

# A Prediction Model for Bank's Liquidity Management to Study on the Impact of Internet Banking in Iran

Fahime Kianian<sup>a,b</sup>, Amirmehdi Parhamfar<sup>a</sup>, Seyedhamidreza Shahabi Haghighi<sup>c,\*</sup>, Maryam Khojani<sup>a,d</sup>

<sup>a</sup> Garmsar School of Amirkabir University of Technology, Garmsar, Semnan Province, Iran.

<sup>b</sup> NRI (Niroo Research Institute), Tehran, Iran.

<sup>c</sup> Department of Industrial Eng. and Sys. of management, Amirkabir University of Technology, Tehran, Iran.

<sup>d</sup> Post bank of Iran.

**Abstract-** Bank managements are interested in determining the rate of liquidity based on a strategy for meeting this need. Lack of sufficient liquidity might impose heavy costs and even lead to bankruptcy. On the other hand, surplus liquidity will result in losing investment opportunities and reduction in productivity and profit ability of banks. In this research, efforts are taken to use the most affecting factors by investigation on important factors effective on the liquidity rate. The data used are chosen from 573 real values of banking operations. The variables are NEII<sup>1</sup>, RTGS<sup>2</sup> and clear transaction and the outcome of these variables is bank liquidity. In this research, two methods of ARIMA and multiple regressions are applied for predicting the future liquidity data and two mathematical models are introduced. The model introduced can predict liquidity rate based on two years data effectively. The results showed that the mean deviations between output of model and actual results are about 9% and 2.46% in first and second year respectively. This means the people preferred to use the internet in second year more than first year.

**Index Terms-** Liquidity, Internet banking, Regression model, Prediction

## I. INTRODUCTION

Study on the liquidity of a bank is important because this parameter affect the performance of the bank. In fact, liquidity management is among the main duties of banks and one important factor for managing assets and debts in a bank. All bank activities depend on its potential in provision of required liquidity to manage its clients' transactions. Therefore, efficient liquidity management needs the cash liquidity of bank to be continuously kept in its minimum possible rates by considering the performance and proper assurance. Therefore, one of the major responsibilities for asset managers is to control the banks' liquidity. Most of the time, the banks encounter the unpredictable demand for cash amounts thus the sufficiency of banks' liquidity shall be performed precisely. In order to evaluate the liquidity of a bank, the due date of assets and debts can be studied. The effective factors on the money circulation in a bank are the interbank transaction system, physical banking and the pure settlement result of the whole state which are daily added in this system. Therefore, these elements have vital importance for state

banking system and the banks shall be able to provide the resources required for settlement at any circumstances. Auty [1] implied that a bank can provide its resources quickly in a suitable rational cost if taking advantage of an appropriate method. For this purpose, prediction of appropriate liquidity for banks would have great importance. Leilidoust [2] described the bank institutes all over the world play critical role in economic and commercial activities and the behavior of these institutes influences the total function of state economy. The effective execution in a money policy, as an important factor, requires focusing on the payment systems by using planned transactions of money market. This can help to control the state financial and economic activity precisely. Besides, development of payment systems can affect the speed of monetary turnover and money demand. Therefore, in different countries the banks use special plans to attract their client with low cost. Although Faghieh [3] described that the first type of bank asset is the cash which is considered as a non-returnable asset, in last few years internet banking was going to have a great roll in bank transaction in Iran.

Instant Gross Settlement System (RTGS) in Iran acts as a unique account for interbank transactions<sup>3</sup> and is a main and inseparable parts of bank's concentrated management system of cash. Thus, in this system, concentrated management of cash is very important. Also NEII<sup>4</sup> is a comprehensive banking electronic network in Iran. NEII was created by the central bank of Islamic Republic of Iran in order to connect the banks' payment networks to each other to perform electronic interbank transactions hub. Thus, determination of a proper model for estimation and prediction of the bank's liquidity is critical in internet banking of Iran. According to this, the current research aims to predict the bank's liquidity in Post Bank of Iran via a mathematical model.

## II. LITERATURE REVIEW

Cabrero et. al [4] has provided a model for liquidity management of the bills in daily circulation for central bank of Europe. Author introduced various seasonal modes for series of bills in daily circulation. The model was based on autoregressive

<sup>3</sup> - All interbank transactions can be defined in the four formats of A)Bank to bank, B) Bank to client, C)Client to bank and D)Client to client.

<sup>4</sup> Network for Exchange of Interbank Information

<sup>1</sup> Network for Exchange of Interbank Information

<sup>2</sup> Real Time Gross Settlement

integrated moving average (ARIMA) which is a statistical method. Cabero used a structural method of time series to analyze the effectiveness of some factors on prediction of liquidity. Esterhuysen et. al [5] investigated the factors affected on the rate of liquidity of the banks in South Africa. The periods of this study were selected before and during the economic crisis in 2004 to 2009 by use of accessible data based on a statistics method. Rajaeyan et al. [6] introduced a mathematical model for control and optimization of the assets at bank by use of a stochastic method. They have tested their model using data taken from Bank of Industry and Mine of Iran. Souri and Vesal [7] have introduced the prevalent tools of liquidity management at traditional banks by applying modern methods of financial provision and liquidity management. They have investigated the tools of liquidity management in Melli Bank of Iran which uses the Islamic bank methods. In their study, the factor of liquidity shortage at Melli Bank based on the balance sheet of Central Bank of Iran was investigated. They studied the control mechanisms of banks regarding to liquidity management. They have studied the interest rate by applying data from Melli Bank and they introduced a model for liquidity management. Monteanu [8] using a regression method introduced a mathematical model to predict the bank liquidity in Romania. The empirical model proposed was based on Net Loans, Total Assets, Liquid Assets, Deposits and short term funding. This paper aims to determine a liquidity prediction model for better management system. For this purpose, the environmental elements effective on the banks' liquidity were studied and by help of a confirmed statistics and data, based on a regression method, the final model is introduced. In fact, this paper proposed an accurate method for fitting and determining the economic model from the view of micro economy for liquidity management. Along this, two equations are determined by taking advantage of special tools and techniques of the econometrics. Each mathematical model belongs to one year to investigate the impact of internet banking in Post Bank of Iran. Here, two models of ARIMA and multiple regressions are applied for prediction of liquidity in Post Bank of Iran.

### III. RESULT AND DISCUSSION

Review of literature and the papers shows that in the issue of liquidity management different statistics methods were used by investigators in the past. Among these methods multi-variable regression model using econometric methods and tools for confirmation and analysis of statistics and accuracy of fitted model is a suitable and reliable method. The main variables affected the final results were investigated initially. Then the influences of each variable on others were studied too. Since this paper seeks a model in micro economy topics, application of economical tools especially econometric tools became a suitable method, thus in this study, a regression method is used.

Initial study shows that important parameters affecting on bank liquidity are bonds, interbank transactions, shares, cash, RTGS, NEII and Clear system. Nowadays in Post Bank of Iran, the last three parameters are more important than others. Therefore, the variables used are focused on RTGS, NEII and Clear system. The respective daily data from the accessible reports and documents in Post Bank were chosen from the

beginning of 2011 by the end of 2012. These data belong to the 24 month timeframe which are separated and studied in two one-year periods. Figure NO .1 gives a general schema of the subjective model.



**Figure 1. Schematic diagram of subjective model**

The mathematical model is focused on RTGS, NEII and Clear system because initial study shows that the majority of Post Bank transactions are consisted on them. Equation No.1 shows model used in this research.

$$Y_t = f(x_1, x_2, x_3) + c + \varepsilon \quad (1)$$

The parameters of this model are as follows:

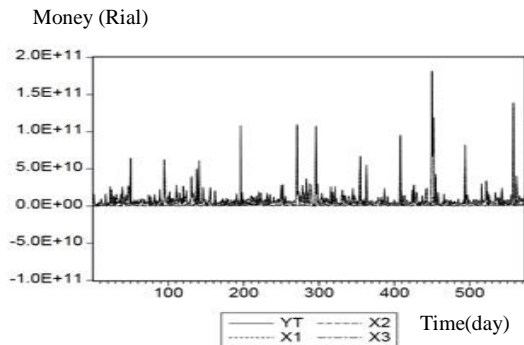
- $x_1$ : RTGS
- $x_2$ : Network for Exchange of Interbank Information
- $x_3$ : Clear System
- C: constant of each period
- $\varepsilon$ : error parameter
- $Y_t$ : Liquidity balance pure for each day

### IV. IMPLEMENTATION AND ANALYSIS OF MODEL

The arrangement of data points of transactions in Post Bank from beginning of 2011 up to 2013 was used as input of time series. In this research, before estimating the model, similarity test is applied for all-time series. If the studied time series is not at uniform time intervals, due to an accuracy of regression, application of self-regression models is not acceptable. A variable time series can be used, in regression analysis, when the mean, variation and the coefficient of self-correlation are fixed during the time. Therefore, the regression analysis was used to study on estimating the relationships among variables of the time series. The analysis was focused on the moment test to investigate on the mean, variance and skew of the time series. The test helps to make sure that the variables are at uniform time intervals. Also, the unit root test is applied for testing the stability. One prevalent unit root detection method is Dickey-Fuller test which is used in this research. In case the rate of statistic computed is lower than the critical rates, the hypothesis zero based on existence of self-correlation in residuals is accepted. In other words, in this condition it is accepted that the residuals have self-correlation and this means that the model is optimally self-explaining.

Software named Eviews ver. 4.1 was exploited to determine the mathematical model. The software uses two methods of ARIMA and multiple regressions to introduce the empirical models. The set of statistics and observations were studied using three independent variables and dependent parameter with 573 observations. At the first step, the data were divided in two one-

year periods and for each of these timeframes two mathematical models were determined. In further paragraphs the above-mentioned items are analyzed. Figure No.2 shows a schematic diagram of three real variables in first year. Also this diagram shows the liquidity balance of the bank in each day separately.



**Figure No. 2- Dependent variables and respective liquidity for two years.**

Two multi-variable regressions are extracted for each of two timeframe sets, considering independent variables, and the liquidity balance of each day, denoted as  $Y_t$  as dependent variable. Equation No.2 and Equation No. 3 show the mathematical models obtained for first and second years using Eviews software respectively.

$$Y_t = 1.004092x_1 + 0.917826x_2 + 1.015121x_3 - 11493407 \quad (2)$$

$$Y_t = 1.000734x_1 + 1.002020x_2 + 0.999076x_3 + 151235078 \quad (3)$$

The stability of equations was investigated for each year of timeframes separately. For this purpose, the coefficients of variables, T distribution and Durbin Watson<sup>5</sup> of each equation is determined separately too. Coefficient of determination denoted as R-squared was estimated for each equation in order to test accuracy of the models. The coefficient of determination indicates how data points fit a line or curve well. Also in statistics, the Durbin–Watson statistic is a test which is used to detect the presence of autocorrelation in prediction errors (residuals). Durbin Watson by a given time lag shows the relationship between values separated from each other in a regression analysis. Therefore, this helps to investigate the changes of each variable in different timeframes of equations. Results show R-squares obtained are 0.63 and 0.99 for first and second year respectively. Also Durbin Watson results are 2.99 and 2.15 for each year respectively. As mentioned above R-squared determined for first and second year are 0.63 to 0.99 respectively. To make sure about accuracy of R-squared, alternative approach of adjusted R-squared was determined by Eviews software. The results show that adjusted R-squared determined for first and second year are ? and ? respectively.

Therefore, when extra explanatory variables are added to the model the data points fit the line predicted by equations 2 and 3. Total data related to first year are 289 and for the second year are 284 (totally 573 data). In order to investigate and confirm the equation models, 10 samples were chosen from 573 randomly. Five samples from first year and five samples from second year were selected randomly. The equations were used to predict randomly for each period and they were compared to their actual values. Also, the deviation of real and predicted ones was determined for each sample in percentage. The liquidity values for the new set of experiments were estimated using Equations No. 2 and 3 and results are shown in Table 1.

**Table No. 1- Comparison between real and predicted values of liquidity for samples**

Random Component		First year	Second year
$x_{26}$	Actual	10,049,611,851	5,694,257,575
	Predicted	9,565,562,833	5,541,694,202
$x_{38}$	Actual	2,288,605,723	3,987,885,988
	Predicted	1,910,709,529	4,176,681,222
$x_{168}$	Actual	4,732,782,183	7,695,431,173
	Predicted	4,393,437,784	7,620,922,685
$x_{220}$	Actual	19,089,640,584	9,057,028,079
	Predicted	18,255,910,739	9,051,339,156
$x_{264}$	Actual	3,550,899,554	3,722,951,156
	Predicted	3,986,283,492	3,920,034,279

The mean difference of average liquidity between the results obtained using the real values and those obtained using approximation model are 9 and 2.46 in percentage for first and second year respectively. (Table 2 shows the results in percentage.) The results showed that the proposed method can be used to predict the bank liquidity using different bank variables. A part of difference between the results obtained using the real values and the approximation model is suspected to be due to seasonal effects and instability of the demands of economic activities. Also, the remaining of difference is due to lack of using bonds, interbank transaction, shares and cash payments in the bank.

Although both of the equations determined can be used to predict the liquidity of the bank precisely equation 3 can predict the liquidity more accurate than equation 2. This is due to people’s tendency to the internet bank. Actually using the internet bank in Iran is not an old method and people who used to use the old banking method in first year observation, in second year used the internet banking more than first year.

**Table No. 2- Deviation between real and predicted values for samples in percentage**

Percentage Difference	$x_{26}$	$x_{38}$	$x_{168}$	$x_{220}$	$x_{264}$	Average in year
First Year	4.82	16.51	7.17	4.37	12.26	9.02
Second Year	2.68	4.73	0.97	0.06	3.9	2.46

Also this point is critical that the coefficients related to  $X_2$ , which is NEII, is increased by time pass in the next period indicating the increase in influence of this variable on the liquidity of the bank. In fact, the rate of exploitation and use of people from this system is increased in the long term. We are observing the encouragement of people for using up-to-dated and electronic banks' mechanized systems. Along this, by taking to account the first year data, the portion of NEII was less than Clear system proportionally, but in a growing process NEII was increased in second year compared to Clear system. This shows that in two years period the people preferred to transfer their money by internet banking which is a relatively new system. This could be because of its easy access, possibility of using anytime and anywhere, more secure and fast in transferring the money in electronic banking.

#### V. CONCLUSION

This study aimed to investigate the impact of important variables on liquidity in Post Bank of Iran. Also, this study investigated on preference of Iranian people to use the internet banking in time pass. Therefore, two years of internet banking in a Post Bank of Iran was observed in two separated years. Some cases in different banks were studied and analyzed to investigate the effects of variables on the bank liquidity. The important variables affected the liquidity in the Iranian banks are RTGS, NEII and Clear system. A regression method, named ARIMA, was used to investigate the effect of important variables on the bank liquidity. Dickey-Fuller test was employed too. Two equations were obtained based on real data in year 2011 and 2012 respectively. By Eviews software, the stability test for used data estimated using two different indicators named R-squared and Durbin Watson. R-squared determined are 0.63 and 0.99 for first and second year respectively. Also, the results for Durbin Watson are 2.99 and 2.15 for first and second year respectively. The mean deviations between real and estimated values of liquidity based on equations developed are 9.02% and 2.46% in first and second year relatively. Thus, based on a regression method, it is concluded that the banks' liquidity is mainly influenced by RTGS, NEII and Clear transactions. Also, the results show that the people were encouraged to use the internet banking in second year more than first year.

#### REFERENCES

- [1] Auty, R. M (2001) The political economy of resource-driven growth; *European Economic Review*, vol 45, 839-846.
- [2] Leilidoust. M (2008) Measuring liquidity risk and its relation with profitability in Mellat bank", Master Thesis, Tehran, Higher Institute of Banking.
- [3] Faghih. M (2004) Credit Risk Management and its policies (applied approach), *journal of bank and economy*, No. 46.
- [4] CABRERO. A, CAMBA-MENDEZ. G, HIRSCH. A, NIETO. F (2002) Modeling the Daily Banknotes in Circulation in the context of the liquidity management of the European central bank, *European Central Bank, Working paper series*, p 1-55.
- [5] ESTERHUYSEN. J, VUUREN. G, STYGER. P (2012) Liquidity Creation in South African Banks under Stressed Economy Conditions, vol 80, 106-122.
- [6] Rajaeyan. A, Ahmadi. P, Sarlak. M, Raei. R (2014) A mathematical model for managing bank asset and liability of banks using an stochastic method, 1st Conference of developing on monetary and banking management. Tehran.
- [7] Souri. D, Vesal. M (1999) Modern methods in financial provision and liquidity management at bank, papers for the 19th Conference of Islamic Banking, Higher Institute of Banking, 231-248.
- [8] Munteanu. I (2012) Emerging Market Queries in Finance and Business, Bank liquidity and its determinants in Romania, *Procedia Economics and Finance* 3, 993 - 998.

#### AUTHORS

**First Author** – Fahime Kianian, Garmsar School of Amirkabir University of Technology, Garmsar, Semnan Province, Iran.

**Second Author** – Amirmehdi Parhamfar, Garmsar School of Amirkabir University of Technology, Garmsar, Semnan Province, Iran.

**Third Author** – Seyedhamidreza Shahabi Haghighi, Department of Industrial Eng. and Sys. of management, Amirkabir University of Technology, Tehran, Iran.

**Fourth Author** – Maryam Khojani, Post bank of Iran.

**Correspondence Author** – Seyedhamidreza Shahabi Haghighi, Department of Industrial Eng. and Sys. of management, Amirkabir University of Technology, Tehran, Iran., email: shahabi@aut.ac.ir