bank. They intermediate all the transactions among agents. They collect deposit D_{jt} from household and set deposit rate r_t^d as a markdown below the loan rate r_t^l. They also make claims against firms and receive r_t^l. In each period, firms are faced with nonperforming loan rate α_t^b and banks receive $(1-\alpha_t^b)r_t^l$.

$$\alpha_t^b = \rho_{\alpha b}\alpha_{t-1}^b + (1-\rho_{\alpha b})\bar{\alpha} + \varepsilon_{t,\alpha b} \qquad \varepsilon_{t,\alpha b} \approx N(0, \sigma_{\alpha b}) \tag{14}$$

α_t^b is nonperforming loan shock.

If the bank is faced with a shortage of funds, it borrows from the interbank market D_t^i and pays r_t^i. Banks set interest rate of interbank by

mutual agreement. r_t^i must be less than r_t^l and more than r_t^d. If r_t^i is more than r_t^l, they don't want to extend loans to firms, because claim to interbank is riskless and has high yield. Banks need a certain amount of borrowing from interbank and deviation from steady state equilibrium condition brings quadratic cost: $\frac{1}{2}\varphi di\left(\frac{D_t^i}{\overline{D}}-1\right)^2$

Where φdi is quadratic cost parameter. γ_t^i is non-repayment ratio of due to interbank. If banks cannot repay timely, they are confronted with cost: $\frac{1}{2}\varphi\gamma di\left[\gamma_t^i d_t^i\right]^2$

$$\gamma_t^i = \rho_\gamma \gamma_{t-1}^i + (1-\rho_\gamma)\overline{\gamma} + \varepsilon_{t,\gamma} \qquad \varepsilon_{t,\alpha b} \approx N(0,\sigma_{\alpha b}) \tag{15}$$

where the above equation shows the non-repayment ratio of due to interbank shock.

Due to interbank is:

$$d_t^i = (d_{t-1}^i)^{\phi_{di}^{di}} (y_t)^{\phi_{di}^{y}} \varepsilon_{t,di} \tag{16}$$

$\kappa K_t \alpha_t^b$, represents what the bank earns in the case of default, that under limited liability, the effective value of collateral pledged by borrower is κK_t. Raw collateral consists therefore of the physical assets of the firm and κ measures the degree of credit market imperfections.

Accordingly, profit of banks is:

$$\pi_t^b = (1-\alpha_t^b)(1+r_t^l)L_t + \kappa K_t \alpha_t^b - (1+r_t^d)D_t - (1+r_t^i)\gamma_t^i D_t^i \tag{17}$$
$$-\frac{1}{2}\varphi_{di\gamma}\left[(1-\gamma_t^i)D_t^i\right]^2 - \frac{1}{2}\varphi_{di}\left[\frac{D_t^i}{\overline{D}_i}-1\right]^2$$

Balance sheet of banks is:

$$l_t = d_t^i + (1-\eta_t)d_t \tag{18}$$

Where η_t is reserve requirement.

Banks maximize profit subject to d_t^l, l_t, d_t.

5.5. Central Bank

Central bank is able to set loan interest rate and reserve requirement. Loan Interest rate is:

$$(1+r_t^l) = \left(\frac{1+r_{t-1}^l}{1+\bar{r}^l}\right)^{\rho_r} \left(\frac{1+\pi_t}{1+\bar{\pi}}\right)^{\rho_\pi} \left(\frac{y_t}{\bar{y}}\right)^{\rho_y} \left(\frac{\mu_t}{\bar{\mu}}\right)^{\rho_m} + \varepsilon_{l,t} \tag{19}$$

Where $\rho_y, \rho_\pi, \rho_m, \rho_r$ are the weights assigned to the output, inflation stabilization, growth of money and interest rate of previous period. Growth of money is:

$$\mu_t = \frac{M_t}{M_{t-1}}(\pi_t) \tag{20}$$

Reserve requirement is:

$$\eta_t = \pi_t^{\phi_\eta^\pi} \eta_{t-1}^{\phi_\eta^\eta} \varepsilon_{t,\eta} \tag{21}$$

ϕ_η^π , ϕ_η^η are weights assigned to inflation rate and reserve requirement at previous periods.

5.6. Government and Oil Sector

Government is financed with tax t_t, oil revenue or_t and money m_t. Government expenditure is:

$$g_t = t_t + or_t + m_t - \frac{m_{t-1}}{\pi_t} \tag{22}$$

Tax is:

$$t_t = y_t^{\varphi_t^y} \tag{23}$$

Where is weight of output. Oil revenue shock is:

$$\mathrm{or_t} = \rho_{\mathrm{or}}\mathrm{or_{t-1}} + (1-\rho_{\mathrm{or}})\,\mathrm{o\bar{r}} + \varepsilon_{\mathrm{or,t}} \qquad \varepsilon_{\mathrm{t,or}} \approx \mathrm{N}(0, \sigma_{\varepsilon \mathrm{t,or}}) \tag{24}$$

$\bar{or}$ is oil revenue at steady state.

5.7. Market Clearing

In equilibrium, the output and liquidity market must clear:

$$y_t = c_t + i_t + g_t + AC_t \tag{25}$$

$$m_t = m_t^h + d_t \tag{26}$$

6. Estimation

6.1. Methodology and Stylized Facts

This paper uses Bayesian techniques to estimate the structural parameters of the model. First, we obtain the first order condition and linearize them, which are explained in Appendix A and B. Then we solve the model. We use the Kalman filter to drive the likelihood function and find the expression of log posterior Kernal. Second, for given parameter values and the given sample data, we maximize the log posterior Kernal, we used Monte Carlo method such as Metropolis - Hastings algorithm to obtain the posterior distribution. The posterior means of the parameters are then used to draw statistical inference on the parameters. The Sample runs during 1981-2012.

6.2. Calibrated Parameters

We fix some parameters, because they are either notoriously difficult to estimate or because they are better identified using other information. Adjusted cost of capital, adjusted cost of inflation, quadratic cost parameter of due to interbank and cost of non-repayment are in line with the literature [Wooters (2007), Dib (2010), De Walque (2010)]. Adjusted cost of capital φ_k is 8.6., adjusted cost of inflation φ_π is 4.26. Quadratic cost parameter of due to interbank φdi and cost of non-repayment $\varphi di\gamma$ are 0.001 and 679. Some parameters are calibrated appropriately for the economy of Iran e.g. ϕ_{di}^{di} and ϕ_{di}^{y} are 0.46 and 0.347.

We compare means, standard deviation and auto correlation to assess the model. Table 1 shows moments and table 2 shows auto correlation for some variables. They show that, the model simulates economy of Iran appropriately.

Table 1: Moments

Standard deviation		**mean**		
real	**model**	**real**	**model**	
1.99	2.041	255027.13	254932.02	Gross domestic product
2.12	2.15	17.5321	17.5328	Inflation
1.64	1.56	16781.19	16797.98	Loan
1.52	1.54	1602.74	1603.26	Deposit

We use Eviews software to calculate autocorrelation for real variables, and then compare them with simulated model. Results show the real and simulated models are similar and this model is appropriate for the economy of Iran (see Table 2).

Table 2: Auto-correlation, real and simulated

Simulated auto-correlation		Real auto-correlation		
Second lag	**First lag**	**Second lag**	**First lag**	
0.61	0.81	0.79	0.89	Gross domestic product
0.37	0.07	0.42	0.08	inflation
0.72	0.78	0.72	0.87	loan
0.73	0.78	0.75	0.89	deposit

6.3. Prior and Posterior Estimates

Prior and Posterior Estimates are reported in Table 3. The method used to obtain the initial values of the parameters includes some parameters such as discount rate and depreciation rate that are identified by solving the model. The weights assigned to the output, inflation stabilization, growth of money and interest rate of previous period, weights assigned to inflation rate and reserve requirement at previous periods and weights of output are estimated by Eviews according to their functions. Parameters of shocks are also estimated by Eviews software according to the following equation:

$$\log(X_t) = c + \rho \log(X_{t-1}) + \varepsilon_{x_t}$$

Where ρ is Autoregressive Coefficient and its standard deviation of ε_{x_t} is used as a standard deviation of variable. Productivity shock is selected according to the structure of the model. Distribution of parameters is selected based on the characteristics of parameters and features of the distribution.

Table 3: Prior and Posterior

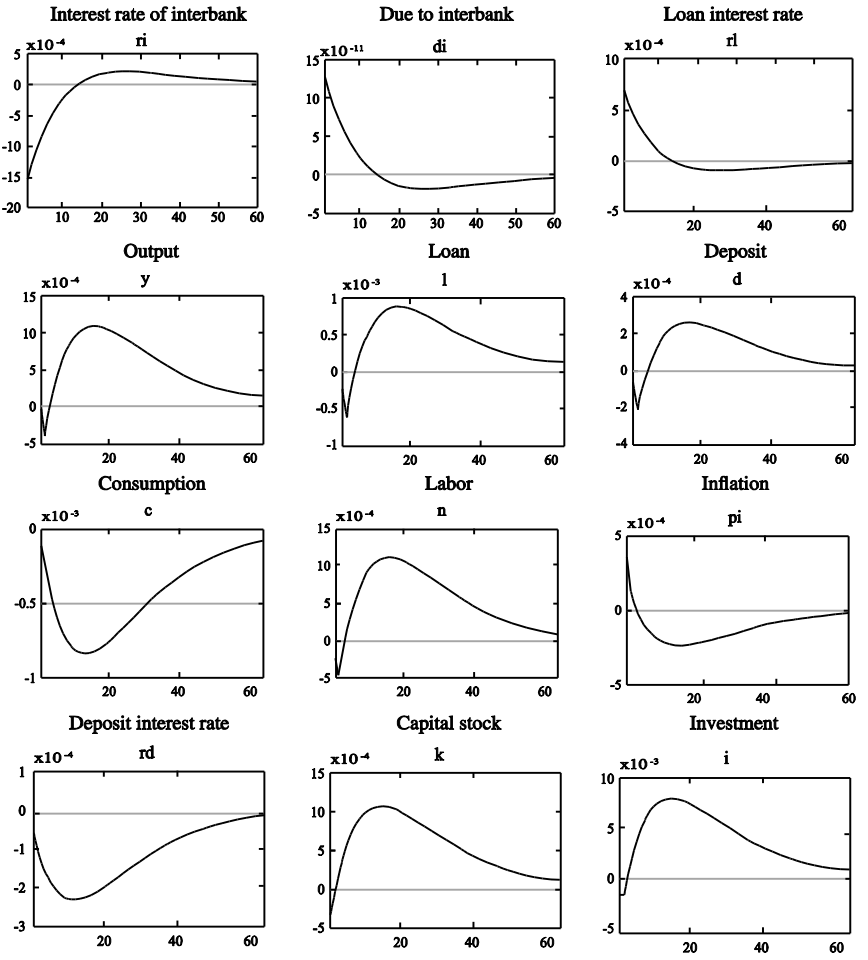
Parameters	Prior distribution		Calibrated from	Posterior distribution	
	Mean	deviation		mean	deviation
σ_c	0.93	0.01	Author's calculations	0.9378	0.1
σ_n	0.63	0.01	Author's calculations	0.6394	0.05
ϑ	0.67	0.01	Author's calculations	0.6697	0.01
δ	0.24	0.01	Solving model	0.06	0.05
θ	4.33	0.01	Mark-up 30%	4.35	0.05
β	0.97	0.01	Solving model	0.9699	0.001
α	0.78	0.01	Author's calculations	0.8167	0.05
ρ_A	0.53	0.01	appropriate structural of model	0.5038	0.05
ρ_{or}	0.56	0.01	Author's calculations	0.5524	0.05
ρ_{pi}	0.89	0.01	Author's calculations	0.6268	0.05
ρ_{mio}	0.82	0.01	Author's calculations	0.5606	0.05
ρ_y	0.36	0.01	Author's calculations	0.3626	0.03
ρ_{γ^i}	0.65	0.01	Author's calculations	0.63	0.05
ϕ_η^π	0.062	0.01	Author's calculations	0.059	0.01
ϕ_η^η	0.83	0.01	Author's calculations	0.83	0.001
κ	1.5	0.01	Collateral to loan ratio	2	0.1

7. Impulse Responses

In this section we want to assess whether and how the transmission of shocks is affected by bank intermediaries in the context of the closed economy with

interbank. We consider three shocks. The first is financial shock, and the second is monetary policy shock (demand shock). The third is technology shock (supply shock).

Figure 5: Non-performing loan shock



7.1. Financial Shocks

The introduction of the nonperforming loan (NPL) shock is to understand the effects of credit losses originating in production sector on business cycles. If sub primers pay back less than expected, bank suffers a loan loss and a reduction in bank capital. As a result, banks either raise new capital or reduce lending if raising new capital is difficult. Hence, the reduction in bank credit propagates recessions.

Figure 5 shows the impulse response of Iranian NPL shock on the economy of Iran. The consequences of the NPL shock on the domestic economy in this model are in line with Lacoviello (2011). NPL shock transmits to the economic activity through the following channels:

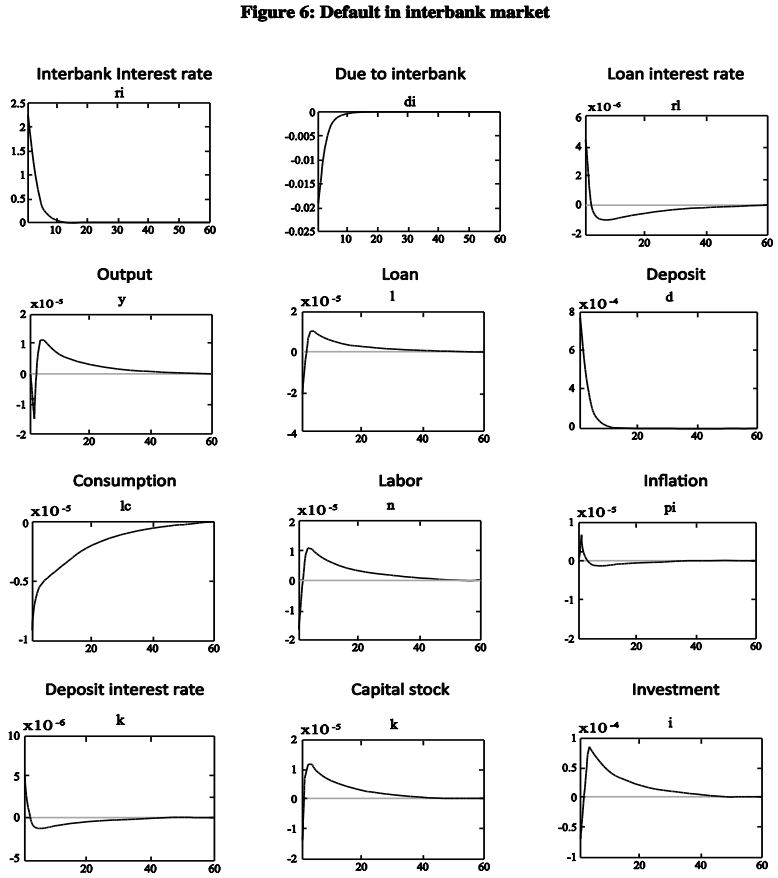
First, the NPL shock starts with the sub primers who pay banks less than what was initially agreed as their obligations, implying that savers transfer wealth toward the borrowers. When facing a positive shock to wealth, households consume more and withdraw deposit from banks. According to the balance sheet identity, decline in deposits leads to a large drop in loans to entrepreneurs. With the reduced loans, entrepreneurs have to accumulate less capital, so that aggregate output falls, then consumption falls.

Second, since the labor supply is elastic, the labor demand of households will also respond to the fall in output. The households save less because of the reduced savings, the marginal product of labor falls, then output declines. Inflation rises in response to the drop in output. The central bank reacts to the shock by raising the loan interest rate and banks reduce interbank interest rate. Due to falling at interbank interest rate, we see rising of borrowing from interbank. Third, the banking system puts direct pressure on the bank balance sheet by reducing the value of banks assets (loans) relative to liabilities (deposit). Without any further adjustment to either loans or deposits, banks borrow from interbank, hence, raise borrowing from interbank. Because of raising borrowing from interbank, interbank interest rate rises and falling of borrowing from interbank continues. The reduction

of credit supply leads to a further decline in output, thus propagating the credit crunch (See Figure 5).

Figure 6 shows the impulse response of Iranian default shock in interbank on the economy of Iran. The consequences of this shock on the domestic economy in this model are in line with De Walque (2010). This shock is transmitted to the economic activity through the following channels.

Figure 6: Default in interbank market shock



First, default shock at interbank starts with less than initially agreed payment of some banks. This phenomenon leads to fall of confidence between banks and banks cut deposit allocated to interbank lending. Banks with default cannot borrow from other banks and borrow from interbank. Due to default in interbank, interbank interest rate rises, then it raises interbank lending and borrowing.

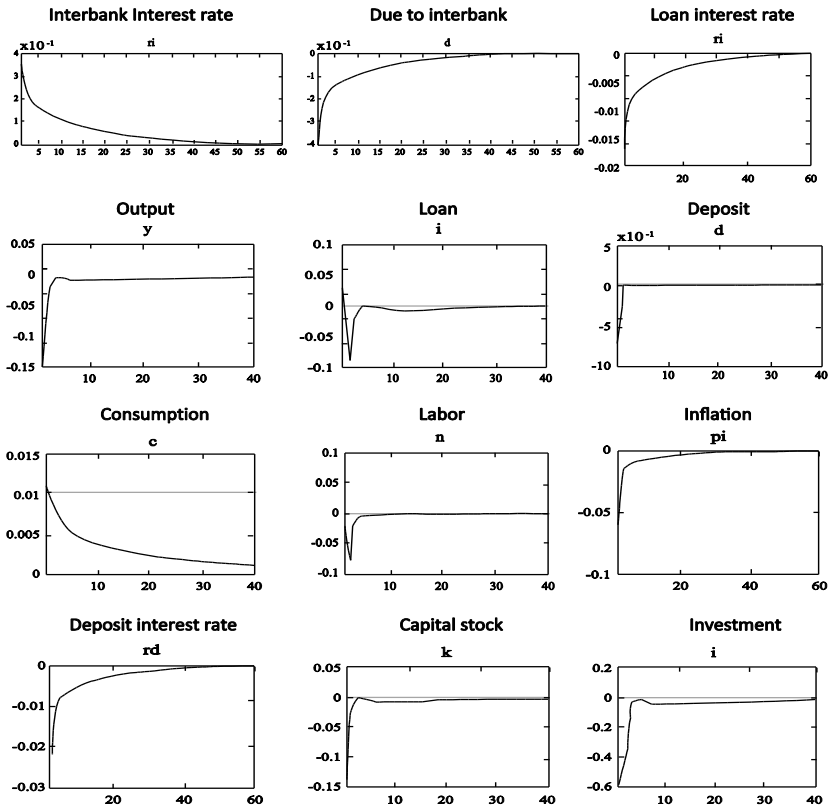
Second, due to default shock at interbank and fall in interbank borrowing, bank funds and loan decrease. Hence, entrepreneurs borrow less and produce less. Output falls and Inflation declines in response to the drop in output. But deposit interest rate rises and households consume less and save more. Then deposit and loan rise in response to the rising in interest rate. This phenomenon leads to rise of capital stock, investment and output, but fall of inflation.

7.2. Monetary policy shock

Next, this paper considers a tightening monetary policy in Iran. Two monetary policies are considered: interest rate and reserve requirement. The role of the banking sector in the transmission of the monetary policy shock has been investigated by previous works such as Christiano et al. (2007), Goodfriend and McCallum (2007) and Gerali et al. (2010). As discussed in Christiano et al. (2007) and Goodfriend and McCallum (2007), Financial frictions enhance the amplitude of business cycles through three channels (borrowing constraint, financial accelerator and nominal debt) besides the traditional interest rate channel. With the existence of banks, the banking attenuator effect identified by Goodfriend and McCallum (2007) and Gerali et al. (2010) is another channel to propagate business cycles. This paper also expects that the banking attenuator effect refers to a sluggish and heterogeneous pass-through of the change the interest rate to monopolistically competitive banks. Here we are not going to highlight how each channel affects the transmission of monetary policy shock, but we focus on the role of the banking sector.

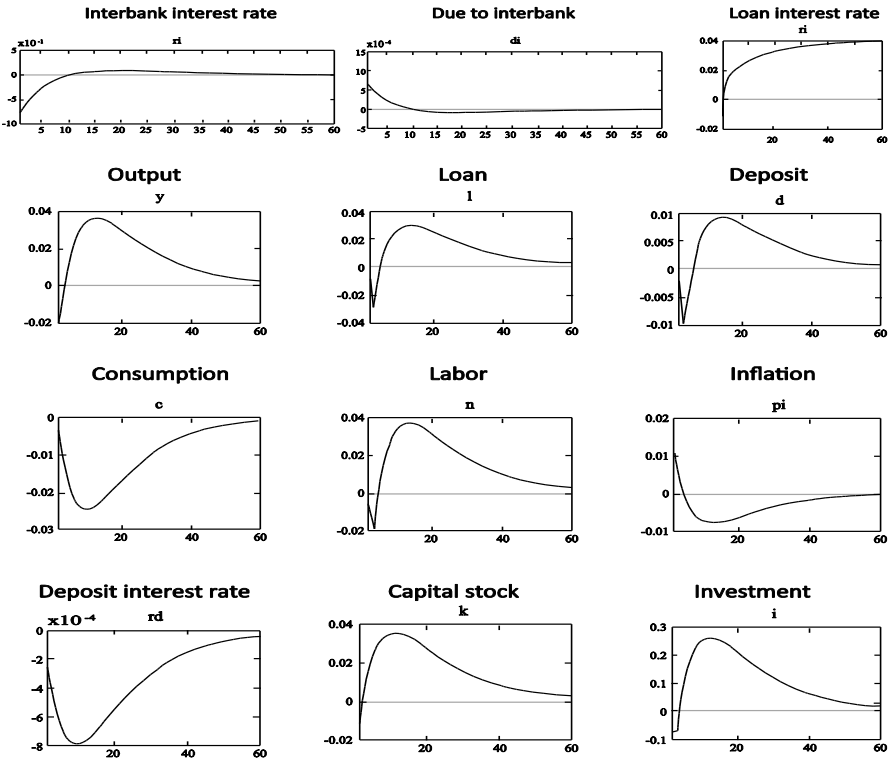
Central bank decreases interest rate. This policy has two effects on banks. First, because of the decreasing loan interest rate, interest revenue decreases and banks decrease deposit rate which leads to decrease of deposits. Households increase consumption and decrease savings. The fall at deposit leads to a further decrease in credit. As a result, investment and output decrease. Cost of production increases and it leads to decrease of inflation. Second, because of decreasing deposit, banks receive loan from interbank; then because of increasing at interbank loan, interest rate of interbank increases, then due to banking system decreases.

Figure 7: Interest rate shock



Central bank raises reserve requirement. Raising in reserve requirement usually aims at short term cash management, affects banking and leads to a further increase of bank's reserve with the central bank and interbank interest rate. Increase of interbank interest rate leads to the decrease of due to interbank. On the other hand, rise of reserve requirement leads to fall of deposit in bank and decreases operational costs. Then loan declines in response to drop of deposit and also profit of bank declines. As a result, financing, investment and output fall; but inflation rises in response to the drop in output (See figure 7).

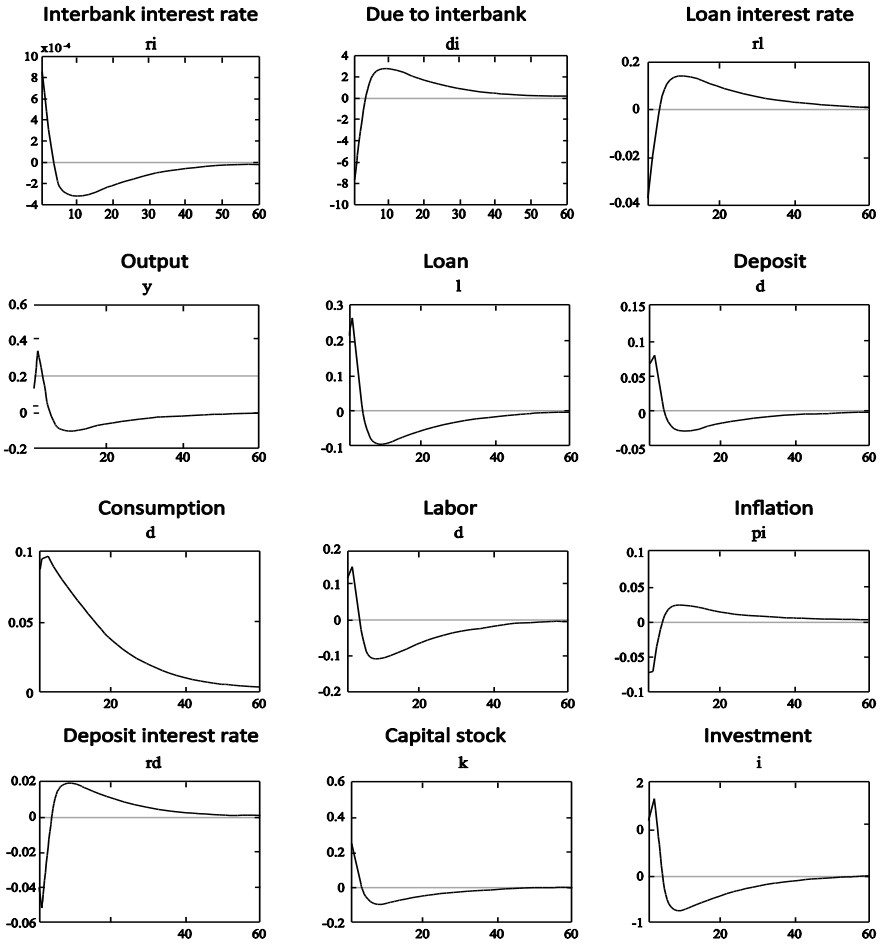
Figure 8: Reserve requirement shocks



7.3. Technology Shock

Figure 9 shows the impacts of positive technology shock on the economy of Iran. Since the production is more efficient, output rises. The Supply of goods increases, thus reducing the price of the goods. The technology

Figure 9: Technology shock



innovation reduces marginal costs and inflation, which leads to a drop in loan rate. Households raise their savings and entrepreneurs borrow more. Because of the rising savings, the marginal product of labor increases so that the aggregate capital increases. The rising in consumption leads to a rising demand for goods, therefore raising inflation. Central bank raises the loan rate. In the presence of bank intermediaries, the endogenous propagation mechanism is amplified because credit spreads benefit entrepreneurs from the greater availability of credit. Entrepreneurs borrow more and produce more. Because of raising production, inflation decreases.

8. Concluding Remarks

This paper proposes a micro funded framework that incorporates a banking sector into a DSGE model to evaluate the role of an active banking sector in business cycles and the contribution of financial shocks to the Iranian economy fluctuations.

Financial frictions are modeled using both the demand and supply sides of credit market. We use the financial accelerator a la BGG[1] to model the demand-side of credit market. The supply-side of credit market consists of heterogeneous banks that offer different banking services and borrow from interbank market. This model provides a rich and rigorous framework to address monetary and financial stability issues. The model includes demand and supply-sides of credit market and thus allows for policy simulation analysis of factors such as: (1) credit default; (2) endogenous bank defaults on interbank borrowing; (3) monetary policies shocks.

The model reproduces salient features of the economy of Iran, reproducing volatilities of key macroeconomic variables and their correlations with output, and the pro-cyclical banks' balance sheet. Banks can affect credit supply conditions and the transmission of real effects of shocks to the economy. Also, financial shocks explain a large fraction of

[1] Bernanke, Gertler and Gilchrist method (1999)

business cycles. This result is robust to simulations with different shocks. Thus, the main role banks play in this economy is to reduce the effects of uncertainty.

Future work will consist of estimating the model's structural parameters, incorporating credit to households, extending the framework to an open economy model and capital requirement regulations.

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Appendix A

Table 4: Moments

definition	variable	mean		Standard deviation	
		real	model	real	model
real consumption	c_t	0.041	0.04	0.48	0.44
supply of labor	N_t	0.054	-0.053	0.65	0.61
liquidity at households	M_t^h	0.059	0.055	0.53	0.54
real wage	w_t	0.017	0.010	0.36	0.31
tax	t_t	-0.074	-0.070	1.58	1.50
interest rate of deposit	r_t^d	0.009	0.006	0.22	0.12
deposit	D_t	-0.008	-0.009	0.18	0.19
inflation	π_t	0.033	0.013	0.15	0.19
quantity of capital	k_t	-0.041	-0.044	0.65	0.63
investment	i_t	-0.35	-0.32	4.45	4.46
production	Y_t	-0.038	-0.033	0.78	0.72
price	P_t	0.015	0.013	0.21	0.19
technology shock	A_t	0.018	0.012	0.44	0.24
loan	l_t	-0.036	-0.031	0.73	0.72
proportion of financing	γ_t	0.0022	0.0025	0.026	0.024
marginal cost	mc_t	0.0041	0.0048	0.11	0.012
interest rate of loan	r_t^l	0.016	0.013	0.16	0.11
interest rate of interbanking	r_t^i	-0.47	-0.48	3.9	3.1
non-repayment ratio	γ_t^i	-0.00047	-0.00042	0.024	0.022
borrowing from interbank	d_t^i	0.0047	0.0041	0.028	0.026

definition	variable	mean		Standard deviation	
		real	model	real	model
reserve requirement	η_t	0.031	0.023	0.16	0.17
growth rate of money	μ_t	0.014	0.013	0.18	0.19
money	M_t	0.00017	0.000159	0.0076	0.0089
tax	t_t	-0.075	-0.0704	1.51	1.50
oil revenue	or_t	0.015	0.014	0.30	0.34
government expenditure	g_t	0.043	0.049	0.72	0.73

Table 5: Auto correlation, real and simulated

definition	variable	Real auto correlation		Simulated autocorrelation	
		Second lag	First lag	Second lag	First lag
real consumption	c_t	0.98	097	0.97	0.94
supply of labor	N_t	0.82	0.93	0.61	0.66
0.61liquidity at households	M_t^h	0.95	0.93	0.89	0.85
real wage	w_t	0.84	0.80	0.58	0.53
tax	t_t	0.83	0.87	0.61	0.65
interest rate of deposit	r_t^d	0.72	0.84	0.52	0.68
deposit	D_t	0.88	0.85	0.62	0.66
inflation	π_t	0.73	0.70	0.59	0.52
quantity of capital	k_t	0.76	0.85	0.78	0.70
investment	i_t	0.97	0.91	0.70	0.79
production	Y_t	0.85	0.87	0.61	0.65
price	P_t	0.73	0.70	0.59	0.52

definition	variable	Real auto correlation		Simulated autocorrelation	
		Second lag	First lag	Second lag	First lag
technology shock	A_t	0.59	0.58	0.43	0.32
loan	l_t	0.87	0.85	0.61	0.66
proportion of financing	γ_t	0.81	0.63	0.45	0.40
marginal cost	mc_t	0.39	0.33	0.19	0.18
interest rate of loan	r_t^l	0.81	0.85	0.71	0.70
interest rate of interbanking	r_t^i	0.63	0.65	0.18	0.14
non-repayment ratio	γ_t^i	0.65	0.63	0.88	0.81
borrowing from interbank	d_t^i	0.68	0.64	0.48	0.41
reserve requirement	η_t	0.86	0.85	0.74	0.72
growth rate of money	μ_t	0.78	0.69	0.69	0.53
money	M_t	0.81	0.79	0.58	0.50
tax	t_t	0.85	0.87	0.61	0.65
oil revenue	or_t	0.44	0.52	0.32	0.27
government expenditure	g_t	0.75	0.77	0.55	0.52

Appendix B: First order condition

1. Household

$$\frac{\partial \ell}{\partial c_t} = \beta^t \left(c_t\right)^{-\sigma_c} - \beta^t \lambda_t = 0 \qquad \text{B-1}$$

$$\frac{\partial \ell}{\partial N_t} = -\beta^t N_t^{\sigma_n} + \beta^t \lambda_t w_t = 0 \qquad \text{B-2}$$

$$\frac{\partial \ell}{\partial d_t} = E_t \left\{ -\beta^t \lambda_t + \beta^{t+1} \left(\frac{1+r_t^d}{\pi_{t+1}}\right) \lambda_{t+1} \right\} = 0 \qquad \text{B-3}$$

$$\frac{\partial \ell}{\partial m^h{}_t} = E_t \left\{ \beta^t \left(m^h{}_t\right)^{-\vartheta} - \beta^t \lambda_t + \beta^{t+1} \frac{\lambda_{t+1}}{\pi_{t+1}} \right\} = 0 \qquad \text{B-4}$$

$$\frac{\partial \ell}{\partial k_t} = -\lambda_t \left[1 + \varphi_k \left(\frac{k_{t+1}}{k_t} - 1 \right) \right] + \beta \left\{ \lambda_{t+1} \left[r_{t+1}^k + 1 - \delta - \frac{\varphi_k}{2} \left(\frac{k_{t+2}^2 - k_{t+1}^2}{k_{t+1}^2} \right) \right] \right\} = 0 \qquad \text{B-5}$$

2. Entrepreneur

$$\frac{\partial \ell}{\partial k_t} = \lambda_t A_t \alpha N_{jt}^{1-\alpha} K_{jt}^{\alpha-1} - \lambda_t^f r_t^k \left(1 + r_t^l\right) = 0 \qquad \text{B-6}$$

$$\frac{\partial \ell}{\partial N_t} = \lambda_t A_t \left(1-\alpha\right) N_{jt}^{-\alpha} K_{jt}^{\alpha} - \lambda_t^f \left(1 + r_t^l\right) w_t = 0$$

$$\frac{\partial \ell}{\partial P_t} = \left\{1-\theta+\theta\left(\frac{P_t}{P_{jt}}\right)mc_{jt}\right\}\lambda_t\left(\frac{P_{jt}}{P_t}\right)^{-\theta}\frac{Y_t}{P_t} - \lambda_t\,\varphi_f\left\{\left(\frac{P_{jt}}{(\bar{\pi})P_{jt-1}}-1\right)\frac{Y_t}{(\bar{\pi})P_{jt-1}}\right\}$$

$$+\beta\varphi_f E_t\left\{\lambda_{t+1}\left(\frac{P_{jt+1}}{(\bar{\pi})P_{jt}}-1\right)Y_{t+1}\left(\frac{P_{jt+1}}{(\bar{\pi})P_{jt}^2}\right)\right\}=0 \qquad \text{B-7}$$

$$mc_{jt} = \frac{\left[\gamma_t(1+r_t^l)w_t\right]^{1-\alpha}\left(\gamma_t(1+r_t^l)r_t^k\right)^{\alpha}}{\alpha^{\alpha}\left(1-\alpha\right)^{1-\alpha}A_t} \qquad \text{B-8}$$

3. Commercial bank

$$\frac{\partial \ell}{\partial l_t} = \lambda_t\alpha^b(1+r_t^l)-\lambda_t^b=0 \qquad \text{B-9}$$

$$\frac{\partial \ell}{\partial d_t} = -\lambda_t(1+r_t^d)+(1-\eta_t)\lambda_t^b=0 \qquad \text{B-10}$$

$$\frac{\partial \ell}{\partial d_t^i} = -\lambda_t\left((1+r_t^i)+\varphi_{di}\left[\frac{D_t^i}{\bar{D}^i}-1\right]+\varphi_{di\gamma}\left[(\gamma_t^i)^2D_t^i\right]\right)+\lambda_t^b=0 \qquad \text{B-11}$$

$$\frac{\partial \partial}{\partial \gamma_t^i} = -(1+r_t^i)D_t^i-\varphi_{di\gamma}\left[(\gamma_t^i)(D_t^i)^2\right]=0 \qquad \text{B-12}$$

Appendix c: Log linear of the model

$$\tilde{w}_t = \sigma_c\tilde{c}_t+\sigma_n\tilde{N}_t \qquad \text{C–1}$$

$$\tilde{c}_t = \frac{\tilde{\pi}_{t+1} - \tilde{r}_t^d}{\sigma_c} + \tilde{c}_{t+1} \qquad \text{C–2}$$

$$\tilde{m}_t^c = \frac{1}{\vartheta}\left(-\tilde{r}_t^d + \sigma_c \tilde{c}_t\right) \qquad \text{C–3}$$

$$\tilde{r}_{t+1}^k = \frac{\sigma_c}{1-\beta(1-\delta)}\left(\tilde{c}_{t+1} - \tilde{c}_t\right) \qquad \text{C–4}$$

$$\tilde{k}_{t+1} = (1-\delta)\tilde{k}_t + \delta \tilde{i}_t \qquad \text{C–5}$$

$$\tilde{N}_t = \tilde{k}_t - \tilde{w}_t + \tilde{r}_t^k \qquad \text{C–6}$$

$$\tilde{\pi}_t = \left(\frac{\theta - 1}{\varphi_f}\right) m\tilde{c}_t + \beta \tilde{\pi}_{t+1} \qquad \text{C–7}$$

$$m\tilde{c}_t = \left(1-\alpha\right)\left(\tilde{w}_t\right) + \alpha \tilde{r}_t^k + \tilde{r}_t^l - \tilde{A}_t + \tilde{\gamma}_t \qquad \text{C–8}$$

$$\tilde{y}_t = \tilde{A}_t + (1-\alpha)\tilde{N}_t + \alpha \tilde{k}_t \qquad \text{C–9}$$

$$\tilde{l}_t = \bar{\gamma}\left((\tilde{r}^k + \tilde{k}_t)\frac{\bar{r}^k \bar{k}}{\bar{l}} + \frac{\bar{w}}{\bar{l}}\tilde{w}_t\right) + \tilde{\gamma}_t \qquad \text{C–10}$$

$$\tilde{d}_t = \frac{\bar{l}}{(1-\bar{\eta})\bar{d}}\tilde{l}_t - \frac{\bar{d}^i}{(1-\bar{\eta})\bar{d}}\tilde{d}_t^i + \frac{\bar{\eta}}{(1-\bar{\eta})}\tilde{\eta}_t \qquad \text{C-11}$$

$$\tilde{r}_t^d = \frac{\alpha_t^b \bar{r}^l (1-\bar{\eta})}{\bar{r}^d}\tilde{r}_t^l - \frac{\bar{\eta}(1+\bar{r}^l)}{\alpha^b \bar{r}^l (1-\bar{\eta})}\tilde{\eta}_t + \alpha_t^b \qquad \text{C-12}$$

$$\tilde{d}_t^i = \phi_{di}^{di}\tilde{d}_{t-1}^i + \phi_{di}^y y_t \qquad \text{C-13}$$

$$\tilde{\gamma}_t^i = \rho_{\gamma^i}\tilde{\gamma}_{t-1}^i + \varepsilon_t^{\gamma^i} \quad \text{C-14}$$

$$\tilde{r}_t^i = \frac{\alpha_t^b \bar{r}^l}{\bar{r}^i}\tilde{r}_t^l - \frac{\phi di\,\gamma + \varphi di}{\bar{r}^i}(\tilde{d}_t^i - 2\tilde{\gamma}_t^i) \quad \text{C-15}$$

$$\tilde{\tilde{m}}_t = \tilde{m}_t - \tilde{m}_{t-1} + \tilde{\pi}_t \quad \text{C-16}$$

$$\tilde{r}_t^l = \rho_r \tilde{r}_{t-1}^l + \rho_\pi \pi_t + \rho_y y_t + \rho_m \mu_t + \varepsilon_{r_t^d} \quad \text{C-17}$$

$$\tilde{\eta}_t = \phi_\eta^\pi \tilde{\pi}_t + \phi_\eta^\eta \tilde{\eta}_{t-1} + \varepsilon_{t,\eta} \quad \text{C-18}$$

$$\tilde{g}_t = \frac{\bar{t}}{\bar{g}}\tilde{t}_t + \frac{o\bar{r}}{\bar{g}}o\tilde{r}_t + \frac{\bar{m}}{\bar{g}}(\tilde{m}_t - \tilde{m}_{t-1} + \tilde{\pi}_t) \quad \text{C-19}$$

$$\tilde{t}_t = \phi_t^y \tilde{Y}_t \quad \text{C-20}$$

$$\tilde{y}_t = \frac{\bar{c}}{\bar{y}}\tilde{c}_t + \frac{\bar{i}}{\bar{y}}\tilde{i}_t + \frac{\bar{g}}{\bar{y}}\tilde{g}_t \quad \text{C-21}$$

$$\tilde{m}_t = \frac{\bar{m}^h}{\bar{m}}\tilde{m}_t^h + \frac{\bar{d}}{\bar{m}}\tilde{d}_t \quad \text{C-22}$$

$$\tilde{\gamma}_t = \rho_\gamma \tilde{\gamma}_{t-1} + \varepsilon_t^\gamma \quad \text{C-23}$$

$$\tilde{A}_t = \rho_A \tilde{A}_{t-1} + \xi_t^A \quad \text{C-24}$$

$$o\tilde{r}_t = \rho_{or} o\tilde{r}_{t-1} + \varepsilon_{or} \quad \text{C-25}$$

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The Impact of Leverage on Firm Investment: Evidence from Tehran Stock Exchange

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Abstract

The impact of financial leverage on firm investment is one of the most important issues in corporate finance. Debt overhang reduces the incentives of shareholder–management coalition in controlling the firm to invest in positive net-present-value investment opportunities. On the other hand, firms without debt in their financial structure face with a new problem known as over-investment. This study uses regression analysis to survey the effects of financial leverage on investment decisions of TSE[1] *firms between years 2001-2010. The results show that in contrary to previous findings in literature, when using total liabilities to total assets as the measure of*

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leverage, there is no relationship between the two parameters and by using long term debt to total assets, we see a positive impact.

***Keywords**: Financial Leverage, Firm Investment, Growth Opportunities, Under-investment, Over-investment*

***JEL Classification:** C10, C15, C21, C23*

1. Introduction

Corporate firms play a significant role in contributing to economic growth. In order to attain their objectives, firms need to manage their funds efficiently. To respond to global competition, firms need to make massive capital investment in modern technologies, infrastructure, product development and product promotion and so on. Such investments may promote productivity and efficiency (Odit & Chittoo; 2008). Every investment requires financing. There are two ways of corporate financing: Internal funds and external funds. Firms also can use a combination of these two methods to finance their needs. In theory, finance impacts firm investments due to imperfect market conditions. Markets are imperfect, because of frictions such as transaction costs and information asymmetries. In a world with incomplete markets, agency problems arising from interactions between shareholders, debt holders, and management give rise to underinvestment or overinvestment incentives; these agency problems introduce a range in which investment may not be fully responsive, or may be over-responsive to changes in economic fundamentals (Aivazian et al., 2005).

Among various sources of corporate financing, financial leverage is perceived to have both positive and negative attributes as a debt financing instrument. The issuance of debt commits a firm to pay cash as interest and principal. A firm with significantly more debt than equity is considered to be highly leveraged. Leverage helps both the investor and the firm to invest or operate. However, it comes with greater risk. If an investor uses leverage to make an investment and the investment moves against the investor, his or her loss would be much greater than it would have been if the investment had not been leveraged. Therefore, leverage magnifies both gains and losses (Odit & Chittoo; 2008).

This paper attempts to contribute to the existing literature by bringing new evidence on the relationship between leverage and investment decisions over a period of 10 years for the case of 275 companies listed on Tehran Stock Exchange. In contrary to the prior findings, using total debts to total assets as a benchmark for measuring financial leverage, we did not find a meaningful relationship between the two parameters. Using long term debts to total assets as the alternative measure of leverage, the relationship is positive. The different results of the paper could be judged as the heavy dependence of Iranian firms on the banking system, the special environment of the financial system, the existence of arbitrary interest rates and the constraints of financing in the economy.

The remainder of the paper is organized as follows: Section 2 provides a brief empirical review of the relations between financial leverage and capital investment. Section 3 gives the data and description of variables. Section 4 indicates econometric analysis adopted to explain the relationship between financial leverage and investment. In section 5, we provide the reader with an overview of panel data estimation. Section 6 reports the results of the findings. We conclude in section 7.

2. The Link between Leverage and Investment

The impact of leverage on firm investment is among the critical issues of finance. If we assume Modigliani and Miller (1958) proposal, in a perfect environment, there would be no relationship between these two parameters and the investment policies of a company should be based on factors such as future demand on its products, production technology, market interest rates and other fundamental factors affecting profitability, cash flows and net worth of the firm. Many empirical evidences challenge this argument, as we live in a world of imperfections. Myers (1977) argues that debt overhang reduces the incentives of the shareholder–management coalition in controlling the firm to invest in positive net-present-value investment

opportunities, since the benefits accrue, at least partially, to the bondholders rather than accruing fully to the shareholders. Hence, highly levered firms are less likely to exploit valuable growth opportunities as compared to firms with low levels of leverage. Thus under-investment problem could be one of the reasons supporting the negative relationship between leverage and investment. On the other hand, Jensen (1986) argues that firms having more internally generated funds than positive net present value investment opportunities, the presence of debt in the firm's capital structure may force managers to utilize the funds in servicing the debt which could have been utilized in investing in negative net present value projects at the detriment of shareholder's interest. Such situation can be coined as the over-investment problem. Hence debt financing can be utilized as an instrument to curtail the over-investment problem by forcing managers to pay out excess funds to service debt. Hence for these types of firms debt financing has a positive impact on the value of the firm. Stulz (1990), Grossman et al. (1980), Zwiebel (1996) and Novaes & Zingales (1995) argued the same. However, too much debt is also not desirable and could lead to financial distress and agency problems (See Kraus & Litzenberger, 1973 and also Myers & Majluf, 1984).

Lang et al. (1996) examine a large sample of US industrial firms over the period 1970–1989 and show that the relationship between leverage and investment is negative for those firms with weak growth opportunities (with Tobin's Q less than one). Aivazian et al. (2005) analyze the impact of leverage on investment for 1035 industrial Canadian firms between years 1982-1999. Using different measures of leverage and various empirical methods, they conclude that the relationship between leverage and investment is negative and this negative relationship is more meaningful for companies with low growth opportunities.

McConnell and Servaes (1995) show that high debt would induce under-investment for firms with a low Tobin's Q; however, low debt would mitigate over-investment to firms with high Tobin's Q. Ahn et al. (2006) hold that within diversified firms, the negative impact of leverage on investment is significantly greater for high Q than for low Q segments and significantly greater for non-core than for core segments. The negative relationship between leverage and investment is also approved in emerging markets such as China. Firth et al. (2008) and Yao & Kong (2008) are among these findings. Also the survey of Odit & Chittoo (2008) for the case of 27 companies, which are listed on the Stock Exchange of Mauritius over a period of 15 years from 1990 to 2004 shows a negative relationship between leverage and investment for low investment opportunity firms. However, previous findings on Tehran Stock Exchange (TSE) are mixed. While Noravesh & Yazdani (2010) show a negative relationship between leverage and investment for 98 Iranian firms listed on TSE from 2001 to 2006, Afshari et al. (2012) examine a sample of 96 firms on the exchange from 2001 to 2005 and find no linear relationship between the two variables. Both surveys suffer from low sample size and short study period.

3. Data and Description of Variables

The data used in this paper are 275 non-financial firms listed on Tehran Stock Exchange over a 10 year period of 2001-2010. Financial institutions including banks, conglomerates, investment companies and other financial intermediaries are excluded from observations since the nature of their activities and investments differ from industrial firms.

After checking and screening for apparent coding errors and missing variables, an unbalanced panel of 2270 observations of 273 firms remained for estimation.

We use two alternative measures of leverage. One is book value of total liabilities divided by book value of total assets, while the other is book value of long-term debt divided by total assets.[1] Both measures have been used in the literature. The first measure does not distinguish between short-term debt and long-term debt while the second one emphasizes the dominant role of long-term debt as a determinant of investment. We try both definitions in our estimation. Tobin's Q is defined as the market value of total assets of the firm divided by the book value of assets and is a proxy for growth opportunities. We calculate the market value of the firm as the sum of total liabilities and the value of the common stocks. Cash flow is measured as the sum of earnings before extraordinary items and depreciation, and Sale is defined as net sales deflated by net value of fixed assets.

Table 1 provides descriptive information for the investment and the financial data. Inspection of the table reveals a high variation of investment among Iranian firms. The mean of the ratio of net investment to fixed assets is 1.34, while the standard deviation is 2.94, which is twice the mean. The sample average Tobin Q of 2.66 reflects market expectations of strong growth opportunities for Iranian firms over this sample period. The mean of the ratio of long-term debt to total assets is 0.10, while the ratio of total liabilities to total assets is 0.69; this suggests that there is a significant reliance on short-term debt finance in Iran's economy.

1. Lang et al. (1996) and Opler and Titman (1994) discuss the reasons for the use of book values.

Table 1: Summary statistics for growth, leverage, and investment opportunities

	Mean	Median	Standard deviation
Net Investment$_t$ /Fixed assets$_{t-1}$	1.34	1.07	2.94
Cash Flow$_t$ /Total Assets$_{t-1}$	0.17	0.92	54.22
Tobin's Q$_{t-1}$	2.66	2.46	54.47
(Long term debt/Total assets)$_{t-1}$	0.10	0.06	0.10
(Total liabilities/Total assets)$_{t-1}$	0.69	0.70	0.22
(Net sales/Fixed assets)$_{t-1}$	5.76	3.87	6.42
(Cash & Short-term investments/Total Assets)$_{t-1}$	0.63	0.20	5.38

4. Econometric Analysis

We estimate a short form of investment regression to examine the effect of leverage on investment. The model is similar to Aivazian et al. (2005) but is extended to include short-term investments. Specifically, we estimate the following equation:

$$\mathrm{I_{i,t}/K_{i,t-1}} = \mathrm{b_1 L_{i,t-1}} + \mathrm{b_2 D_{Q_{i,t-1}} * L_{i,t-1}} + \mathrm{b_3 Q_{i,t-1}} + \mathrm{b_4 (CF_{i,t}/K_{i,t-1})} + \mathrm{b_5 (CS_{i,t-1}/K_{i,t-1})} + \mathrm{b_6 (S_{i,t-1}/K_{i,t-1})} + \mu_{i,t} + \mathrm{e_{i,t}} \quad (1)$$

Where $I_{i,t}$ is the net investment of firm i at time t; $K_{i,t-1}$ is lagged net fixed assets; $L_{i,t-1}$ is lagged leverage; $CF_{i,t}$ is cash flow of firm i at time t; $CS_{i,t-1}$ stands for short-term investments including cash; $Q_{i,t-1}$ is lagged Tobin's Q; $D_{Q_{i,t-1}}$ is a dummy variable which is equal to 1 if Tobin's Q>1, and 0 otherwise; $S_{i,t-1}$ is lagged net sales of firm i; $\mu_{i,t}$ is the individual effect of firm i, and $e_{i,t}$ is the error term.

Our variable of interest is leverage. We used the book value definition of leverage as to the market value of leverage. Lang *et al*. (1996) point that the market value leverage gives too much weight to the deviations in equity values. The book value of leverage does not reflect recent deviations in the market valuation of the firm. If leverage has a significant negative effect on investment, two interpretations can be adopted. First, it would mean that capital structure plays an important role in the firm's investment policies. Second, it can also be explained by an agency problem between the agents and the shareholders. If managers are overburden by debt, they may give up projects which may yield positive net present values. Also, there will be support for both the under-investment and over-investment theory.

We used two alternative measures of leverage to distinguish between total debt and long-term debt in firms' financial structure. According to this, we can rewrite equation (1) into following terms:

$$I_{i,t} / K_{i,t-1} = b_1 LTD_{i,t-1} + b_2 D_{Q_{i,t-1}} * LTD_{i,t-1} + b_3 Q_{i,t-1} + b_4 (CF_{i,t} / K_{i,t-1}) + b_5 (CS_{i,t-1} / K_{i,t-1}) + b_6 (S_{i,t-1} / K_{i,t-1}) + \mu_{i,t} + e_{i,t} \quad (2)$$

$$I_{i,t} / K_{i,t-1} = b_1 LLD_{i,t-1} + b_2 D_{Q_{i,t-1}} * LLD_{i,t-1} + b_3 Q_{i,t-1} + b_4 (CF_{i,t} / K_{i,t-1}) + b_5 (CS_{i,t-1} / K_{i,t-1}) + b_6 (S_{i,t-1} / K_{i,t-1}) + \mu_{i,t} + e_{i,t} \quad (3)$$

All the variables in the above equations are the same as equation (1), except in $LTD_{i,t-1}$ which denotes total debt to total assets and $LLD_{i,t-1}$ which denotes long-term liabilities to total assets.

To test for differences in the role of leverage for high versus low growth opportunity firms, we used the dummy variable of $D_{Q_{i,t-1}}$ in the above equations.

5. An Overview of Panel Data Estimation

Panel data sets for economic research possess several major advantages over conventional cross-sectional or time-series data sets (see Hsiao 2003). Panel data usually give the researcher a large number of data points, increasing the degrees of freedom and reducing the co-linearity among explanatory variables, hence improving the efficiency of econometric estimates. More importantly, longitudinal data allows a researcher to analyze a number of important economic questions that cannot be addressed using cross-sectional or time-series data sets.

Table 2: Correlation among independent variables

Corr.	Cash & Short-term Investments	Tobin's Q	Sales	Total Debt/ total assets	Long-term Debt/ total assets	Cash Flow
Cash & Short-term Investments	1	-	-	-	-	-
Tobin's Q	0.004	1	-	-	-	-
Sales	0.192	0.010	1	-	-	-
Total Debt/ total assets	-0.022	-0.011	0.127	1	-	-
Long-term Debt/ total assets	-0.036	-0.013	-0.109	0.157	1	-
Cash Flow	-0.896	0.003	0.008	0.032	0.019	1

We analyzed unbalanced panel data set using Eviews 7 software. Since our data set includes less than 15 periods, there is no need to control for data stationary. The estimates have been corrected for both heteroscedasticity and serial correlation. There is also a possibility of high correlations among the independent variables. Table 2 shows the correlation among independent

variables. The correlation between cash flow and short-term investments is high. We used variance inflation test to check for multi-co-linearity between these two variables. If $\frac{1}{1-R^2} > 10$; then multi-co-linearity is not a problem of concern (O'brien, 2007). In simple words, if R^2 coefficient is larger than 90%, then co-linearity is probable. After running variance inflation test, we saw R^2 coefficient of 84%, which means multi-co-linearity is not a matter of concern for the two variables.

6. Results

Table 3 reports the regression results for the investment equation using the two alternative measures of leverage and three different methodologies: Pooling regression, Random effect model, and Fixed effect model. To identify which empirical methodology—pooling, random effect, or fixed effect regression—is most suitable, we perform two statistical tests: First, to compare the pooled estimates and random effect estimate, the Lagrangian Multiplier Test is performed. The null hypothesis is that the individual effect is 0. The p-value statistics are reported in Table 3, and are equal to 0.186 and 0.209, respectively for the two alternative definitions of leverage. Thus, the null hypothesis is not rejected at 1% significance level for both measures of leverage.

Second, to compare the random effect estimates with the fixed effect estimates, the Hausman test is performed. If the model is correctly specified and if the individual effects are uncorrelated with the independent variables, the fixed effect and random effect should not be different. The random effect assumes that the error term is uncorrelated with the dependent variable. However, this is not the case when using the fixed effect method. According to the data in the table, fixed effect is not seen in the cross section and time series. Chi-square of zero also reveals that there is no random effect in the model. Thus the estimation of the data is based on pooling regression as the

appropriate model. The results suggest that considering total liabilities to total assets as the measure of leverage, there is no significant relationship between leverage and investment. On the other hand, by using long-term debt to total assets as the alternative measure of leverage which is more reliable to check its impact on investment, the relationship is positive.

Table 3: Regression analysis results

	Leverage= (Total liabilities /Total assets)t-1			*Leverage= (Long term debt /Total assets)t-1*		
	Pooling	**Fixed effect**	**Random effect**	**Pooling**	**Fixed effect**	**Random effect**
Intercept	1.379*	1.042*	1.253*	-0.148	0.811*	0.976*
	(4.84)	(2.25)	(3.41)	(-0.65)	(2.34)	(7.01)
Leverage	-0.169	0.094	-0.169	15.599*	0.465	-0.612
	(-0.58)	(0.28)	(-1.15)	(9.91)	(0.44)	(-0.90)
*Dummy Variable * Leverage*	-1.443*	-0.291	-0.092	-11.751*	0.709	1.743*
	(-3.33)	(-0.67)	(-0.22)	(-6.33)	(1.09)	(3.34)
Tobin's Q_{t-1}	0.000	0.000	0.000	0.000	0.000	0.000
	(0.38)	(1.16)	(1.01)	(0.22)	(0.81)	(0.74)
(Net sales/Fixed assets)t-1	0.101*	0.041	0.016	0.112*	0.043	0.018
	(4.35)	(1.00)	(0.90)	(4.85)	(1.04)	(0.87)
(Cash & Short-term investments/ Total Assets)$_{t-1}$	0.582*	0.275	0.263	0.587*	0.275	0.263
	(8.74)	(1.37)	(1.49)	(8.97)	(1.38)	(1.46)
Cash Flow$_t$/Total Assets$_{t-1}$	0.051*	0.031	0.020	0.051*	0.031	0.020
	(7.77)	(1.37)	(1.51)	(7.86)	(1.37)	(1.49)
LM Test	Chi^2= 301.97	P-value=0.186		Chi^2= 299.94	P-value=0.209	
Hausman Test	Chi^2= 0	P-value=1		Chi^2= 0	P-value=1	
Adj. R^2	0.060	0.048	0.047	0.090	0.048	0.048

* Significant at the 1% level

7. Conclusion

This paper extends earlier empirical studies on the relationship between leverage and investment in the bank-based economy of Iran. It examines the relationship of 275 Iranian corporations that are quoted on Tehran Stock Exchange for the years 2001 – 2010. Prior empirical works suggest financial leverage can have a negative impact on firm investment because of under-investment and over-investment theories reflecting agency problems among

different stakeholders of the firm. We used two alternative measures of leverage and found different results comparing to prior findings in the literature. Based on total liabilities to total assets, there is no significant relationship between leverage and investment. On the other hand, using long-term debt to total assets, we saw positive impact of leverage on firm investment. Our results suggest capital structure doesn't play an important role in Iranian firms' investment policies. One of the reasons of this finding could be the environment of the country's economy as a heavily bank-based financial system with arbitrary interest rates and the insignificant role of the capital market in financing. Thus debt overhang is not an issue of concern among Iranian firms and they seek to use the maximum level of bank leverage with no regard to investment opportunities. This could lead to misallocation of funds and resources. It should be noted that the findings of the paper are subjected to some limitations due to some trading restrictions such as price limit and trading halts. Although the figures are deflated using the value of assets at the beginning of each year, high inflation of the economy together with differences in the age and size of the companies could lead to different times of acquiring assets on the balance-sheet that might affect the results. Considering firms' age and size in the model and thinking of better alternatives to categorize investment opportunities could be a matter of interest for further research in the future.

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The New Method for Ranking Grouped Credit Customer Based on DEA Method

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Abstract

Data Envelopment Analysis (DEA) is a widely used non-parametric method for ranking by Decision-Making Units (DMU). Despite the fact that DEA method does not require numerous preconditions, the necessity of the DMUs to be homogeneous is one of the most important rules in applying this technique. Moreover, in real world problems, due to the nature of DMUs, the need for ranking the grouped data has gained significant importance. Credit rating of the financial facility applicants is considered by the banks and financial institutions as one of the most important management issues and significant budget is allocated to develop and imply an effective rating system. Since the applicant organizations operate in different businesses and

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industries, and simultaneous rating of these companies using the DEA method leads to violation of homogeneity rule, thus, application of this powerful tool is restricted. The purpose of this paper is to resolve this key weakness in such a way that makes it possible to simultaneously consider the heterogeneous companies. The results of the proposed method have shown an enhanced capability for rating the decision-making units.

***Keywords**: Modified Data Envelopment Analysis, Grouped data, Credit rating, banking.*

***JEL Classification:** C10, C14, C18, C30, G21*

1. Introduction

The purpose of this paper is to develop a Data Envelopment Analysis (DEA) method for simultaneous rating of the grouped units such as financial facility applicants which operate in different industrial groups. DEA is a non-parametric efficiency evaluation method and has the benefit of not assuming a particular functional form for the production function and deals directly with observable data. The basic idea of the application of non-parametric methods for efficiency measurement were introduced by Farrell (1975) in "Effective productivity measurement" paper which actually led to the development of a novel mathematical method compared with the parametric methods. His theories and ideas led the mathematicians and economists to develop the non-parametric production functions and different efficiency measurements. He laid the foundation of optimization branches in the mathematics science by proposing the most pivotal ideas about the structures of the productivity measurement models and methods and increasing the output and consequently, the productivity without requiring more resources. This was later extended by the work of Charnes, Cooper and Rhodes in 1978 based on the mathematical programming models known as CCR model. In 1984, another model was developed and proposed by Banker, Cooper and Charnes known as BBC. In other words, the basic DEA model is divided into CCR and BCC models. Each model can be investigated from two perspectives: Input-Oriented and Output-Oriented. There are two solutions for each model (CCR and BCC). Thus, eight basic DEA models have been used by some researchers and various models have been developed and extended based on these basic models.

During the last decade, in most of the countries, different applications of the DEA method for performance evaluation have been witnessed. The reason for this widespread acceptance is the possibility of evaluating the complicated and ambiguous relationships among multiple inputs and

outputs. This method also provides the ability of benchmarking and identifying inefficient resources. Despite the capabilities of this method, some preconditions especially about the nature of DMUs have restricted the application of this method. One of these preconditions is the homogeneity of the DMUs. The violation of this rule leads to deviations in the problem results. A great deal of rating problems in organizations deal with units that are grouped in completely individual groups and it is necessary to rate them simultaneously. Diversity of the companies and industries adds to the complexity of the credit-based ranking of the financial facility applicants. In other words, one of the most important problems that banks and financial institutions are facing for credit rating of their clients is difference of financial structures and performance of the clients across different groups or industries. This has become a difficult condition for managers and executives in this field. In this paper, DEA method has been extended in order to achieve a comprehensive model for rating the grouped data to be able to perform the rating of different groups of financial facilities applicants at the same time. Then, in section2, literature review of the rating models including the application of DEA method is provided. In section 3, the research methodology is explained in a hierarchical structure. In section 4, the proposed model is explained in greater detail using the data obtained from Tehran Stock Exchange. Section 5 is dedicated to the conclusion. In the final section, limitations and implications for future research are provided.

2. Literature Review

With continuous development of the credit evaluation field, this field plays an important role in the economy of the countries and certification bodies leverage new tools and methods and more advanced technologies in order to extend the credit management process. Credit evaluating is one of the major efforts that have been made in this field. Credit evaluation is defined as the assessment of the client's (credit and financial facility applicants) repayment

ability and the probability of the client's failure to repay the debt. The credit evaluation models are divided into two categories: parametric and non-parametric methods. Discriminate Analysis, Linear Probability Model, Logit and Probit models are among the widely used parametric models in various credit researches. The most notable non-parametric models are Analytical Hierarchy Process (AHP), Decision Tree Classification Method, Genetic Algorithm (GA), Expert Systems, Artificial Intelligence, Neural Networks, and Mathematical Planning (Data Envelopment Analysis). The previous researches and studies show that DEA is recognized as one of the most applied rating methods as the mathematical methods subsets. Figure 1 illustrates the steps of this structured process. As it is shown in figure 1, the rating and DEA problems have been investigated in parallel and after the review of the national and international studies, the focus is put on the rating models using DEA method and finally, research innovations are determined through the Gap Analysis.

Result of the Figure 1 has shown that DEA method has been applied mostly for the comparison of the utility of the banks and their branches. The researches made in the field of banking utility (productivity) has led to the publication of special issues in the original operational research journals and has become a specialized field.

Performance measurement of banks at the branch level shows that the number of the studies carried out for credit-based ranking of the clients using DEA method is limited. For instance, ZChe et al., in 2010; Eddie al., in 2007; Emel et al., in 2003 used DEA method for credit rating of clients. One of the major reasons that DEA method has not been applied in credit evaluating field is the heterogeneity of the units. As we mentioned earlier, homogeneity of the DMUs is one of the principal preconditions for the application of DEA method where the financial facility applicants in different industries are not homogenous at the first view. Moreover,

necessity for simultaneous rating of these enterprises with respect to the limited resources of the banks for credit allocation and industry prioritization has driven the banks and financial institutes to develop and implement viable and robust system for this purpose. In this paper, besides determining the credit evaluation metrics (criteria), DEA model has been developed in a way that it is applicable for simultaneous rating of applicant companies in different industries. Table 1 provides the summary of the gap analysis results that define the innovation of this research.

Figure1: Schematic view of the literature review process.

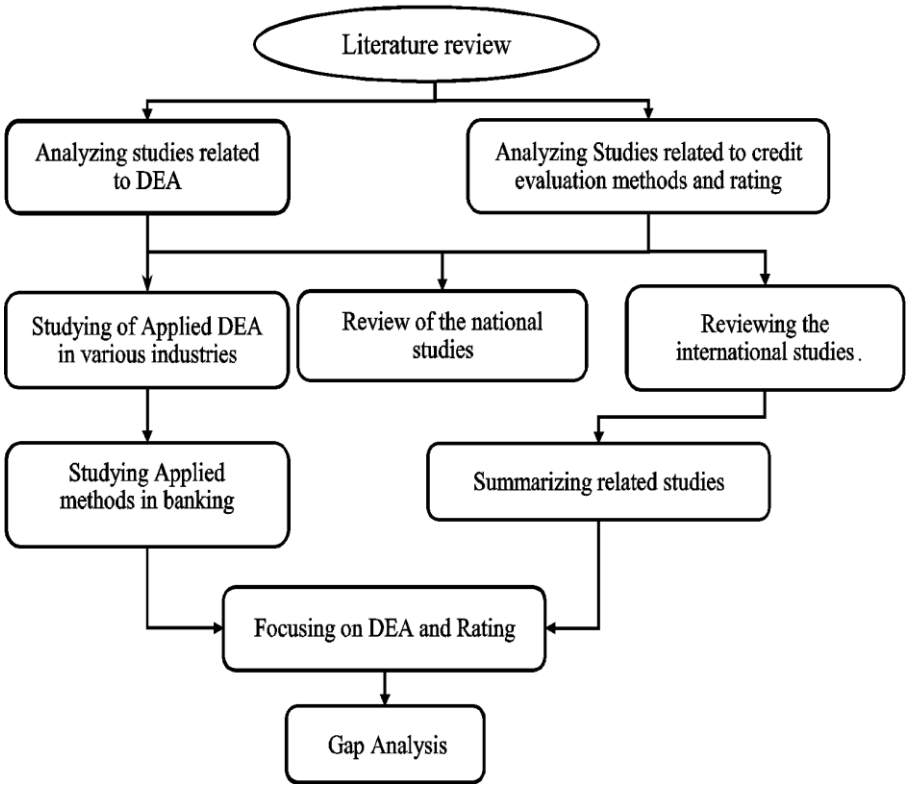


Table 1: The gap analysis results

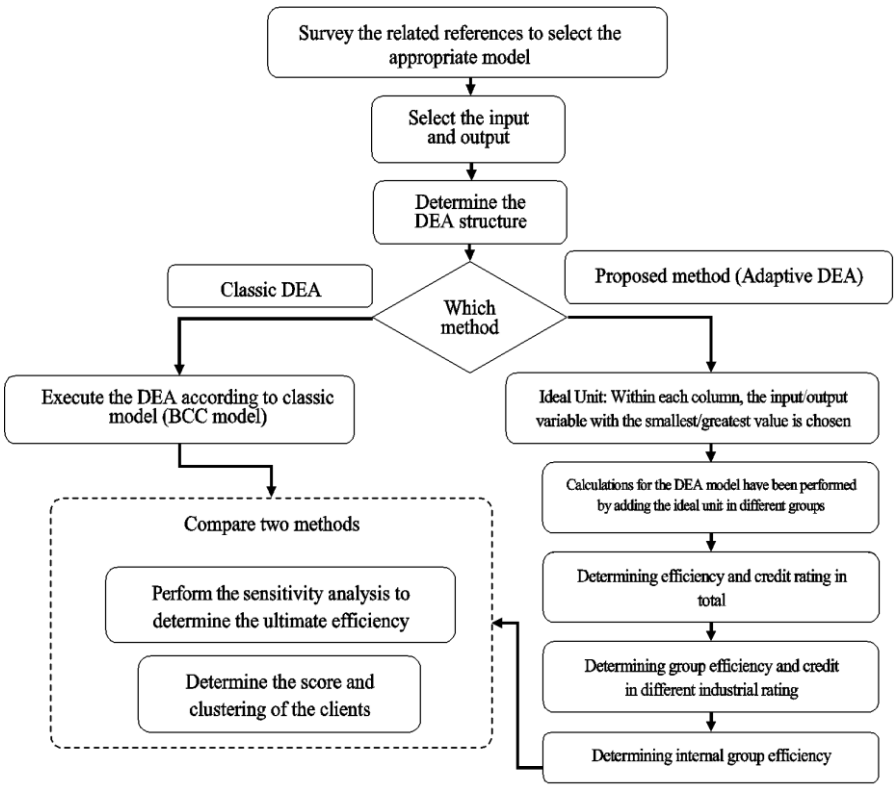
Authors	Year	Evaluation Criteria Determination	Criteria Prioritization	Rating/Scoring	Group- based Rating	Efficient Units Rating	Designing the Credit Evaluation Structure	Model Comparison	Sensitivity Analysis
Emel et al.,	2003	✓	✓	✓				✓	✓
Grunertet et al.,	2005	✓	✓	✓					
Lee and Chen	2005	✓	✓	✓				✓	
Jankowitschet et al.,	2007	✓	✓						✓
Huang et al.,	2007	✓	✓	✓				✓	
Eddie	2007	✓		✓					✓
Abdou et al.,	2008			✓				✓	
Stefanescu et al.,	2009			✓					
Abdou	2009	✓	✓	✓				✓	✓
Tsai and Chen	2010	✓		✓				✓	✓
ZChe et al.,	2010	✓	✓	✓					✓
Yap et al.,	2011	✓		✓				✓	
Malik M., Thomas	2012	✓		✓					✓
Chi and Hs	2012	✓	✓	✓				✓	✓
Hens and Tiwar	2012			✓				✓	
Bijak and Thomas	2012	✓		✓				✓	
This study	-	✓	✓	✓	✓	✓	✓	-	✓

3. Models and Methodology

3.1. Using the DEA method for ranking grouped data

In this study the overall implementation steps of proposed model for credit evaluating of grouped data are as follows:

Figure 2: The implementation steps of proposed model (Adaptive DEA) for client credit clustering



1- Identify and categorize model's input and output and normalize the applicants' information.
2- Execute DEA model in the existing and proposed method which is called Adaptive DEA.
3- Perform the sensitivity analysis to determine the ultimate efficiency.
4- Compare the obtained results from two DEA methods and determine the efficiency and accuracy of the proposed model.
5- Determine the score and clustering of the clients.

In this study, the adaptive DEA method has been used to identify the credit criteria for the bank's facilities applicants and then an efficient method has been proposed for credit clustering of the bank's facility applicants. The applied DEA model in this study is described as follows:

Model Parameters and variables
i = 1, 2, …, n Number of input variables
J = 1, 2, …, m Number of output variables
K = 1, 2, …, k Number of the industry
R = 1, 2, …, r Number of industrial clusters
θ = efficiency

S_{iR}^{-} :Input slack of i^{th} variable in R^{th} cluster

$$S_R^- = \sum_{i=1}^{n} S_{iR}^-$$

S_{jR}^{+} :Output slack of j^{th} variable in R^{th} cluster

$$S_R^+ = \sum_{j=1}^{m} S_{jR}^+$$

λ_{KR} : Shadow price of K^{th} industry in R^{th} cluster

λ_R : Shadow price of R^{th} cluster

$$\lambda_R = \sum_{K=1}^{k} \frac{\lambda_{KR}}{K}$$

$$\sum_{R=1}^{k} \lambda_R = 1$$

γ_K : Shadow price of K^{th} industry

$\gamma_K = \lambda_R \times \lambda_{KR}$

X_{iKR} :i^{th} Input variable vector for K^{th} industry in R^{th} cluster

Y_{JKR} :J^{th} output variable vector for K^{th} industry in R^{th} cluster

X_{iR} :i^{th} Input variable vector for R^{th} cluster

$$X_{iR} = \sum_{K=1}^{k} \frac{X_{iKR}}{K}$$

Y_{JR} :J^{th} Output variable vector for R^{th} cluster

$$Y_{JR} = \sum_{K=1}^{k} \frac{Y_{JKR}}{K}$$

X_R : Input variable vector for R^{th} cluster

$$X_R = \sum_{i=1}^{n} \frac{X_{iR}}{n}$$

Y_{JR} :Output variable vector for R^{th} cluster

$$Y_R = \sum_{j=1}^{m} \frac{Y_{JR}}{m}$$

X_{oR} : The input variable value of the ideal unit between R^{th} clusters

Y_{oR}: The output variable value of the ideal unit between R^{th} clusters

X_{oKR}: The input variable value of the ideal unit between all units

Y_{oKR}: The output variable value of the ideal unit between all units

Mathematical Model:
Objective function

$$Min = \theta - \varepsilon(\sum_{i=1}^{n}\sum_{r=1}^{r} S_{iR}^{-} + \sum_{j=1}^{m}\sum_{r=1}^{r} S_{jR}^{+})$$

The Objective function is defined in order to maximize the efficiency and minimize distance from efficiency frontier.

Constraints:

$$\sum_{R=1}^{r} \lambda_R \times Y_{JR} - S_R^+ = Y_R \qquad \text{j:1,2,….,m}$$

$$\sum_{R=1}^{r} \lambda_R \times X_{iR} + S_R^- = \theta X_R \qquad \text{i:1,2,….,n}$$

$$\sum_{K=1}^{k}\sum_{R=1}^{r} \lambda_{KR} \times Y_{JKR} - S_{JR}^+ = Y_{JR} \qquad \text{j:1,2,….,m}$$

$$\sum_{K=1}^{k}\sum_{R=1}^{r} \lambda_{KR} \times X_{iKR} + S_{iR}^- = \theta X_{iR} \qquad \text{i:1,2,….,n}$$

$$\sum_{R=1}^{r}\sum_{k=1}^{k} \lambda_R \times \lambda_{KR} = \sum_{K=1}^{k} \gamma_K = 1$$

$$\sum_{R=1}^{r} \lambda_R = 1$$

$$X_{oR} = Min\left\{X_{1R}, X_{2R}, ..., X_{nR}\right\}$$

$$Y_{oR} = Max\left\{Y_{1R}, Y_{2R}, ..., Y_{mR}\right\}$$

$$X_{oKR} = Min\left\{X_{111}, X_{112}, ..., X_{nkR}\right\}$$

$$Y_{oKR} = Max\left\{Y_{111}, Y_{112}, ..., Y_{mKR}\right\}$$

$$X_R^* = Min\left\{X_1, X_2, ..., X_R\right\}$$

$$Y_R^* = Max\left\{Y_1, Y_2, ..., Y_m\right\}$$

$X_{iR}, Y_{JR}, X_R, Y_R \geq \varepsilon$ i = 1, 2, …, n, J = 1, 2, …, m, R = 1, 2, …, r

$\lambda_{KR}, \lambda_R, S_{iR}^-, S_{jR}^+, S_R^-, S_R^+ \geq 0$

θ free

3.2. The influential factors on customer credit rating

For determining the criteria affecting the client's credit rating, in the first step, the criteria have been identified and categorized through the literature review. Then, these criteria and the related clusters have been improved through several interviews with senior experts from different bank branches and banking facility applicants. The summary of the final criteria and their clustering is provided in table 2.

Table 2: Comparative Studies and Input and Output Variables

Variable	Factor		Authors
Input	In(1)	Capital	Cummins et al.(2002) , Feroz et al., 2(2003)
	In(2)	Retained Profit	Aitman (1998), Feroz et al., 2(2003), Cheng et al. (2007)
	In(3)	Current Liability	Liang et al.(2006)
	In(4)	Long-term Liabilities	Omero et al.(2005), Molhotra et al.(2008)
	In(5)	Legal reserves	-
Output	Out(1)	Interest Coverage Rate	Liang et al.(2006), Cheng et al.(2007), Molhotra et al.(2008), Margaritis et al.(2009)
	Out(2)	Asset Return Ratio	Brid (2001), Capobianco et al.(2004), Duzakin et al.(2007), Molhotra et al.(2008)
	Out(3)	Quick Ratio	Duzakin et al.(2007)
	Out(4)	Average Collection Period	Feroz (2003)
	Out(5)	**Return on Shareholder's equity**	Brid (2001), Margaritis et al.(2009), Liang et al.(2006)

For determining the validity level of the criteria, the opinions of the banking credit experts, financial management professors and credit applicant experts have been taken into account. Stability of these criteria has been calculated through the Cronbach's Alpha method and has been verified by 86%.

Static population in this study has been drawn based on the investigation and consultation with filed senior experts and as a result, 35 companies that have received the bank financial facilities from 2009 to 2010 and were listed in the Tehran Stock Exchange have been selected. These information and financial ratios have been completed with respect to the Stock Exchange rules and regulations and are homogenous and highly accurate. Also, access to the financial information of the selected companies is easier in this way.

4. The Proposed DEA Model (Grouped DEA)

In this study, a dummy unit has been considered as an “ideal” unit and is named as "Ideal unit". The output and input variables in the ideal unit are determined as follows (the schematic is shown in figure 2):

1- Within each column, the input variable with the smallest value is chosen.

2- Within each column, the output variable with the greatest value is chosen.

3-The minimum value of every input variable is considered as the input variable value of the ideal unit.

4- The maximum value of every output variable is considered as the output variable value of the ideal unit.

5- Calculations for the DEA model have been performed by adding the ideal unit as a new unit.

6- Determining efficiency and credit rating in total

7- Determining group efficiency and credit rating in different industries

8- Determining internal group efficiency

In the Adaptive DEA, the ideal unit has to be defined whenever the model is executed. Use of the ideal unit in DEA model reduces the company prioritizing steps based on the efficiency level, reduces the decision-making and calculation time, eliminates the efficiency of 100% and above 100%, optimizes the number of the target companies, and finally, encourages the efficient companies to achieve the ideal condition. This model proposes a direct, shortcut and dynamic path for efficient and inefficient companies to achieve a higher level of efficiency.

4.1. Information analysis of the understudied companies

Debt collection constitutes a considerable amount of financial resources required for banking operations. For banks that have been unsuccessful at collecting debts, it means the loss of a considerable part of assets and financial resources. Therefore, banks try to properly evaluate the credit applicants more efficiently by using different methods for reducing the credit and facilities' non-pay off risk. The companies for the statistical sample have been chosen from 10 different industries including: food, pharmaceutical, electrical devices, automotive, basic metals, cement and plaster, manufacturing equipment and machinery, telecommunications, glass and crystal, and mineral industry.

When model input and output are defined, it is necessary to normalize the information due to industry variety and statistically heterogeneous companies. The normalized information is provided in table 3.

Using the normalized information and GAMS software, efficiency for each unit is calculated. The obtained results from the DEA method for companies (relative and final efficiency) are provided in table 4.

Table 3: Input and output values for the studied companies

DMU	group	Inputs					Outputs				
type		In(1)	In(2)	In(3)	In(4)	In(5)	Out(1)	Out(2)	Out(3)	Out(4)	Out(5)
DMU 1	1	0.457	0.133	0.075	0.174	0.382	0.135	0.982	0.18	0.257	0.317
DMU 2		0.186	0.327	0.054	0.251	0.527	0.282	0.917	0.245	0.118	0.397
DMU 3		0.172	0.088	0.012	0.171	0.394	0.197	0.575	0.207	0.158	0.286
DMU 4		0.328	0.214	0.015	0.165	0.277	0.125	0.411	0.135	0.752	0.294
DMU 5		0.248	0.165	0.021	0.121	0.391	0.148	0.725	0.822	0.695	0.268
DMU 6		0.368	0.018	0.015	0.115	0.094	0.032	0.516	0.502	0.827	0.721
DMU 7	2	0.185	0.055	0.029	0.118	0.411	0.128	0.726	0.197	0.531	0.427
DMU 8		0.224	0.782	0.341	0.275	0.274	0.099	0.769	0.165	0.127	0.315
DMU 9	3	0.161	0.981	0.189	0.492	0.412	0.087	0.918	0.809	0.172	0.712
DMU 10		0.167	0.063	0.012	0.151	0.392	0.257	0.896	0.159	0.217	0.349
DMU 11		0.148	0.529	0.275	0.316	0.545	0.179	0.942	0.951	0.111	0.712
DMU 12		0.183	0.225	0.027	0.251	0.297	0.112	0.812	0.407	0.769	0.727
DMU 13		0.028	0.975	0.016	0.216	0.592	0.192	0.851	0.291	0.912	0.127
DMU 14	4	0.199	0.352	0.173	0.115	0.274	0.118	0.168	0.392	0.891	0.429
DMU 15		0.617	0.369	0.096	0.116	0.276	0.112	0.818	0.418	0.413	0.642
DMU 16	5	0.218	0.276	0.015	0.127	0.527	0.122	0.728	0.389	0.695	0.518
DMU 17		0.128	0.242	0.026	0.119	0.112	0.105	0.175	0.197	0.517	0.812
DMU 18		0.094	0.179	0.431	0.475	0.048	0.167	0.284	0.415	0.375	0.915
DMU 19	6	0.419	0.098	0.25	0.341	0.327	0.027	0.725	0.147	0.192	0.175
DMU 20		0.124	0.126	0.013	0.121	0.142	0.042	0.395	0.871	0.527	0.287
DMU 21		0.056	0.829	0.012	0.181	0.121	0.165	0.452	0.325	0.361	0.296
DMU 22		0.253	0.147	0.011	0.162	0.872	0.014	0.222	0.498	0.397	0.452
DMU 23	7	0.068	0.196	0.282	0.277	0.505	0.182	0.241	0.272	0.539	0.481
DMU 24		0.217	0.141	0.015	0.117	0.285	0.125	0.892	0.189	0.894	0.586

DMU	group	Inputs					Outputs				
DMU 25	8	0.328	0.137	0.014	0.252	0.219	0.096	0.945	0.197	0.367	0.421
DMU 26		0.242	0.415	0.011	0.211	0.417	0.027	0.127	0.212	0.285	0.297
DMU 27		0.018	0.745	0.021	0.117	0.128	0.172	0.922	0.842	0.471	0.342
DMU 28	9	0.621	0.248	0.051	0.282	0.351	0.225	0.968	0.158	0.542	0.571
DMU 29		0.317	0.156	0.016	0.151	0.342	0.117	0.722	0.751	0.821	0.428
DMU 30		0.286	0.541	0.025	0.174	0.351	0.115	0.741	0.925	0.274	0.272
DMU 31		0.321	0.722	0.042	0.124	0.512	0.217	0.269	0.261	0.295	0.568
DMU 32		0.045	0.641	0.121	0.212	0.115	0.486	0.516	0.927	0.116	0.821
DMU 33	10	0.441	0.025	0.168	0.274	0.012	0.227	0.249	0.822	0.271	0.572
DMU 34		0.352	0.049	0.257	0.215	0.541	0.411	0.275	0.711	0.561	0.625
DMU 35		0.412	0.117	0.618	0.718	0.217	0.126	0.212	0.768	0.549	0.276
Ideal DMU		0.018	0.018	0.011	0.115	0.012	0.486	0.982	0.951	0.912	0.821

Table 4: Calculated efficiency

Type	Efficiency	Credit rating	Group efficiency	Group credit rating	Internal group efficiency	Internal group credit rating
DMU (0)	1	1	1	1	1	1
DMU 1	0.976	2	0.797	3	0.987	2
DMU 2	0.961	3			0.973	3
DMU 3	0.497	24			0.503	5
DMU 4	0.467	26			0.473	7
DMU 5	0.482	25			0.488	6
DMU 6	0.949	4			0.960	4
DMU 7	0.521	22	0.718	5	0.544	3
DMU 8	0.915	5			0.956	2
DMU 9	0.901	6	0.876	2	0.948	2
DMU 10	0.853	8			0.897	3
DMU 11	0.508	23			0.534	6
DMU 12	0.841	9			0.885	4

Type	Efficiency	Credit rating	Group efficiency	Group credit rating	Internal group efficiency	Internal group credit rating
DMU 13	0.828	10			0.871	5
DMU 14	0.371	33	0.581	7	0.414	3
DMU 15	0.791	12			0.883	2
DMU 16	0.768	13	0.731	4	0.868	2
DMU 17	0.744	14			0.842	3
DMU 18	0.682	16			0.771	4
DMU 19	0.659	17	0.544	9	0.795	2
DMU 20	0.452	27			0.545	4
DMU 21	0.439	28			0.529	5
DMU 22	0.628	18			0.757	3
DMU 23	0.597	19	0.572	8	0.749	2
DMU 24	0.548	20			0.689	3
DMU 25	0.422	29	0.437	11	0.550	3
DMU 26	0.532	21			0.696	2
DMU 27	0.357	35			0.466	4
DMU 28	0.342	36	0.479	10	0.361	6
DMU 29	0.385	32			0.408	4
DMU 30	0.417	31			0.448	3
DMU 31	0.886	7			0.943	2
DMU 32	0.367	34			0.383	5
DMU 33	0.812	11	0.614	6	0.896	2
DMU 34	0.425	30			0.469	4
DMU 35	0.705	15			0.778	3

4.2. Sensitivity analysis

For analyzing the results, the process is repeated by eliminating an input or an output factor from all of the DMUs based on stepwise method. This may cause an increase, decrease or no change in DMU's efficiency. If elimination of an input factor leads to the unit's efficiency increase, then that input

variable is a surplus and has a significant effect on the efficiency of that unit. However, if the efficiency of that unit is reduced, that means the unit has accurately and carefully utilized the input variable and has a significant impact on unit's efficiency. Also, this analysis can be performed by eliminating the output variables. For example, if elimination of an output leads to the increase of unit's efficiency, then that unit has not been successful in achieving the desired output and should pay more attention to increase its output and that output has a considerable impact on DMU's efficiency. On the contrary, if the efficiency of that unit is reduced, that means the DMU has been successful in achieving the desired output and has a significant impact on DMU's efficiency.

Accordingly, the changes of DMU's efficiency are provided in table 5.

Table 5: Efficiency reduction in case of input or output variable elimination

		Efficiency reduction value in case of input elimination					Efficiency reduction value in case of output elimination				
Group	Efficiency	In(1)	In(2)	In(3)	In(4)	In(5)	Out(1)	Out(2)	Out(3)	Out(4)	Out(5)
1	0.797	0.036	0.360	0.013	0.016	0.096	0.241	0.000	0.049	0.042	0.019
2	0.718	0.076	0.203	0.125	0.129	0.357	0.011	0.214	0.000	0.141	0.191
3	0.876	0.786	0.108	0.179	0.134	0.140	0.232	0.062	0.091	0.001	0.109
4	0.581	0.074	0.093	0.108	0.108	0.382	0.000	0.304	0.000	0.354	0.151
5	0.731	0.000	0.055	0.122	0.130	0.284	0.000	0.000	0.000	0.286	0.000
6	0.544	0.000	0.132	0.000	0.004	0.159	0.105	0.018	0.064	0.094	0.062
7	0.572	0.148	0.000	0.000	0.248	0.000	0.008	0.011	0.098	0.000	0.008
8	0.437	0.120	0.000	0.077	0.084	0.067	0.067	0.034	0.082	0.038	0.039
9	0.479	0.016	0.126	0.082	0.094	0.084	0.074	0.017	0.085	0.108	0.003
10	0.614	0.322	0.173	0.161	0.173	0.356	0.040	0.004	0.065	0.062	0.005

In order to determine the importance of each input and output variable globally, it is necessary to calculate the average efficiency reduction. Accordingly, based on the average efficiency reduction, it is possible to provide an overall analysis on each input and output variable's importance (priority) among the facility applicants.

Accordingly, inputs and outputs have been eliminated for each industry and the respective efficiency has been calculated. The importance of the inputs and outputs for each industry are provided in table 6.

Table 5: Efficiency reduction in case of input or output variable elimination

Efficiency reduction value in case of input elimination							Efficiency reduction value in case of output elimination				
Group	**Efficiency**	**In(1)**	**In(2)**	**In(3)**	**In(4)**	**In(5)**	**Out(1)**	**Out(2)**	**Out(3)**	**Out(4)**	**Out(5)**
1	0.797	0.036	0.360	0.013	0.016	0.096	0.241	0.000	0.049	0.042	0.019
2	0.718	0.076	0.203	0.125	0.129	0.357	0.011	0.214	0.000	0.141	0.191
3	0.876	0.786	0.108	0.179	0.134	0.140	0.232	0.062	0.091	0.001	0.109
4	0.581	0.074	0.093	0.108	0.108	0.382	0.000	0.304	0.000	0.354	0.151
5	0.731	0.000	0.055	0.122	0.130	0.284	0.000	0.000	0.000	0.286	0.000
6	0.544	0.000	0.132	0.000	0.004	0.159	0.105	0.018	0.064	0.094	0.062
7	0.572	0.148	0.000	0.000	0.248	0.000	0.008	0.011	0.098	0.000	0.008
8	0.437	0.120	0.000	0.077	0.084	0.067	0.067	0.034	0.082	0.038	0.039
9	0.479	0.016	0.126	0.082	0.094	0.084	0.074	0.017	0.085	0.108	0.003
10	0.614	0.322	0.173	0.161	0.173	0.356	0.040	0.004	0.065	0.062	0.005

Table 6: Input and output variables priority rating by industry

Efficiency reduction value in case of input elimination						Efficiency reduction value in case of output elimination				
Group	**In(1)**	**In(2)**	**In(3)**	**In(4)**	**In(5)**	**Out(1)**	**Out(2)**	**Out(3)**	**Out(4)**	**Out(5)**
1	3	1	5	4	2	1	5	2	3	4
2	5	2	4	3	1	4	1	5	3	2
3	1	5	2	4	3	1	4	3	5	2
4	5	4	2	3	1	5	2	4	1	3
5	5	4	3	2	1	5	4	3	1	2
6	5	2	4	3	1	1	5	3	2	4
7	2	5	4	1	3	3	2	1	5	4
8	1	5	3	2	4	2	5	1	4	3
9	5	1	4	2	3	3	4	2	1	5
10	2	4	5	3	1	3	5	1	2	4

5.2. Conclusion and Suggestions for Future Research

The purpose of this paper is to resolve this key weakness in such a way which makes it possible to simultaneously consider the heterogeneous companies (DMUs). The results of the proposed method have shown an enhanced capability for rating the decision-making units. In this study, these financial ratios have been considered as the DEA model input and output variables. In this research, the efficiency has been calculated using the existing and the Adaptive DEA model which demonstrates identical results. Then, the effect of each input and output variable on the efficiency value has been determined using the sensitivity analysis. Finally, the companies were rated by industry and results show the influence of the industry type on the input and output ratings. The proposed model defining an ideal unit results in the reduction of prioritizing steps, calculation and decision-making time, and reduction of the number of target companies to achieve the ideal situation. Furthermore, the new proposed DEA model provides a straightforward, shortcut and dynamic path to obtain a greater efficiency for both efficient and inefficient companies and it is used for simultaneous rating of the grouped units such as financial facility applicants that operate in different industrial clusters and groups.

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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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Economic Freedom and Banking Stability in Selected Countries

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Abstract

This paper investigates the role of economic freedom in banking stability by using a panel data set for the period 1998-2013 in 43 selected countries. We turn our investigation to the effects of economic freedom on banking stability. The effects of economic freedom on financial stability are estimated. This paper calculates the z-score measure for banking stability. The findings from this study seem to suggest that overall economic freedom has positive impacts on the banking stability in the selected countries. The positive sign of the coefficient indicates that higher (lower) freedom on the activities that banks can undertake increases (reduces) banks' stability, which is consistent with the view that less regulatory control allows banks to engage in various activities enabling banks to exploit economies of scale and make income from non-traditional sources. Furthermore, higher freedom on entrepreneurs helps to start businesses and job creation and consequently, increases intermediation performance which increases banks' stability.

Keywords: *Financial stability, Banking, Dynamic panel data*

JEL Classification: *G21, C23, G10 .*

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1. Introduction

The banking sector is probably the most important financial intermediary in an economy because of the role it plays as a provider of liquidity in monitoring services and as producers of information (Diamond and Dybvig, 1983). In most countries, banks provide essential financial services that facilitate economic growth. They lend money to start businesses, purchase homes, secure credit for the purchase of durable consumer goods, and furnish a safe place in which societies can store their wealth. For developing countries, improvements in the banking sector could have significant impact on the allocation of financial resources since the sector remains still, the most important source of financing private investment of firms, given the underdevelopment of the financial markets.

Because of the vital role banks play in the economy, the banking sector has been singled out for special protection and it is clear why such great emphasis is placed on regulation and supervision of the banking sector (Barth et al., 2006). The regulation and supervision serves two main purposes. First is to safeguard the safety and soundness of the financial system. And second, to ensure that financial services firms meet their basic fiduciary responsibilities. Ultimately, both tasks fall under a government's judiciary to enforce contracts and to protect its citizens against fraud by requiring financial institutions to publish their financial statements verified by an independent audit, so that borrowers, depositors, and other financial actors can make informed choices.

These important insights have spurred further exploration into the various channels in which economic freedom influences economic growth (e.g. Heckelman and Knack, 2009; Altman, 2008; Powell, 2003; Adkins et al., 2002; DeHaan and Sturm, 2000; Heckelman and Stroup, 2000; Heckelman, 2000; DeHaan and Siermann, 1998). Most of these studies conclude that there exists a positive impact of various measures of economic freedom on economic growth. Noticeably absent in the literature is an

examination of the links between economic freedom and bank performance. The limited research in this area is somewhat surprising given the importance of bank lending in promoting economic development (e.g. Chinn and Ito, 2007; Beck et al., 2000; Levine, 2005; Beck and Levine, 2004) and the impact that economic freedom is likely to have on the banking sector. The purpose of the present paper is to extend the earlier works on the performance of the banking sector in a developing economy and establish empirical evidence on the impact of economic freedom for the first time.

The paper also investigates to what extent the performance of banks is influenced by internal factors (i.e. bank specific characteristics) and to what extent by external factors (i.e. macroeconomic and financial market conditions). Although empirical evidence which examines the performance of banking sectors are abundant in the literature, to the best of our knowledge, virtually nothing has been published to address the impact of economic freedom on the banking sector's performance. In light of the knowledge gap, this study provides for the first time empirical evidence of the impact of economic freedom on banking sector's performance. The present study should interest not only the managers of the banks, but numerous stakeholders such as the central banks, bankers associations, governments, and other financial authorities. For example, as in virtually all-emerging markets, banks are the dominant financial institutions in Malaysia. Banks control most of the financial flows and possess more than 70% of the financial system's total assets. Given the close relationship between the well-being of the banking sector and the growth of the economy, the health of the banking sector is therefore crucial. Furthermore, explicit knowledge of the factors that influences the banking sector's performance would be useful for policymaking and research purposes.

A well-developed banking sector often represents major elements of economic development. Theoretical explanations suggest that banking sector

effect by resolving a range of market imperfection problems. Banks provide services as efficient monitoring agent, provider of liquidity, efficient risk smoother, provider of research function and incentive for good governance and corporate control. Studies by King and Levine (1993), Rajanand Zingales (1998), Becketal (2000) represent this point and role of banking in economic growth. Many studies on financial development examine the various conditions that influence the pattern of financial development which include legal structure, openness, macroeconomic condition such as La Porta et al. (1998); Levine (2002) , Rajan and Zingales 2003, Stultz and Williamson (2003), Beck et al. (2003) , Hung (2003) .

This empirical study represents that the inefficiency of banking system due to a range of from government interferences to intervention of government and less freedom in banking system creates moral hazard (Mishkin, 1999). Therefore, a key to achieving a sustainable economic growth promotes the sound banking system. Previous studies on banking development have employed various variables without economic freedom index. The present paper extends the banking literature by providing a relationship between the economic freedom in the countries and their banking sector stability. We examine the effect of economic freedom on stability banking system in the selected countries.

This paper is structured as follows. The next section reviews the related studies in the literature, followed by a section that outlines the econometric framework. Section 4 reports the empirical findings. Finally, Section 5 concludes and offers avenues for future research.

2. Related Studies

Economists have long recognized that the less government intervention in economy will lead to economic growth. Torsensson1994, Knack & Keefer 1995, Barro 1996 show the importance of various institutional and policy variables in promoting economic growth. More specifically, this growth

literature points out that stable law, good enforcement of contracts, protection of individual and property rights, sound money policy are important to achieving economic growth. Gwatney and Lawson (2003) represent that economic freedom of the world index captures many of the institutional and policy related areas of a country. It can be used as a proxy for institutional and policy framework of a country. Dawson (1998) , Ayal , Karras (1998), Gwartney et al.(1999) , De Hann , Sturm (2000), Calson , Lundstrom (2002), Karabegovic et al. (2003), focus on the relationship between Economic freedom and economic growth. Haan et al. (2006) represents that economic freedom has a strong relationship with economic growth. In their studies economic freedom has positive relationship between economic freedom and economic growth. Studies that focus on economic growth and banking stability include King and Levine (1993), Jayarante and Straham (1996), Rajan and Zingales 1998, Beck et al. 2000. A well-developed financial system normally includes well-functioning banks and equity markets and there has been substantial research on the various determinants of financial development. More generally, empirical literatures have shown that stable macroeconomic policies contribute to well-functioning financial system (Boyd et al. 2001). Beck et al. 2005 indicate that legal system with effective resolutions and contract increase firms access to financing.

Empirical work has also supported the view that country capital account openness and its openness to international trade have positive effects on financial sector development (Soo- Wah Low et al., 2010). Empirical research on the major determinants of banking stability indicate that various institutional and policy variables affect banking stability. This study examines the link between economic freedom and banking stability. The index of economic freedom reflects different policy areas of a country. The index of economic freedom is made up of several sub components. Five

areas of economic freedom are size of government, legal structure and security of property rights, access to sound money, openness to trade internationally and regulation of credit, labor and business. This index provides a clear picture of policy area that helps to understand the role of government in promoting banking stability.

According to King and Levine (1993), the degree of government intervention can have important influences on a country's banking systems. These reasoning forms a basis that calls for a free market which either minimizes government interventions or a market that replaces government interventions with market determined variables as inputs for financial or banking decisions (Soo- Wah Low et al., 2010).

If economic freedom is a key determinant for banking system, then the government should not implement policies that severely limit economic freedom.

The empirical studies on the performance of banking sectors has focused on both the returns on assets, returns on equity and net interest margins. It has traditionally explored the impact of bank specific factors such as risk, market power, size, and capitalization of bank performance. More recently, research has focused on the impact of macroeconomic factors on bank performance.

To date, empirical researches have focused mainly on a specific country mainly the US banking system (Hirtle and Stiroh,2007; Stiroh and Rumble, 2006; DeYoung and Rice, 2004; Angbazo, 1997, etc.) and the banking systems in the western and developed countries such as Greece (Pasiouras and Kosmidou, 2007; Athanasoglou et al., 2008). Heffernan and Fu (2008) examine the performance of different types of Chinese banks during the period 1999 to 2006. The results suggest economic value added and the net interest margin (NIM) do better than the more conventional measures of profitability, namely return on average assets (ROAE) and return on average equity (ROAA). Some macroeconomic variables and financial ratios are significant with the expected signs. Though the type of

bank is influential, bank size is not. Neither the percentage of foreign ownership nor bank listings has a discernable effect.

Ben Naceur and Goaied (2008) examine the impact of bank characteristics, financial structure, and macroeconomic conditions on Tunisian banks' net-interest margin and profitability during the period of 1980–2000. They suggest that banks which hold a relatively high amount of capital and higher overhead expenses tend to exhibit higher net-interest margin and profitability levels, while size is negatively related to bank profitability. During the period under study, they find that stock market development has positive impact on banks' profitability. The empirical findings suggest that private banks are relatively more profitable than their state owned counterparts. The results suggest that macroeconomic conditions have no significant impact on Tunisian banks' profitability.

Economic freedom is the driving force behind why some societies thrive while others do not. It is widely believed that economic freedom engenders economic prosperity, and a country's economic freedom is associated with the development of capital market and financial stability. For example, La Porta et al. (1997) claim that a country's legal environment is very important for investor protection and it affects market capitalization. Li (2002) confirms that greater economic freedom is always related to stronger shareholder protections and the relative market capitalization. In other words, for investors seeking superior investment returns, countries that are experiencing greater economic freedom improvement should be selected for their investment portfolios.

3. Finance and Economic Performance

Different perspectives on the relationship between finance and economic performance have been underlined and theoretical and empirical controversies on this subject exist since the beginning of the XXth century

(Ang, 2008). The discussion can be summed up as follows: The development of finance induces a better allocation of resources, mobilizes savings, can reduce risks and facilitates transactions. The financial sector acts as grease for the economy, ensuring a smoother allocation of resources and the emergence of innovative firms. Some more distrustful authors believe that the link between finance and economic growth is exaggerated (Stiglitz, 2000; Rodrik and Subramanian, 2009). De Gregorio and Guidotti (1995) argue that the link is tenuous or even non-existent in the developed countries and suggest that once a certain level of economic wealth has been reached, the financial sector makes only a marginal contribution to the efficiency of investment. It abandons its role as a facilitator of economic growth in order to focus on its own growth. This generates banking and financial groups that are finally "too big to fail"; enabling these entities to take excessive risk since they know it will be mutualized via public authorities' interventions. Their fragility rapidly transmits to other corporations and to the real economy. The subprime crisis is certainly a good example of the power and magnitude of the effects of correlation and contagion on financial markets.

Numerous empirical studies have investigated these questions. However, until recently, the studies highlighted a positive relationship between financial development and economic growth. Bumann et al. (2012) in an attempt to reconcile the divergent views expressed in the literature, has assumed a nonlinear relationship between finance and economic growth. Beck and Levine (2004) by introducing credit to the private sector and the square of this variable in order to take account of potential non-linearity of financial depth have been thus able to show that the relationship between economic growth and private sector credit is positive, but that the relationship between economic growth and the square of private sector credit (that is to say, the effect of credit to the private sector when it is at a high level) is negative. Taken together, these two factors indicate a concave relationship between economic growth and credit to the private

sector: the relationship is positive up to a certain level of financial depth, and beyond a threshold, the effects of financial depth is negative.

Beck et al. (2012) insist on the fact that finance growth affects branches from firms rather than households. However, in developed countries, financial deepening originates from more households' lending. This may explain the weakness of the finance effect in high-income countries. It is worth acknowledging that those show that it do not exclude each other. They might even reinforce themselves and create an excess of finance that degenerates into financial instability.

Beyond questions of non-linearity, finance can also have its own potential negative effects. Indeed, liquidity and maturity transformation from deposit and savings to long-term investments can expand economic performance but can also be harmful. Deregulation and information asymmetries have encouraged banks to take more and more risks in recent years. Combined with financial deepening, it led to excessive lending, and created conditions for financial fragility. The failure of financial institutions can have strong negative externalities. Laeven and Valencia (2012) show that banking crises tend to have larger real effects in advanced economies. Output losses are driven by deeper banking systems that impact deeply on the whole economy.

4. Financial Stability and Banking Stability

Schinasi (2004) proposes to define financial stability from its different characteristics views, such as "enhancing economic processes, manage risks and absorb shocks". Financial stability represents the ability of a financial system to absorb the shocks the system has to face. On a micro level, it refers to the market structures (a high degree of concentration reinforces the contagion risks from one bank to another) and to financial institutions themselves (depending on the fact that their business model requires high or

low risk). On a macro level, it also relates to the monetary stability and to the functioning of the payment system. These are organized and supervised by central banks, supervisory authorities and private firms that confirm the operation of the payment system between the financial institutions. Failures in the supervision may make possible financial instability.

Financial instability is exogenous to the financial system, and risks should be managed on an individual basis. This is an approach and spillover effects between unrelated institutions. Macro prudential policies focus on the economic system as a whole and are aimed at limiting shocks that may have a macro impact.

The complexity to define conceptually financial stability also involves various ways to measure it. Loayza and Ranciere (2005) measure financial fragility as the standard deviation of the private credit/GDP ratio over non-overlapping 5-year averages or at the micro level. Several authors capture financial stability in the banking sector through the Z-score (Uhde and Heimeshoff, 2009; Fink et al., 2009) that measures the probability of default for a bank or a banking system. Nevertheless, this indicator suffers from several limitations (Cihák et al., 2012). Using the financial stress index developed by the IMF for thirteen industrialized economies, Proaño et al. (2013) analyze how the effect of the sovereign debt-to-GDP ratio on economic growth depends on financial stability and find that the debt-to-GDP ratio impairs economic growth only if financial stress is high. This paper investigates the effects of economic freedom on banking stability.

5. Data and Methodology

We build a dataset that encompasses information on banking and nonbanking sector for 43 countries over the period 1998-2013. These countries are Argentina, Australia, Austria, Belgium, Bulgaria, Canada, Chile, China, Colombia, Costa Rica, Germany, Denmark, Ecuador, Egypt, Spain, Finland, France, Greece, Hungary, Iceland, Ireland, India, Indonesia,

Iran, Italy, Japan Luxembourg, Malaysia, Mexico, Netherlands, New Zealand, Norway, Pakistan, Poland, Portugal, South Africa, Russia, Sweden, Switzerland, Turkey, United Kingdom, United States, and Venezuela. We choose these countries based on the availability of data. All data at bank level variable are composed from Bankscope. This paper employs the economic freedom measure from Fraser Institute. This paper investigates the role of economic freedom on banking stability.

Following Hafer R.W. (2013) and Low S.W. et al. (2010), the paper estimates the relationship between banking stability and economic freedom using the GMM estimator developed by Arellano and Bond (1991). The regression equation can be described in the following form:

$$BS_{it} = \alpha_0 + \alpha_{1*} EF + \alpha_{2*} BV + \alpha_{3*} EV \quad (1)$$

Where the subscripts i and t indicate country and time period respectively, and *BS* is banking stability, *EB* is economic freedom, *BV* is banking variable and *EV* is economic variable

In this paper, three types of variable exist in equation (1). These are banking variable, economic variable and economic freedom variable. The economic variable such as (money growth, capitalization) indicated the effect of economic on banking stability and the banking variable included return on asset and capital ratio and deposit ratio influence on banking stability. The economic freedom Index represents the impact of freedom on banking stability.

Z-score represents a variable that proxy for banking stability. This paper uses a measure of the Z-score, which represents a universal measure of bank stability according to Boyd et al., (2006) and Laeven and Levine (2009). It is defined as $Z = (ROA+EA) / \sigma(ROA)$, where *ROA* is the rate of return on assets (ratio of pre-tax profit to total assets), *EA* is the ratio of equity to assets, and $\sigma(ROA)$ is an estimate of the standard deviation of the rate of return on assets.

This paper calculated the Z-score for the proxy of banking stability in banks for each country. To calculate $\sigma(ROA)$ at time *t*, we use data from the two previous years (i.e., *t-1*, *t-2*) and verify that using three or four lags gives very similar results. A higher *Z* indicates that a bank is farther from insolvency. Since *Z* is highly skewed, we use its natural logarithm, which is normally distributed. *Z-score* reflects the number of standard deviation units by which profitability would have to decline before bank capitalization is depleted. This bank stability indicator increases with higher profitability and capitalization levels but declines with unstable earnings reflected by a higher standard deviation of return on assets. A higher *z-score* implies that a bank is farther from default and hence more stable.

Liquid asset ratio, defined as the ratio of liquid assets over total bank assets, is employed to capture the impact of bank liquidity (*LIQUIDITY)* on bank stability. The usual regulatory view is that more liquid assets enhance bank stability as they are less vulnerable to liquidity shocks as well as reducing the level of risk on bank balance sheets. Nevertheless, it is argued from a theoretical perspective that higher asset liquidity can increase bank instability and is associated with bank failures.

The ratio of equity over total assets is to control for bank capitalization (*CAPITALratio*).

A well-capitalized bank with higher book value of equity to total assets might have fewer incentives to engage in excessive risk taking (Laeven and Levine, 2007). Thus, this variable is expected to display a positive correlation with bank stability.

To assess the role that economic freedom plays in explaining financial development, the paper uses the overall measure of economic freedom and its major subcomponents. Since more detailed definitions for these indexes are available from Gwartney et al. (2010), for present purposes a brief description will suffice. The freedom measure uses a 10 point scale; the higher the value, the greater the degree of economic freedom. The subcomponents of the overall index capture specific aspects of economic

freedom as it relates to the level of government activity, the legal structure, and the regulatory environment within which firms operate. More specifically, the Government component accounts for government size relative to the economy, Legal captures the existing legal structure and property rights, Money is used to measure government policies to protect the purchasing power of the currency, Trade assesses how free international trade is, and Regulation measures the degree of regulatory intervention. Based on previous work, higher levels of economic freedom are expected to promote greater development in financial intermediaries and banking stability. According to the studies, higher levels of economic freedom predict faster economic growth, higher levels of wealth, and healthier and happier populations (Dawson 2003, Welsch 2003, Gwartney et al. 2006, Inglehart et al. 2008, and Gropper et al. 2011). And as noted earlier, Baier et al. (2012) report that greater levels of economic freedom are associated with a lower probability of financial crises, thus suggesting that more freedom begets a more stable financial system.

Bank profitability is typically measured by the return on assets (ROA) and/or the return on equity (ROE) and expressed. Money and quasi money growth (annual %) indicate the macroeconomic effect on banking stability. Capitalization shows the Market capitalization of listed companies (% of GDP) in the selected countries. These variables include the economic variables in this model.

The main problem in empirical work is heteroskedasticity. Although the consistency of the instrumental variables coefficient estimates is not affected by the presence of heteroskedasticity, the standard instrumental variables estimates of the standard errors are inconsistent, preventing valid inference. The usual form of the diagnostic tests for endogeneity and over-identifying restrictions will also be invalid if heteroskedasticity is present. These problems can be partially addressed through the use of heteroskedasticity-

consistent or robust standard errors and statistics. The conventional instrumental variables estimator, although consistent, however, is inefficient in the presence of heteroskedasticity (Hoffmann, 2010).

The usual approach today when facing heteroskedasticity of unknown forms is to use the Generalized Method of Moments (GMM). Due GMM considers the unobserved effect transforming the variables into first differences; we consider this technique as an efficient tool to deal with endogeneity problems.

When the unobserved effect is correlated with independent variables, pooled OLS regression produces estimations that are biased and inconsistent. This problem can be controlled by using the first difference or the fixed effect (with-in) estimators (Hansen, 1982). Nevertheless, whether the strict exogeneity of the independent variables condition fails, either the first difference or the fixed effect estimators are inconsistent and have different probability limits. The general approach in this case is to use a transformation to eliminate the unobservable effects and instruments to deal with endogeneity (Nickell, 1981). Therefore, the econometric method considers the unobserved effect transforming the variables into first differences, and uses the GMM to deal with endogeneity problems. Tests of Hansen/Sargan are estimated to test the model specification validity. This test examines the lack of correlation between the instruments and the error term. This paper uses GMM methodology because the banking stability in countries is related to banking stability in previous time.

6. Results

Before estimating the equation, it is necessary to test unit root of all applied variables in estimations, because unit root variables create quasi regression problem for both time series data and panel data. Therefore, Levin, Lin and Chu test, Im, Pesaran and Shin W-stat test and Fisher and Hadri test are used to study common unit root of variables. Results are presented in table (1).

Table 1: Results

variable	Levin, Lin and Chu test,	Im, Pesaran and Shin w-stat test	PP - Fisher Chi-square	ADF - Fisher Chi-square	Hadri z
Capitalization	-8.72(0.000)	-3.74(0.001)	169.1(0.000)	138.5(0.000)	10.03(0.000)
EF	-18.18(0.000)	-12.39(0.000)	286.5(0.000)	318.5(0.000)	13.43(0.000)
Capital ratio	-16.75(0.000)	-14.03(0.000)	448.5(0.000)	319.5(0.000)	5.97(0.000)
Deposit ratio	-2.196(0.014)	-3.64(0.0001)	258.9(0.000)	141.58(0.00)	11.89(0.000)
Money growth	-17.54(0.000)	-7.68(0.000)	289.5(0.000)	173.7(0.000)	11.2(0.000)
Roe	-6.86(0.000)	-1.77(0.000)	113.8(0.000)	107.25(0.000)	8.78(0.000)
Roa	-6.8(0.000)	-8.94(0.000)	394.4(0.000)	232.9(0.000)	3.89(0.000)
liquidity	-15.66(0.000)	-10.5(0.000)	405.9(0.000)	263.4(0.000)	5.93(0.000)
z-score	-13.96(0.000)	-11.79(0.000)	436.9(0.000)	291.4(0.000)	5.082(0.000)

* The figures in parentheses are p value.

Table 2 presents the results of estimating equation (1), for analysis of the results, this research focused on the factors of determination of banking stability. For estimation, this research used the dynamic panel data. This coefficient and (t-stat) for models are significant and the Sargan test for instrument validity is reported in our estimation. The results of estimations for the model are reported in Table 2. The coefficient of lagged z-score shows that a point estimate of near 0.64 (significant at the 1% level) proves that the dynamic model is a good choice in explaining banking stability.

Table 2: The result of estimation equation1

variable	Model 1	Model 2	Model 3	Model 4	Model 5
z-score(-1)	0.64(23.7)	0.65(25.8)	0.67(24.3)	0.65(22.3)	0.81(23.45)
EF	0.65(7.74)	0.68(10.5)	0.52(6,65)	0.68(11.09)	0.88(7.75)
Capital ratio	3.27(7.18)	3.26(7.7)	3.06(7.14)	3.22(7.5)	3.48(7.63)
Deposit ratio	0.26(9.95)	0.26(6.73)	0.41(7.05)	0.27(6.65)	0.23(6.89)
Money growth	0.0082(1.89)	--	--	--	--
Capitalization	--	0.0072(11.049)	--	--	--
Roe	--	--	0.22(4.5)	--	--
Roa	--	--	--	--	0.16(3.75)
liquidity	--	--	--	-0.016(-2.22)	-0.079(-2.78)
R-Squared	0.78	0.62	0.77	0.88	0.65
J-stat(rank)	43.4(38)	42.4(38)	47.4 (38)	39(38)	39(39)
p-value	0.25	0.28	0. 141	0.4	0.46

*The figures in parentheses are t value.

The ROE as profitability banking variable has a positive and significant impact on the banking stability. This would mean that banks in Iran preferred to increase profits for achieving banking stability. The capital ratio has positive impact on z-score when capital ratio increase, the banking stability increases. This coefficient is positive and significant in our estimation. The greater economic freedom leads to more banking stability. In addition, the estimated coefficients on the economic freedom measures are all positive and statistically significant across the financial measures. This suggests that countries with more economic freedom impede the development of financial intermediaries and banking stability. The results using more narrowly defined measures of economic freedom indicate that openness in foreign trade and reductions in regulatory burden are associated with increases in financial intermediary development and banking stability.

The evidence thus indicates that a higher level of economic freedom is an important component to the future development of financial intermediation and banking stability. Deposit ratio has positive impact on banking stability, when deposit increases in balance sheet, banking stability increases.

Liquid asset ratio, defined as the ratio of liquid assets over total bank assets, is employed to capture the impact of bank liquidity on bank stability. The results show that more liquid assets decrease bank stability. It is argued from a theoretical perspective that higher asset liquidity can decrease bank instability. The capitalization and money growth variable have positive effect on banking stability. This coefficient is significant.

7. Conclusion

A number of studies have found that financial development and higher levels of economic freedom are associated with banking stability. This paper examines the relationship between economic freedom and banking stability by using panel data analysis for the period 1998-2013.

The paper found that countries with higher levels of economic freedom, exhibit greater levels of banking stability. The results of this study explain the observed link between economic freedom and banking stability. The estimated coefficients on the economic freedom measures are all positive and statistically significant across the financial measures. This suggests that countries with more economic freedom impede the development of financial intermediaries and banking stability. The results using more narrowly defined measures of economic freedom indicate that openness in foreign trade and reductions in regulatory burden are associated with increases in financial intermediary development and banking stability. The evidence thus indicates that higher levels of economic freedom are an important component to the future development of financial intermediation and banking stability.

Deposit ratio has positive impact on banking stability, when deposit increases in balance sheet, banking stability increases.

This suggests that excessive government interference in the financial institutions' activities may adversely affect the banking stability. Banks operating in countries characterized by a high degree of economic and financial freedom and good governance tend to display relatively higher levels of efficiency and stability. These banks indicate a more effective management in controlling costs while maximizing the profits in contexts described by policies that improve banks' degree of freedom thus resulting in a more efficient resource allocation process. Controlling for these broader, national characteristics, including freedom as captured by the freedom indexes, can explain cross-bank differences in terms of efficiency.

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چکیده فارسی مقاله‌ها

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عوامل مشترک زیر– اجزای شاخص قیمت مصرف‌کننده و پیش‌بینی تورم

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چکیده

در این مقاله، به بررسی این موضوع می‌پردازیم که آیا وارد کردن عوامل مشترک زیراجزای شاخص قیمت مصرف‌کننده به مدل‌های پیش‌بینی، دقت پیش‌بینی تورم را افزایش می‌دهد. ما عوامل مشترک را با دو روش ایستا و پویا استخراج کرده و سپس آنها را در مدل ARMA و VAR قرار می‌دهیم. با استفاده از داده‌های فصلی شاخص قیمت مصرف‌کننده و زیر اجزای آن، مدل‌های مزبور را در بازه زمانی ۱۹۹۰:۲ تا ۲۰۰۸:۲ تخمین زده و پیش‌بینی‌های برون‌نمونه‌ای برای بازه ۲۰۰۸:۳ تا ۲۰۱۲:۱ تولید می‌شوند. نتایج نشان می‌دهد که در اغلب موارد عملکرد مدل‌هایی که حاوی عوامل مشترک زیراجزای شاخص قیمت می‌باشند از مدل پایه خودرگرسیون بهتر است. اما این عملکرد فقط در افق دو گام به جلو به لحاظ آماری بهتر معنادار است. همچنین مدل FAVAR نسبت به سایر مدل‌های عامل عملکرد بهتری در پیش‌بینی تورم دارد.

واژگان کلیدی: پیش‌بینی، تورم، زیر اجزای شاخص قیمت مصرف‌کننده، مدل‌های عامل، ARMAX, FAVAR

طبقه‌بندی JEL: C32, C53, E31

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مدل تکانه های مالی در بانکها و عملیات بین بانکی ایران

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چکیده

این مقاله یک مدل تعادل عمومی پویای تصادفی در چارچوب خرد شامل بهینه‌سازی بخش بانکی ارائه کرده است و نقش بانک‌ها و شوک مالی در ادوار تجاری را بیان می‌کند. فرض شده است که بانک‌ها خدمات مختلفی را ارائه می‌دهند و در بازار بین بانکی فعالیت دارند. برای اعطای وام از سپرده و استقراض از بازار بین بانکی استفاده می‌شود. بانک‌ها قدرت انحصاری دارند اما نمی‌توانند نرخ بهره اسمی وام و سپرده را تعیین نمایند. مدل همچنین شامل شوک تأمین مالی و شوک سیاست پولی است. یافته‌های اصلی مقاله عبارت هستند از: ۱- مدل ویژگی خاص اقتصاد ایران را نشان می‌دهد. ۲ -رفتار بانک بر وضعیت عرضه اعتباری و انتقال شوکهای مختلف اثر دارد. ۳- شوک‌های مالی اثر معنی داری بر نوسانات ادوار تجاری ایران دارند.

واژگان کلیدی: بانک‌ها، بازار بین بانکی، شوک‌های مالی و سیاست پولی

طبقه‌بندی JEL : E12, E32, E37, E44, G21, G33

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بررسی اثرات اهرم مالی بر تصمیمات سرمایه‌گذاری شرکت‌ها: شواهدی از بورس تهران

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چکیده

تأثیر اهرم مالی بر تصمیمات سرمایه‌گذاری شرکت ها یکی از مباحث مهم در مدیریت مالی بنگاه ها است. دغدغه بدهی، انگیزه مجموعه سهامداران و مدیران را برای سرمایه‌گذاری در فرصت‌های سرمایه‌گذاری با ارزش فعلی خالص مثبت، کاهش می‌دهد. از سوی دیگر، عدم وجود بدهی در ساختار سرمایه شرکت ها مشکل تازه‌ای تحت عنوان سرمایه گذاری بیش از حد را ایجاد می‌کند. تحقیق حاضر به بررسی تاثیر اهرم مالی بر تصمیمات سرمایه‌گذاری شرکت‌های حاضر در بورس تهران در فاصله سال های ۱۳۸۰ تا ۱۳۸۹ با استفاده از تحلیل رگرسیونی می‌پردازد. نتایج تحقیق نشان می‌دهد برخلاف آنچه در ادبیات موضوعی مطرح است؛ اثر اهرم مالی بر تصمیمات سرمایه‌گذاری نه تنها منفی نیست، بلکه رابطه مذکور بر مبنای نسبت کل بدهی به کل دارایی به عنوان معیار اهرم، معنی‌دار نبوده و بر مبنای نسبت بدهی‌های بلندمدت به کل دارایی‌ها مثبت است.

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واژگان کلیدی: اهرم مالی، سرمایه‌گذاری، فرصت‌های رشد، سرمایه‌گذاری ناکافی، سرمایه‌گذاری بیش از حد

طبقه‌بندی JEL : C10, C15, C21, C23

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روش جدید رتبه بندی مشتریان معتبر گروه بندی شده بر اساس DEA

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چکیده

روش تحلیل داده‌های پوششی (DEA) روشی غیر پارامتری متداولی برای رتبه‌بندی توسط واحدهای تصمیم‌گیر (DMU) می‌باشد. بر خلاف این واقعیت که روش DEA نیازی به پیش‌بینی متعدد ندارد، همگن بودن واحدهای تصمیم‌گیر از مهم‌ترین نیازهای کاربرد این روش می‌باشد. به‌علاوه، در مورد مسایل جهان واقعی، به واسطه طبیعت واحدهای تصمیم گیر، رتبه‌بندی گروهی اهمیت ویژه‌ای به دست آورده است. رتبه‌بندی اعتباری متقاضیان تسهیلات مالی، مهمترین پدیده مدیریتی بانک‌ها و مؤسسات مالی می‌باشد و بودجه قابل توجهی برای ایجاد و کاربرد یک سیستم مؤثر رتبه‌بندی اعتباری دارد. چون سازمان‌های کاربر در زمینه‌های مختلفی فعالیت می‌کنند، و رتبه‌بندی همزمان این سازمان‌ها با استفاده از روش DEA سبب انحراف از اصل همگنی می‌باشد، کاربرد این ابزار محدود می‌شود. هدف این بررسی عبارت است حل این نقطه ضعف به

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گونه‌ای است که امکان در نظر گرفتن سازمان‌های غیرهمگن را فراهم آورد. نتـایج روش پیشنهادی نشان‌دهنده توان تقویت شده این روش برای واحدهای تصمیم‌گیر می‌باشد.

واژگان کلیدی: تحلیل تغییریافته روش داده‌های پوششی، داده‌های گروهی، رتبه‌بنـدی اعتباری، بانکداری
طبقه‌بندی JEL: C10, C14, C18, C30, G21

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تحریم های مالی و عملکرد بانک‌های ایران

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چکیده

در این مطالعه با استفاده از روش تجزیه و تحلیل مرز تصادفی، به تخمین کارایی هزینه، بازدهی‌های نسبت به مقیاس و پیشرفت فنی بانک‌های ایران در طی سالهای ۱۹۹۹ تا ۲۰۱۲ میلادی می‌پردازیم. نتایج تحقیق تفاوت قابل ملاحظه‌ای را در خصوص کارایی هزینه در دوره‌های قبل و بعد از تحریم‌های مالی اخیر وضع شده بر علیه صنعت بانکداری ایران نشان می‌دهند. علاوه بر آن نتایج حکایت از آن دارند که بانک‌های تخصصی دولتی نسبت به بانک‌های تجاری دولتی و نیز بانک‌های غیردولتی، کارایی کمتری را در دوره پس از وضع تحریم‌ها نشان می‌دهند. همچنین در این تحقیق، ما قادر به تأیید وجود یک ارتباط منطقی بین کارایی هزینه و اندازه بانک‌های ایرانی نشدیم. بر اساس یافته‌های مطالعه، کاهش‌های ایجادشده در هزینه بانک‌ها که از پیشرفت فنی و بازدهی‌های نسبت به مقیاس ناشی می‌گردند در دوره‌های قبل از وضع تحریم‌های مالی اخیر به نسبت بزرگتر بوده‌اند.

واژگان کلیدی: کارایی هزینه، پیشرفت فنی، بانکداری، تحریم‌ها، ایران.

طبقه‌بندی JEL: G21

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تأثیر آزادی اقتصادی بر ثبات بانکی در برخی از کشورهای منتخب

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چکیده

در این مقاله به بررسی تأثیر شاخص آزادی بـر ثبـات بـانکی در ۴۳ کشـور منتخـب در سال‌های ۲۰۱۳- ۱۹۹۸ پرداخته شده است. تـأثیر آزادی اقتصـادی بـر ثبـات بـانکی از طریق شاخص z-score در نظر گرفته شده است. تأثیر شاخص آزادی اقتصادی بر ثبات بانکی با روش داده های تابلویی پویا صورت گرفته است. مطـابق بـا نتـایج ایـن تحقیـق، آزادی اقتصادی دارای تأثیر مثبت بر ثبات بـانکی بـوده و بـا افـزایش آزادی اقتصـادی و گسترش فعالیت‌های اقتصادی و سرمایه‌گذاری، تقاضا بـرای تسـهیلات بانـک‌هـا توسـط کارآفرینان افزایش یافته و بانک‌ها با افزایش فعالیت‌های واسطه‌گری مالی ثبات بـانکی را افزایش خواهند داد .

واژگان کلیدی : ثبات بانکی، ثبات مالی، داده‌های تابلویی پویا

طبقه‌بندی JEL: G21, C23, G10

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