LIQUIDITY MANAGEMENT IN COMMERCIAL BANKS OF UZBEKISTAN

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ABSTRACT

This article is devoted to the research of existing mechanisms of liquidity management in practice of commercial banks. In addition, it presents description and grouping of theoretical approaches to the liquidity management in commercial banks. We also formulated main requirements to the mechanism of liquidity management process. Moreover, it proposes and demonstrates the results of testing mathematical model of analysis and forecast of bank cash flows which is based on ARIMA method.

Keywords: liquidity management, commercial banks, stability of commercial banks, assets and liabilities, liquidity risk

INTRODUCTION

Liquidity management plays a significant role in maintaining the stability and efficiency of commercial banks and of the banking system as a whole. Nowadays the lending volume by commercial banks of Uzbekistan is increasing (CBU Uzbekistana 2016), a constant transformation of assets and liabilities is going on. For example, the volume of loans allocated to the real sector of the economy increased by 27.3% in comparison with 2014, and in 2015 this indicator amounted to 42.7 trillion UZS. At the same time, the current liquidity degree exceeds 64.5%, that is twice more than the minimal degree established according to the international standards (CBU Uzbekistanb 2016). However in practice Uzbek banks do not possess any mechanism that regulates the procedure of analysis, forecasting and liquidity regulation. Although the situation seems to be stable, but still under such conditions the issue of having liquidity management mechanism is crucial for all Uzbek banks. Therefore, in this research paper we have tried to create an effective mechanism of managing the liquidity of commercial banks. We have developed necessary mathematical model and tested it on the basis of the database of a sample bank of Uzbekistan. The techniques of system analysis and regressive analysis have been widely used in the article.

LITERATURE REVIEW

Definition of liquidity and basic approaches to its' management

Bank liquidity is classically defined as «ability of fulfilling obligations for depositors and lenders timely and without loss» (Lavrushin 2000, p. 140). However, the modern point of view determines liquidity as «dynamical state reflecting ability of timely fulfilling obligations for depositors and lenders due to its assets and liabilities management» (Matz 2002, p. 8).

The theory of bank liquidity management has appeared and developed almost simultaneously with the organization and development of the commercial banks. Initially, the issue about the bank liquidity had two theoretical approaches (Kiseleva 2002, p. 46):

1. The first approach was based on the fact that the structure of the bank's assets by terms must exactly match the structure of its liabilities. This has nearly excluded the necessity for a bank to conduct a policy for managing its liquidity. On this theoretical basis has been worked out "golden banking rule": the amount and timing of the

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bank's financial requirements should correspond to the amounts and maturity of its liabilities.

2. The second approach was based on a real mismatch of assets and liabilities of the balance. This approach enabled to obtain higher profits. It was further developed in two areas: assets management and bank's liabilities management.

Currently the assets and liabilities management is based on 3 methodological statements (Matz 2002, p. 30-50):

1. bank can maintain liquidity, if the assets are placed in short-term loans and are timely repaid;
2. bank may be liquid if its assets can be transferred or sold to other lenders or investors;
3. bank liquidity can be planned, if the basis of the schedule of payments and the repayment of loans will comprise the borrower's future income.

The theory of assets and liabilities management, in turn, is based on two statements (Matz 2002, p. 30-50):

1. the bank must solve the problem of liquidity by attracting additional funds, buying them on the capital market;
2. the bank can ensure its liquidity due to extensive borrowings, including borrowings from the Central Bank.

These are only the theories and approaches, which can be used by the bank as guidance for its activity by the will of the bank management and depending on the prevailing market situation.

Let's consider two approaches to the problem of assessing liquidity and the main directions of assessment and management of the bank liquidity on the basis of the generally accepted banking theory of liquidity notions as «reserve» and «flow».

1) Liquidity as the «reserve» includes determining the level of commercial bank's possibility to fulfill its obligations for clients at the certain period of time by changing the structure of assets and liabilities in favour of their high-liquidity items due to retained reserves available in this sphere (Kiseleva 2002, p. 45).

Historical example of assessing necessity of the bank in liquid funds from the point of view of reserves is the approach "theory of demand for money" represented by works of Baumol (1952, p. 545-556), Tobin (1956, p. 241-247), Miller and Orr (1966, p. 413-435), Whalen (1966, p. 314-324).

One of the significant limitations of the Baumol model (1952, p. 545-556) and Tobin (1956, p. 241-247), making it non-applicable for aims to manage the bank liquidity is the assumption that the funds are spent with the constant speed and are coming periodically. Proceeding from these statements we can determine the optimal volume of liquid remainders.

The best results are given by the Miller and Orr model (1966, p. 413-435). The model represents a compromise between simplicity and reality. Regarding to the banks, it helps to answer the question: how should the bank manage their stock of liquid assets, if it is impossible to predict the daily outflow or inflow of funds? They are used in creating the model of Bernoulli process. This is a stochastic process in which the receipts and expenditures of money from time to time are represented by independent random events.

Good results of determining necessary liquidity for the aims of managing bank's liquidity are illustrated by the model of Whalen (1966, p. 314-324). The bank demand for liquidity is considered as a precaution. It is assumed that the exact amount of funds received by the bank is unknown as well as unknown the amount of payments that should be made in the future. If the bank does not possess sufficient liquidity to make payments, it will suffer loss. The more liquidity the bank maintains, the less likely that it will suffer loss, the higher income it will lose. The optimal amount will be between the minimum amount of liquid assets required for cash transactions and the volume sufficient to cover all needs.

Common disadvantage of "reserve" models can be their static character and dependence from subjective assessments to volatility of different types of assets and liabilities of the bank.

2) Common principle of assessing and managing the liquidity as the "flow" is that indicators of the bank are analyzed from the dynamic point of view. This assumes assessment of bank's ability to change an unfavourable liquidity degree or prevent worsening of the achieved liquidity degree which is objectively necessary, during a certain period of time. It is implemented due to the efficient management of assets and liabilities, attracting additional borrowings, and raising financial stability of the bank by the growth of income (Kiseleva 2002, p. 45).

Under this approach bank liquidity is determined by the following statement: bank is considered to be liquid if the total of its liquid assets or liquid funds which it can quickly mobilize from other sources, enough for timely redeeming its current liabilities (Lavrushin 2000, p. 139].

Under this approach the most widely-spread mechanism of assessing liquidity is GAP-analysis of assets and liabilities by demand terms. This method is described in details in the book of Peter S. Rose(1991).

It is possible to conclude that the bank's liquidity is mostly of a dynamical, but not a static condition. It demonstrates ability to execute its obligations for lenders and depositors efficiently due to the management of its assets and liabilities and getting high profits.

Theoretical review of the views of economists

Detailed description of the assessment measures and instruments of managing liquidity is contained at scientific works of Matz (2002), Bessis (2002), Ritter (1967), Darling (1991). Their researches present theoretical preconditions of appearance of liquidity management theories as well as a number of measures and mechanisms which can be classified according to the following directions:

A. evaluation of the liquidity risk bank;

B. forecasting state of the liquidity;

C. mechanisms of the liquidity management.

1) Evaluation of the liquidity risk. The main focus in assessing the liquidity risk is given to different statistical coefficients reflecting the state of the bank balance. For example, they can be the ratio of the various groups of assets, bank's liabilities, capital and other factors. Overall, this assessment of the balance is typical for the above-stated approach to the liquidity as to the "reserve".

2) Forecasting state of the liquidity. Here, the main focus is given to the dynamical state of the bank being assessed by the "flow" principle. In the opinion of economists, the main instrument is "cash flow projection". Compiling forecast of the cash flow

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enables to see a possible development of the bank under a usual scenario of the business development.

Advantages of the cash flow forecast are the following:

i. complexity: the ability to take into account all assets, liabilities and off-balance sheet obligations and other sources of liquidity;

ii. flexibility: possibility of presenting the assets as both sources of liquidity and an opportunity to use excess liquidity. Taking into account liabilities' volatility;

iii. possibility to use for forecasting future performance;

iv. reflection of the temporary structure of liquidity risk: possibility of dividing the various future periods for liquidity assessment at predetermined time intervals.

The only disadvantage of the cash flow forecast is that such liquidity analysis reflects only one scenario of development.

3) The complex of measures on liquidity management. Economists offer a variety of tools for assessing and reducing liquidity risk. They can be the following:

i. precisely developed complex programmes of the exit of crisis situations;

ii. variety of mechanisms to improve the condition of the assets, liabilities, and attracting additional investments;

iii. conducting GAP-analysis for assessing the risk of non-compliance of assets and liabilities by terms;

iv. evaluation of interest rate risk and determining sensitivity of assets and liabilities to changes of interest rates.

Unfortunately, these authors (Matz 2002; Bessis 2002; Ritter 1967; Darling 1991) haven't provided qualitative examples of creating the mechanism, comprehensive system of liquidity management with the help of the methods described above. We could find some empirical researches, devoted to the certain issues of the liquidity management. In his scientific papers, Kouwenberg (2001, p. 279-292) uses vector autoregression for forecasting main economic indicators as well as for the opportunity of stochastic modeling and assessing the Pension fund performance in future conditions. The research of Frauendorfer and Schurle (2003, p. 602-616) is devoted to the research of the performance of demand deposits of the bank clients. They consider the demand deposits to be the most complicated part of bank liabilities for forecasting. The scientific paper of Gatev and Schuemann (2006) is dedicated to establishing the model of assessing the performance of attracted funds of clients depending on the market conditions. Ringbom et. al. (2004, p. 1319-1335) conducted analysis of the banking system which liquidity risks have been caused by depositors at the growth of the necessity in cash. They offered the method of accumulated bank reserve requirements maximizing the bank profit and evaluated the liquidity crisis.

As a result, it is possible to make a conclusion that the economists favoured the method of liquidity management on the basis of forecasting of the bank cash flows. However, the issue of the practical development of the forecast, in particular, the selection, justification and application of models that enable to make a forecast of the banking activity with the account of mathematical technique, is still of a big concern. Thus, in this article we have tried to work out such a model and prove its efficiency and application.

METHODOLOGY

As we have already told, to assess dynamic liquidity of the bank we need particular mathematic technique enabling to get objective assessment of the future condition of the bank liquidity and forecast of cash flow of clients.

As the instrument for analysis of the time series we propose to use the model named ARIMA (Autoregressive Integrated Moving Average). ARIMA assumes a high level of flexibility and performs as a typical case for the majority of models used in modern analysis of time series.

In general, the ARIMA model is as follows:

$$Y_t = \mu + \frac{\theta(B)}{\varphi(B)} a_t (1)$$

here

Y_t– value of time series at the moment of time *t*;

μ– average value of the series;

B– operator of backward deviation ($BY_t = Y_{t-1}, B^2Y_t = Y_{t-2}$, ...);

$\varphi(B)$– autoregressive operator which represents polynomial of the operators of backward deviation ($\varphi(B) = 1 - \varphi_1 B - \varphi_2 B^2 - \varphi_3 B^3 - \ldots - \varphi_p B^p$);

$\theta(B)$– operator of moving average, representing polynomial of the operators of backward deviation ($\theta(B) = 1 - \theta_1 B - \theta_2 B^2 - \theta_3 B^3 - \ldots - \theta_q B^q$);

a_t– independent random component.

Equation (1) will look like the following:

$$Y_t = \left(1 - \varphi_1 B - \varphi_2 B^2 - \varphi_3 B^3 - \ldots - \varphi_p B^p\right) \cdot \mu + \varphi_1 Y_{t-1} + \varphi_2 Y_{t-2} + \varphi_3 Y_{t-3} + \ldots + \varphi_p Y_{t-p} + a_t - \theta_1 a_{t-1} - \theta_2 a_{t-2} - \theta_3 a_{t-3} - \theta_q a_{t-q} (2)$$

These two equations represent theoretical model of stochastic process that generates factual vales of ARIMA time series (p, q).

In the framework of this model we assume that current values of the time series smoothened by including variable average values depend on its previous values expressed by autoregressive parameters.

In case of including regressors in the model, equation (1) will look like as it follows:

$$Y_t = \mu + \sum_i \frac{w_i(B)}{\delta_i(B)} B^{k_i} X_{i,t} + \frac{\theta(B)}{\varphi(B)} a_t (3)$$

Here:

$X_{i,t}$– value of time series of explanatory variable at the moment of time *t*;

k_i– time lag of regressor effect;

$w_i(B)$– numerator, polynomial of the deviation function for *i*-th time series;

$\delta_i(B)$– denominator, polynomial of the deviation function for *i*-th time series.

A more compact model can be written as follows:

$$Y_t = \mu + \sum_i \psi_i(B) X_{i,t} + n_t \quad (4)$$

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Here

$\psi_i(B)$– function of *i*-th factor impact $\psi_i(B) = \frac{\psi_i(B)}{\delta_i(B)} B^{k_i}$;

n_t– noise of direct time series $n_t = \frac{\theta(B)}{\varphi(B)} a_t$.

This model combines an effect on the predictable variable random of past exogenous variables and past values of the time series itself. It means that this model considers analysis of previous deviations, patterns of time series, their relation to the exogenous variables. As a result we can obtain the forecast of the bank cash flows, even for the determined time period in the future, as defined in the model.

Further analysis - forecasting cash flow as well as developing of various criteria for liquidity management will be implemented on the database of Savdogarbank, a commercial bank of Uzbekistan. The data for analysis has been received on the free-of-charge basis from the representative of the Head office of the bank for conducting dissertational research. To make models of balance indicators we have been provided with the data of Savdogarbank only on funds attracted from the individuals and legal persons without mentioning initial information of the clients. The data on funds attracted from other credit institutions or banks have not been provided because of the bank secrecy. Modeling has been done with the application of software «SAS System for Windows».

RESULTS OF EMPIRICAL ANALYSIS

Modeling funds attracted from individuals

The following model is the most completely reflects performance of time series data:

$$(1 - B^1)(1 - B^{12})Y_t = \psi PPI_t + \frac{(1 - \theta)}{(1 - \varphi_1 B^1)}$$

Here:

Y_t– attracted funds of individuals;

B^i– deviation operator;

ψ, θ, φ – appropriate estimated coefficients before model variables which values we showed in table 1.

Table 1. Parameter Estimates HOUSEHOLD: bank ppi + ARIMA (1,1,2)(0,1,0) s NOINT

Model Parameter	*Estimate*	*Std. Error*	*T*	*Prob>|T|*
Moving average, Lag 1	1.10799	0.1833	6.0443	<.0001
Moving average, Lag 2	-0.60372	0.1559	-3.8752	0.0004
Autoregressive, Lag 1	0.79053	0.1662	4.7578	<.0001
ppi	1594	698.5448	2.2825	0.0275
Model Variance (sigma squared)	46773292	-	-	-
Fit Range:	JAN2011 to DEC2014			

So the forecasted amount of the cash inflow for the period of time *[t-1, t]* will make:

$$Y_t - Y_{t-1} = Y_{t-12} - Y_{t-13} + 1594PPI_t + \frac{(1 - 1.11B^1 + 0.6B^2)}{(1 - 0.79B^1)}a_t.$$

Modeling funds attracted from legal persons

In the final model ARIMA(1,1,2), in the form of formula:

$$(1 - B^1)Y_t = \frac{(1 - \theta_1 B^1 - \theta_2 B^2)}{(1 - \varphi_1 B^1)}a_t, \qquad \text{or,}$$

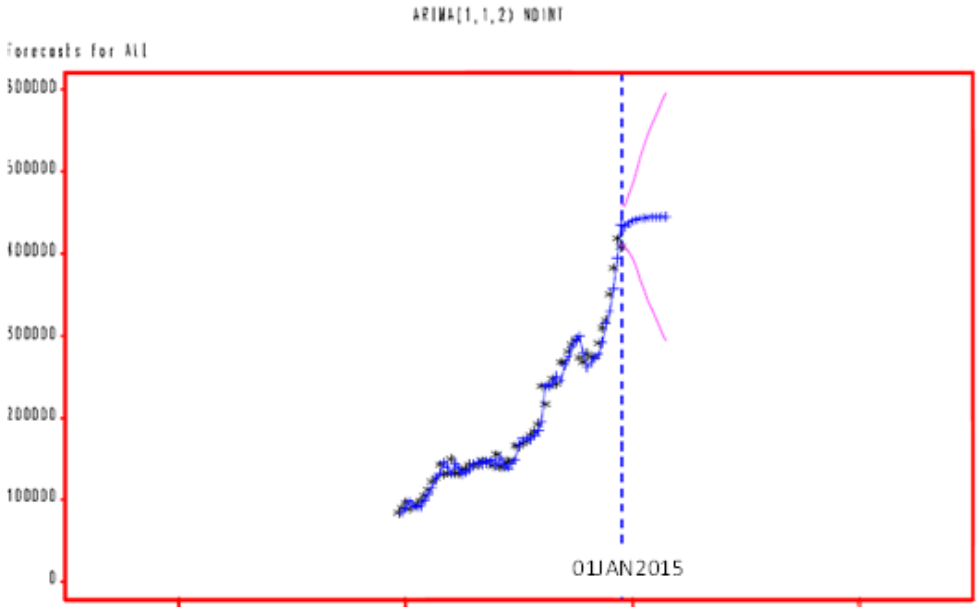
$$Y_t - Y_{t-1} = \frac{(1 - 0.75B^1 + 0.45B^2)}{(1 - 0.66B^1)}a^t$$

In this case with the help of analysis we couldn't detect a significant dependence of time series from exogenous indicators. At the same time, there is autoregressive dependence of the 1-st level and dependence of the moving average of the 1-st and 2-nd level.

Statistics of the model of funds attracted by Savdogarbank of Uzbekistan from legal persons is illustrated in Table 2.

Table 2. Parameter Estimates

	Estimate	*Std. Error*	*T*	*Prob>|T|*
Moving average, Lag 1	0.75	0.23	3.34	0.0015
Moving average, Lag 2	-0.45	0.14	-3.19	0.0024
Autoregressive, Lag 1	0.66	0.21	3.09	0.0031
AIC	1119.4			
BSC	1125.7			
Fit Range:	*JAN2011 to DEC2014*			



Graph 1. Forecast of cash flow from legal persons

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It should be noted that this time series differs by high volatility in comparison with the funds of individuals that is reflected in relatively big values of AIC and BIC and 95% of the confidence interval.

CONCLUSION

Conducted research of the problem of liquidity management in commercial banks enables to make the following conclusion:

- there has been carried out analysis of different models of the bank liquidity and on its basis has been offered our modeling of the bank liquidity;

- mathematical model ensuring receiving an objective assessment of the future condition of the bank liquidity has been tested in practice. Research has shown that a future condition of bank's liabilities as well as bank cash flows can be objectively forecasted. We have performed these calculations with the method of ARIMA on the basis of analyzing historical database of the bank.

An important result of ARIMA model application is that a proposed procedure can be performed for both internal and external users. It will be useful for internal users to make liquidity forecast and efficient for external users to research dynamics of funds attracted by the bank and assessment of risks for future liquidity.

It should be noted that the model, proposed in the article, cannot entirely optimize the activity of the bank and minimize risks of liquidity management. On the one hand, it is connected with the fact that the forecast for future cash flows of the bank is made with the certain probability. Thus if we raise the time series, the reliability of the results will be decreased.

Therefore we suggest future researches conducting analysis with the account of occurrence of new internal and external factors and search for opportunities to apply other instruments of financial analysis.

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