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Banks’ Liquidity in Ukraine shortly before and during Political Instability of 2013-2015

Bachelor thesis

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Abstract
This thesis discusses causes of the liquidity crises in Ukraine. The topic is covered from both theoretical and practical point of view. The discussions on the policies implemented by Central Bank are presented as well as the analyses for three liquidity ratios, using time series data and ordinary least squares. The main hypotheses of the thesis are: there is a positive correlation between the liquidity level and proportion of foreign capital to total bank capital; higher capital adequacy ratio leads to better liquidity ratios; liquidity is procyclical and thus depends positively on the economic growth of the country and we presume negative correlation between discount rate and liquidity. In addition to the aforementioned hypotheses, we also examine the effect of additional explanatory variables such as inflation, total assets of banking sector, spread between loans and deposits, ratio of non-performing loans to capital, unemployment rate, returns on assets and equity, and investment in securities. The quick liquidity ratio, short-term liquidity ratio, and current ratio are used as dependent variables and separate model is constructed for each of them.

Keywords
liquidity, Ukraine, banking sector, time series analysis, ordinary least squares, liquidity crisis, first differencing

Range of thesis: [ 89,571 characters (with spaces), 58 pages ]
Declaration of Authorship

1. The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.

2. The author hereby declares that all the sources and literature used have been properly cited.

3. The author hereby declares that the thesis has not been used to obtain a different or the same degree.

Prague, July 29th 2016

Signature
Acknowledgments
I would like to express my gratitude to my supervisor Mgr. Iuliia Brushko M.A..
Furthermore, I am thankful to the nearest ones for their permanent support and understanding.
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<th>Description</th>
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<tbody>
<tr>
<td>NBU</td>
<td>National Bank of Ukraine</td>
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<tr>
<td>CPI</td>
<td>Consumer price index</td>
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<td>OLS</td>
<td>Ordinary least squares</td>
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<tr>
<td>TOA</td>
<td>Total assets</td>
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<tr>
<td>INF</td>
<td>Inflation rate</td>
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<td>NPLC</td>
<td>Non-performing loans to capital ratio</td>
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<tr>
<td>SPR</td>
<td>Spread between loans and deposits</td>
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<tr>
<td>GDP</td>
<td>Gross domestic product</td>
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<td>UNM</td>
<td>Unemployment rate</td>
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<td>ER</td>
<td>Exchange rate</td>
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<tr>
<td>ROE</td>
<td>Return on equity</td>
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<tr>
<td>ROA</td>
<td>Return on assets</td>
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<tr>
<td>FOR</td>
<td>Proportion of foreign capital to total capital</td>
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<td>CAR</td>
<td>Capital adequacy ratio</td>
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<tr>
<td>CONTR</td>
<td>Max amount of risk on one contragent</td>
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<td>INV</td>
<td>Investment in securities</td>
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<tr>
<td>DS</td>
<td>Discount rate of Central Bank</td>
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<td>OWN</td>
<td>Share of own capital to total assets</td>
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<td>VAR</td>
<td>Vector autoregressive models</td>
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<td>ADF</td>
<td>Augmented Dickey-Fuller test</td>
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<tr>
<td>IMF</td>
<td>International Monetary Fund</td>
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<tr>
<td>VIF</td>
<td>Variance inflation factors</td>
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<td>B-P</td>
<td>Breusch – Pagan test</td>
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<tr>
<td>VIF</td>
<td>Variance Inflation factor</td>
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<td>HAC</td>
<td>Heteroskedasticity – consistent standard errors</td>
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<tr>
<td>UAH</td>
<td>Ukrainian hryvnia</td>
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<tr>
<td>USD</td>
<td>US dollar</td>
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<td>ATO</td>
<td>Anti-terroristic operation</td>
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<tr>
<td>ICE</td>
<td>Interbank Currency Exchange</td>
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<tr>
<td>DGFI</td>
<td>Deposit Guarantee Fund for Individuals</td>
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<tr>
<td>ADF</td>
<td>Augmented Dickey-Fuller test</td>
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1. Introduction

The banking system is an organism; it is specific economic and legal organizational structure that ensures the functioning of the money market and the economy in general. The liquidity then determines the reliability of the banking system.

The beginning of the political crisis in Ukraine in late 2013 triggered a powerful banking crisis, which is still ongoing. The banking system faced a number of problems, both subjective and objective ones, and not always consistent actions of NBU as a regulator has often exacerbated a serious condition of the whole system.

In 1873, the famous economist and philosopher Walter Bagehot put the fundamental principle of art of central banking during the financial crisis in his landmark work, "Lombard Street: Money Market description": "free loans at high interest rates for deposits are good." This principle has served as the main mantra for the next two centuries, regulators, and most importantly - this principle has led to the positioning of the institute of the central bank as the "lender of last resort."

Since 2013 90 banks out of 184 registered in the beginning of 2014 were liquidated. The number is quite significant so what was the main problem? Is it due to inefficient policies implemented by National Bank of Ukraine? Is it due to the depth of financial crises? Is it due to NBU artificially trying to close banks, those who were operating only for private business of its owners and make Ukrainian banking system healthy and compatible?

The thesis is organized in the following way. Chapter 2 describes the banking system of Ukraine Chapter 3 is dedicated to the review of the policies initiated by Central Bank in order to provide liquidity to the banks and keep the level of currency on the market and its discussion. In the Chapter 4, we discuss the measurements of bank liquidity; how it should be defined and how it is regulated. Also it explains why liquidity is so crucial for financial stability of the financial sector. Chapter 5 describes the data and sources used in our work. The methodology of the research is presented in Chapter 6. In Chapter 7 we outline the econometric model and also state hypotheses we aim to investigate. The hypotheses are the following: the higher proportion of foreign capital in bank capital leads to the better liquidity indicators, the lower discount rate implies the higher liquidity in the banking system, the boom stage of business cycle (measured by GDP growth) indicates improved liquidity situation in the banking sector, therefore liquidity is procyclic and lastly higher capital adequacy ratio is positively associated with liquidity ratios. In Chapter 8 we discuss tests performed in order to test for Gauss-Markov assumptions. Chapter 9 is devoted to the presentation of the empirical results. The last two chapters summarise the thesis and propose further extensions.
2. Ukrainian Banking System

To start with analyses of Ukrainian banking system, it makes sense to begin with the emergence of Ukrainian banking system together with independence of Ukraine in 1991.

The prototype of Ukrainian banking system appeared in USSR banking system in the end of 80s. By that time, banks were registered in 4 categories: commercial banks on the basis of state USSR bank, industry and departmental commercial banks, branches of large Russian banks and state, and cooperative commercial establishments that had the right to conduct financial and credit activities. After the announcement of independence in 1991, all banks had to re-register in Ukrainian republican book of registration of banks, currency exchanges, and other financial-credit organizations. This period is characterized by the emergence of legal framework under which Ukrainian banking system was build according to two level bank system principle, which is common for free market economies. Already by the end of 1991, the number of commercial banks was around 90.

The next stage of Ukrainian banking system development is described by the opening of great number of so called “pocket banks”. These banks were founded by enterprises or private individuals and had an opportunity to operate without any burdens; they drew individual equity, equity of small and joint ventures, corporations, or state funds. “Pocket banks” were oriented on short-term lending for trade intermediary activity and they were able to obtain profit from inflation processes in Ukrainian economy. By the end of 1991 around 100 of “pocket banks” has emerged.

In the following stage of the banking system development, number of economic reforms, which were based on monetary policy, was implemented. It helped to stop the inflation and stabilize the economy. After the monetary reform in second half of 1996 when the national currency – hryvnya, was introduced, Ukraine reached financial stability and became a target for foreign investors. During the period of 1994-1996, 14 banks with foreign capitals registered in Ukraine. At that time, the number of banks in 1995 was already 230. The stability of financial sector, which was reached by monetary policies was not supported by stability in others sector on micro and macro levels. It was expressed in the actions of government, which was rather maximizing internal and external short-term debt than implementing policies to balance public spending with real budget revenue. The following financial crisis in 1998 hit the economy and caused commercial banks to lose the most attractive market segments where they were operating: government bonds and currency markets. Due to the significant devaluation of the national currency, total capital of Ukrainian banks decreased by an average of 30-35%.

The main purpose of the next stage of banking system development was to ensure financial stability, solvency and liquidity of the banking system as a whole. On December 7th 2000, in order to reform banking system, Ukrainian Parliament signed Law of Ukraine "On Banks and Banking", which specifies the establishment and operation of a two-tier banking system of Ukraine.

According to this law, the National Bank of Ukraine represents the first level of banking system, with the central office in Kiev and regional offices. NBU is the central
bank and it is responsible for the banking system as a whole. Other banks, which can be privately or state owned, represent the second level of the banking system.

Table 1 Number of banks in banking system by years

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<td>176</td>
<td>180</td>
<td>162</td>
<td>120</td>
<td>106</td>
</tr>
</tbody>
</table>

Source: NBU

Table 1 presents the number of registered banks in Ukraine during 2002-2015. It is notable that in last 2 years the number of banks felt below the average and that just in 2015 42 banks were liquidated. Among 106 banks operating in Ukraine on the June 1st 2016, we can distinguish that 22% of them have private Ukrainian capital, 17% are funded with foreign capital (except Russian), 21% - banks with Russian capital and 40% - state owned banks. In total, 38.6% of banks operating in Ukraine are funded with foreign capital.

It is important to discuss the evolution of monetary policies in Ukraine. Until 2014 there has been fixed exchange rate in Ukraine, which was working under the conditions of accumulation of the disbalances in economy. It helped to keep the overvalued exchange rate and provided fiscal domination, which means that with the presence of large amount of debt, pressure on monetary policy towards easing will increase, and therefore the latter will not be able to fully comply with such objectives as low inflation. There comes an interesting distortion functions: monetary policy stabilizes the real value of public debt and fiscal policy determines the desired inflation rate. For obvious reasons, the fiscal dominance regime is characterized by high and more volatile inflation. The main aim of the fixed exchange rate instrument was exchange rate stability.

With financial crisis coming in the 2014, NBU had to change their policy not only because management was changed due to political changes in the country, but also due to the new challenges in the country. During the crisis, the regime of National Bank can be called “Eclectic policy” because of the variety of instruments used. On February 7th 2014 exchange rate changed from fixed to a floating one, due to the significant current account deficit ($ 16.5 billion), a decrease of foreign exchange reserves and a strong devaluation pressure on the hryvnia would become the beginning of a gradual transition to a market rate fixing, leveling the balance of payments, and structural restructuring of the economy. Another parameter of “Eclectic policy” was monetary targeting, according to which the amount of money in circulation is the determining factor of economic development. Monetary targeting regime does not involve any active measures to compensate short-term supply and demand shocks related to changes in interest rates. However, by maintaining a constant money growth, this mode partially compensates them. Thus, in the case of a negative demand shock on commodity market, monetary targeting would lead to a decrease in interest rates. This would have positive impact on aggregate demand, but full shock compensation would not happen. In the case of a negative supply shock, monetary targeting is not providing any shift in aggregate demand curve. Except floating exchange rate and monetary targeting, the
fiscal domination was still present. The goal of this policy was to stabilize financial system, provide viability of the state, and minimize devaluation of the currency. The period 2015-2016 was and still is a stabilization term of financial system, the main feature of which is transition from monetary targeting to inflationary targeting. According to the inflation targeting, the level of inflation is the determining factor of economic development. It is characterized by floating exchange rate regime and transition to active interest rate policy. The main reasons for changing the monetary policy to inflation targeting are: inability to use the exchange rate as a nominal anchor - either due to overheating of the economy, either through exhaustion of international reserves; no stable connection between money and inflation - ineffectiveness of goals of monetary aggregates; necessity for rapid disinflation; strengthening of central bank independence, and avoid fiscal dominance.

The idea of this policy is to reach disinflation, increase international reserves, and stabilize currency market.

In April 2016, there was issued document by the parliamentary committee on financial policy and banking "Strategy for development of banking system of Ukraine 2020", which aims to initiate a new discussion about the development of the banking sector. According to this document, there are three groups of problems, which led to financial crisis:

The first group of causes of the crisis includes:

- The destructive model of development of the economy as a raw material appendage of the global market and de-industrialization, generating vulnerability of the balance of payments, and high foreign exchange risks.
- Clan-oligarchic system, monopolization or oligopolization markets and assets and systemic corruption on the state level of government, which preserves the raw type of economic development; the transformation of government bodies in the inefficient and corrupt management.
- The recurring problems with property rights to block the business motivation for long-term investment.

The second group of causes of the crisis includes:

- Systemic problems of the banking system: system deficit of long resources deprive the banking system from investment lending options.
- Focus on current operations and the failure of the banking system, the main function of the creditor for the strategic restructuring of the economy.
- Disparities in bank balance sheets by maturity, maturing assets and liabilities (maturity mismatch); bank balance sheets by currency imbalances (currency mismatch), which creates a systemic vulnerability of the banking sector and its clients to currency shocks.

The third group of causes of a systemic banking crisis, which has exacerbated and actualized the first two - it shocks by the actions of monetary control as a result of its fundamental system errors in the monetary, foreign exchange and communication
policy, as well as wrong the concept of the seven selected activities in the field of banking regulation.
In addition, much attention is paid to the strategy of direct monetary policy pursued by the controller.
3. Central Bank Policies and its Discussion

During 2014 — 2015 Ukrainian economy and the banking sector has went through the deepest crisis since the independence in 1991. This was due to the military conflict and Russian annexation of Ukrainian territory, due to the large-scale of structural imbalances accumulated over the past decade. The additional source of problems was the fact that the banking sector remained for a long time without proper regulation and effective supervision. This led to a rapid increase in the number of institutions that did not intend to serve as a classical financial intermediary and was considered by shareholders solely as a funding instrument for related business. The legal insecurity of creditors played the negative role in the deterioration of the financial condition of banks. The restructuring of the financial sector and restart of banking system, which is happening nowadays, is exposing many fundamental issues and demonstrates extremely high cost for the economy because of the delay in the adoption of socially-unpopular, but necessary decisions.

The financial sector remains vulnerable to the external and internal shocks. The stability of the banking sector has been gradually recovering during 2016, but the pace of the recovery will depend largely on the recognition of external risks and the ability to minimize them.

The external conditions of the economy and financial sector remain fierce because of on-going aggression of Russia in the east of Ukraine, deteriorating terms of trade, high volatility and unpredictability of prices of basic export commodities that has been lately creating pressure on the currency market. The macroeconomic risks for financial stability are decreasing. NBU and independent experts are expecting economic growth in 2016 and in the following years. However, they emphasize that this year's economic recovery will be slow.

During the last few years, Ukrainian banking system has been facing serious challenges, such as inflation, corruption, devaluation of the currency, searching for methods of transferring the risks, and control over the balance of interaction of the banks in Ukraine. The situation was complicated by the uniqueness of the situation in the country and the necessity to look for own anti-crisis recipe. There were a lot of good decisions, but also huge amount of mistakes made by NBU. Nevertheless, the main conclusion is that dynamic evolution of the National Bank of Ukraine has started.

The characteristic feature of macroeconomic dynamics in 2013 was the stabilization of consumer inflation almost at zero level. The growth rate of consumer price index in annual terms ranged from -0.8% (March and April) to 0.5% (in December). The increasing food supply and relatively low growth of regulated prices and tariffs largely fueled such price dynamics.

Also, the major factor of supporting low inflation environment in 2013 was projected dynamics of the hryvnia exchange rate to the US dollar, which fell by 1.2% - to 8.1508 UAH/ USD on the interbank market.
Under these conditions, there was a rapid growth of monetary aggregates, which under the aforementioned circumstances had inflationary consequences. The monetary base increased by 20.3% during 2013.

The impact of unfavorable foreign economic situation on the real economy was not offset by ongoing measures to structural changes in the economy. So in 2013 there was recorded zero growth in real GDP. The recession in the economy aggravated public finances - fiscal deficit Ukraine in 2013 amounted to 4.4% of GDP. The unfavorable macroeconomic trends continued in 2014 alongside the backdrop of social and political tension in the country. The decline in economic and financial sector led to active price dynamics. As a result, the growth rate of the consumer price index in March 2014 accelerated to 3.4% compared to 0.5% in 2013 in annual terms. The slowdown in economic activity and currency depreciation contributed to the reduction of deficit of the current account balance to 0.3 billion USD in January-February 2014 compared to 1.6 billion USD in the same period in 2015. However, economic and political instability in the country led to capital outflows in the financial account balance of payments. Its deficit in January-February amounted to 3.7 billion USD. Due to the reasons mentioned above, there has been a decrease in international reserves in January - March 2014 from 5.3 billion USD - to 15.1 billion USD.

In order to strengthen the competitiveness of the national economy and the ability of the financial system to withstand external shocks, there was an introduction of a transition to a system of flexible exchange rate in February 2014. It affected the dynamics of currency immediately. In the first quarter of 2014 exchange rate USD/UAH fell by 34.9% - to 10,9981 USD/UAH on the interbank market.

The actions of National Bank in terms of outflow of funds from bank accounts were primarily fuelled by the need to maintain banks' liquidity at an appropriate level. It was necessary in order to avoid payments crisis and ensure the timely relocation of bank liabilities to depositors. Thus, NBU has developed additional specific mechanisms to support liquidity of banks that suffered from outflows of deposits. Just in 1Q/2014 the volume of refinancing loans amounted to 63.1 billion USD. The aforementioned issue resulted in faster growth of the monetary base (7.4%) compared to the money supply (3.8%) in this period.

NBU has declared that the strategy of monetary policy in the medium term will include the use of inflation targeting. It is important to improve the operational structure of the monetary policy. The major efforts to achieve inflation targeting will be aimed at enhancing percentage leverage on the monetary market. Also the conversion of interest rate into the main operational tool and a guide of a monetary policy is a goal. The use of flexible exchange rate will contribute to this.

The analysis of the problems faced by the banking system of Ukraine at the end of 2013 - first half of 2014, and the adequacy of the actions of the NBU as a regulator follows. Firstly, the main problems are defined as:

- **Capital outflows from the banking system**

The political events in the end of 2013 primarily triggered the outflow of deposits. The outflow began in the fall of 2013. The panic of depositors increased in January 2014
after the first shootings on the Maydan and reached unprecedented proportion in February. The volume of deposits of individuals in the national currency decreased by 18%, and in dollar by third during first three quarters of 2014. As a result of outflows, banks experienced the lack of liquidity, which struck even more by the tranquility of depositors and closed the circle. At the same time, due to the unstable political situation and strong devaluation of the national currency, enormous outflow of capital occurs.

Before the crisis, the average daily trading volume on the Interbank Currency Exchange has hovered around US $ 1-1.5 billion. In the period from beginning of January 2014 to the end of February 2014 (date when the National Bank introduced first regulatory restrictions on the outflow of capital from the banking system) the average daily trading volume fluctuated in the range of 3-5 billion USD.

- **Losses related to military activities**
  The annexation of the Crimea, the fighting in Luhansk and Donetsk region influenced the panic among Ukrainians, which aggravated devaluation of a currency and contributed to the outflow of deposits. But most importantly, banks lost their assets in the Crimea and in the zone of the ATO. According to the various estimates, from 12 to 15% of banking system assets were concentrated in the Crimea and in the ATO area.

- **The quality of loan portfolios**
  Here it is possible to identify two main factors influencing the situation in the banking system: a large number of insider loans (more than half of Ukrainian banks were part of certain financial and industrial groups, for which banking business is not the primary, i.e. servicing); huge gaps between assets and liabilities in banks - deposits of individuals and legal entities in the banking system were short (six months average term accommodation) and almost half was in a foreign currency, while the loans up to 90% were in UAH (there was as a ban on lending in foreign currency, besides exporting companies in the scrip does not exceed the annual amount revenues in the foreign currency) with an average maturity of approximately 3 years.

- **Not enough capitalization of the banking system**
  Over the years, the requirements of the regulator related to the minimum regulatory capital of banks were more than liberal, not taking into account the stress crisis situations. That, in turn, made it possible to create a large number of artificial banks with full banking licenses.

Analysing the adequacy of the actions of NBU in the first months of the crisis broke out, we can say conclude following. National Bank took passive approach from the beginning of fluctuations period in the banking sector. It was restricting activity on the ICE without regulatory restrictions by conducting foreign exchange interventions on the ICE from the official foreign reserves. It led to subsequent extension of tools such as currency auctions of the Dutch type; which under circumstances of galloping exchange rate had no effect, because banks were unable to buy the foreign currency at the auction. Banks were buying it on the ICE at any rate, thereby further fueling the hype. These actions led to a fairly rapid decrease in reserves, without the desired effect on the currency market. NBU took the first significant regulatory actions only on February 2nd 2014.
They put limits on the removal of currency from the deposit accounts of individuals in the first place. In addition, stricter requirements on return of foreign currency revenues of exporters were placed. Also the introduction of requirements, which increased the duration of the operations of currency purchase, allowed the controller to predict the market. Following this, NBU launched a new mechanism for short simplified refinancing of banks. It aimed solely at maintaining the liquidity of banks associated with the outflow of deposits of individuals. However, the rate of banks refinancing of this kind was clearly overpriced (3X NBU discount rate). Also the collateral requirements have been greatly simplified. Some part of this refinancing really helped conscientious banks to maintain liquidity. But low collateral requirements enabled unscrupulous banks to close the problem of insiders by the received funds, followed by withdrawal from the market. Further bank's problems were shifted to the Deposit Guarantee Fund of individuals.

These actions had relatively short-term effect. Besides a significant number of banks saw the impossibility of implementation of the commitments and became insolvent (totally during 2.5 years already insolvent or liquidated are 90 banks, out of 184 registered in the beginning of 2014). Here important to note, that majority of banks that closed, were the artificial ones. They were made in order to provide the banking service for the owners’ businesses. Almost banks funded by foreign capital stayed in the system. Pirate banks had an opportunity to reallocate the revenues from other countries to maintain the appropriate level of capital in the banks to follow all the prudential normatives.

NBU actions in the first months of the crisis can be considered as chaotic and non-systemic, aimed at putting out individual fires, but not at changing the situation as a whole. Starting from the summer 2014, NBU started to pursue a more balanced systemic policy, aimed at tightening the requirements for the banking system in terms of the timely recapitalization of banks.

During this period, the National Bank introduced a new procedure for the refinancing of banks, allowing banks to rely on the permanent support from the regulator at more weighted terms. The refinancing rate was tightly tied to the NBU discount rate (x2). The requirements for the quality of the collateral increased and the mechanism of personal banks’ owners liabilities issued by Refinance was introduced.

At the same time, NBU and DGFI launched a tough fight with unscrupulous banks by putting in them interim administration. These actions, however, had a negative effect due to the fact that the deposit amount guaranteed by the state to return was about 260 000 UAH (according to actual UAH/USD rate - 8000 USD). The huge number of depositors lost their savings forever, which in turn caused public outrage by NBU actions.

This was followed by arguably the most resonant regulator's decision - a ban on the withdrawal of capital of non-residents received as income from activity on the territory of Ukraine (including dividends and proceeds from the sale of corporate securities). At same time, requirements for buying foreign currency on the ICE and liabilities on exporters to sell foreign exchange earnings were announced. These innovations had both positive (exchange rate no longer galloping) and negative effect - the volume of investments decreased in Ukraine. Starting from the middle of 2015, NBU has been
gradually reducing the limitations imposed on the foreign exchange market. The percentage of the mandatory sale of foreign currency earnings is reduced and term of buying currency is decreased from four days to two. The purchase of currency under the contracts of assignment of claims is authorized. Simultaneously, the amount of the issuance of savings from currency accounts citizens is increased and all restrictions on removal of citizens in local currency are removed. It is also worth to note that during 2015 NBU managed to introduce a market mechanism of formation of the national currency, which in turn had a positively impact on the liberalization of the market. As a consequence, there is only one market rate of national currency in the country now. Overall, during the period of the crisis, it may be noted that NBU actions looked non-systemic at an early stage. However, they became more rational later and committed to a common strategy. The most importantly, NBU has become politically independent institution acting exclusively within their competence.
4. Measuring Bank Liquidity

Timeliness and completeness of the performance of banking institutions functions and the banking system as a whole is heavily dependent on their liquidity, which is one of the common quality characteristic of the bank and determines its reliability, sustainability, and competitiveness. In the process of business, banks are constantly exposed to liquidity risk, i.e. the probability of mismatch between demand and supply of money and failure of the bank to meet its financial obligations.

First of all, it is important to define what liquidity is and what it means to be illiquid. There exist two types of the liquidity: market and funding. Market liquidity is asset liquidity, while funding is the cash liquidity. For our purpose, we consider only funding liquidity. However, there are several definitions of liquidity:
- Ability to settle obligations with immediacy. It follows that a bank is illiquid if it is unable to settle obligations in time (Drehman and Nikolaou, 2009)
- Ability to raise cash at short notice either via asset sales or new borrowing. (Borio, 2000, Strahan (2008), Brunnermeier and Pedersen (2009))
- Dynamic state that ensures timeliness, completeness and continuity of all monetary liabilities of the banking system, characterizes the level of reliability and sufficiency of funds to meet the needs of economic development (National Bank of Ukraine).
- Ability of the banking system to ensure timely implementation of obligations to depositors, creditors and shareholders of banks, ability to attract in sufficient quantity available assets of businesses and individuals to provide loans and invest in the economy.( National Bank of Ukraine)

In order to regulate liquidity of banks National Bank of Ukraine in the current situation on the money market applies:
1) Refinancing operations (permanent line of refinance to provide banks with overnight loans and refinancing loans);
2) Repo transactions (transactions of direct repo and reverse repo transactions);
3) Operations with own debts (certificates of deposit and overnight for up to 90 days);
4) Transactions with public Ukrainian public bonds.

The mechanism of liquidity provision for commercial banks is requirements established by the state for liquidity, solvency, and capital structure. Each indicator is not sufficient to state separately and unambiguously that the particular bank is liquid.

In order to protect the interests of customers and to ensure the financial soundness of banks, National Bank of Ukraine sets up economical standards for all commercial banks; which includes liquidity requirements-the implementation of which is intended to provide sufficient liquidity for commercial banks. They are set up in order to help with analysis of the ability of commercial banks to fulfil their obligations and in dynamics to assess trends in bank liquidity. The information about these trends is a prerequisite for good governance liquidity and therefore good bank financial condition and stability of the whole banking system. Other mandatory requirements of risk,
capital, and currency positions are not directly related to liquidity, but help bank to be liquid, warning against too risky operations or deterioration of financial condition.

Liquidity risk can be measured by two main methods: liquidity gap and liquidity ratios. The liquidity gap is the difference between assets and liabilities at both present and future dates. At any date, a positive gap between assets and liabilities is equivalent to a deficit (Bessis, 2009).

Liquidity ratios are various balance sheet ratios, which should identify main liquidity trends. These ratios reflect the fact that bank should be sure that appropriate, low-cost funding is available in a short time. In order to monitor the state of liquidity banks, National Bank of Ukraine sets the following liquidity ratios: quick liquidity (R4), current liquidity (R5), and short-term liquidity (R6).

**Quick Liquidity Ratio**

Quick liquidity ratio (R4) is set to monitor the bank's ability to provide timely fulfilment of their monetary obligations due to the highly liquid assets (cash and balances on correspondent accounts). It is defined as the ratio of cash and balances on the correspondent accounts to bank liabilities, which are recorded on current accounts:

\[ R_4 = \frac{\text{Cash} + \text{Money on NBU’s current accounts} + \text{Money on other banks’ current accounts}}{\text{Liabilities by current accounts}} \]

Normative value of the R4 shall be not less than 20%.

**Current Liquidity Ratio**

Current liquidity ratio (R5) is defined as the ratio of assets with residual maturity up to 31 days for bank liabilities with residual maturity up to 31 days. This standard describes the minimum required amount of bank assets to ensure that the current volume of commitments within one calendar month.

\[ R_5 = \frac{\text{Assets of primary and secondary liquidity with 30 days maturity}}{\text{Liabilities with 30 days maturity}} \]

Assets of primary and secondary liquidity in calculating current liquidity are: cash; precious metals; funds on correspondent accounts in the National Bank and other banks; term deposits with the National Bank and other banks; debt securities refinanced and issued by the bank held for sale and investment; debt securities available for sale and investment and loans.

Liabilities include: deposit; short and long term credits received from the National Bank and other banks; Ukraine budget funds; term deposits from banks and customers; subordinated debt issued by the bank; subordinated debt of the bank; obligations and requirements for all types of guarantees, sureties and loan commitments given to customers and banks.
Normative values of R5 must be at least 40%.

**Short-Term Liquidity**

Short-term liquidity is established to oversee the bank's ability to meet its short-term obligations with liquid assets. Short-term liquidity is defined as the ratio of liquid assets to short-term liabilities with original maturity of one year. It determines the minimum required amount of assets to secure performance of its obligations for one year and it is calculated according to the following formula:

\[
R6 = \frac{\text{Liquid assets with 1 year maturity}}{\text{Short-term liabilities with one year liquidity}}
\]

Normative values of R5 must be at least 60%.

The liquidity ratios are ones of the prudential ratios, that are used to stabilize the national financial systems. The idea of prudential data and prudential analysis has as its microprudential purpose the restriction of probability of individual institutions bankruptcy. The macroprudentials’ central goal is to identify the risks posed in the financial system as a whole.

Core Principles for Effective Banking Supervision are the safe minimum standards of prudential regulation and supervision of the banks and the banking system. First published by the Basel Committee on Banking Supervision in 1997, they are used in the different countries as benchmarks for assessing the quality of their supervisory systems. International Monetary Fund and the World Bank in the context of the Financial Sector Assessment Program to assess the effectiveness of bank supervision and practice in different countries use the core principles.

Within the "Basel I" was defined the set of principles and rules that are conceptually logically and reasonable. Also they payed attention to the specific features of the existing surveillance systems and accounting in certain member countries of the Basel Committee on Banking Supervision. It must be emphasized that the document was designed to establish minimum reserve capital for banks existing internationally. It defined the bank capital ratio which requires banks to maintain a minimum ratio of total capital to risk weighted assets at 8% level. Basel I provided description of 2 tiers of capital: Tier 1 – bank core capital, includes issued shares and declared reserves: Tier 2 – bank supplementary capital, contains gains on investment, long-term debt and hidden reserves. Also Basel I grouped banks’ assets in to 5 risk categories: 0%, 10%, 20%, 50%, and 100%. However Basel I was criticised a lot, with the rapid growth of banking system, it took too simplistic approach and other types of risk were ignored. That is why Basel II was introduced in June 2004. It contained 3 pillars:

- **1st**: Minimum capital requirements for the credit risk, market risk and operational risk;
• **2nd**: Supervisory review process: framework for the banks and supervisory framework;
• **3rd**: Market discipline – disclosure requirements for the banks.

The financial crises 2007/2008 revealed the inefficiency of Basel II concept and brought the necessity for Basel III, which is intended to strengthen bank capital requirements by increasing bank liquidity and decreasing bank leverage. Originally it was scheduled to be introduced from 2013 to 2015, however, was extended till March 31<sup>st</sup> 2019. Unlike Basel I and Basel II, which focus primarily on the level of bank loss reserves that banks are required to hold. Basel III focuses primarily on the risk of a run on the bank, requiring differing levels of reserves for different forms of the bank deposits and other borrowings. Therefore, Basel III does not supersede the guidelines known as Basel I and Basel II; rather, it will work alongside them. There are 3 key principles: capital requirements, leverage ratio and liquidity requirements. The capital requirements ratio is calculated by dividing Common Equity Tier 1 by Risk Weighted Assets, it should be maintained on the level no less than 4.5% by all banks all the time. The banks are expected to maintain a leverage ratio in excess of 3%, and this is calculated by dividing Tier 1 capital by Total exposure. The Liquidity Coverage Ratio would be suppose to require the bank to hold sufficient high-quality liquid assets to cover its total net cash outflows over 30 days.

Currently National Bank of Ukraine is using Basel II approach, but hopefully with the progressive countries moving to more efficient Basel III, Ukraine will change as well. This could help to escape future liquidity crises.
5. The data

The sample data for my research consists of 3 dependent variables and 16 explanatory variables. We use monthly data for 10 consecutive years (from 2006 to 2015). After analyzing other researches about liquidity, we came to a certain set of proposed explanatory variables. Nevertheless, we had to compromise on the final selection of regressands due to the data availability issue for concerned years. However, for some variables data was presented on a quarterly basis, so we had to apply simple linear interpolation in order to obtain missing values of variables. The commercial bank liquidity determined both by bank specific factors (such as total assets, ROE, ROA, proportion of foreign capital, etc.) as well as macroeconomic factors (such as GDP growth, inflation, etc.) are taken into account. We use two main data sources for our analysis. The main data source consists of the reports of National Bank of Ukraine. The second one is State Statistic Service of Ukraine (UKRSTAT).

The dependent variables in the model are liquidity ratios presented in the Chapter 4: Quick liquidity ratio (R4) - QLR, Current liquidity ratio (R5) – CLQ, and Short-term liquidity ratio (R6) - STLR. The plot of all dependent variables after taking first differences can be found below:

*Figure 1. Plots of Liquidity Ratios*

The plots of all explanatory variables can be found in Appendix (*Figure A 1 – original value, Figure A 2 – variables after first differences*).
The description of explanatory variables along with their corresponding source is presented below:

Table 2 The description of explanatory variables with corresponding sources

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
<th>Source</th>
<th>Measured in</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOA</td>
<td>Total assets of the banks in the industry</td>
<td>NBU</td>
<td>Thds UAH</td>
</tr>
<tr>
<td>INF</td>
<td>Inflation rate (CPI index)</td>
<td>UKRSTAT</td>
<td>%</td>
</tr>
<tr>
<td>NPLC</td>
<td>Non-performing loans to capital ratio</td>
<td>NBU</td>
<td>%</td>
</tr>
<tr>
<td>SPR</td>
<td>Spread (between loans and deposits)</td>
<td>NBU</td>
<td>Thds UAH</td>
</tr>
<tr>
<td>GDP</td>
<td>Growth rate of gross domestic product</td>
<td>UKRSTAT</td>
<td>%</td>
</tr>
<tr>
<td>UNM</td>
<td>Unemployment rate</td>
<td>UKRSTAT</td>
<td>%</td>
</tr>
<tr>
<td>ER</td>
<td>Exchange rate</td>
<td>NBU</td>
<td>USD/UAH</td>
</tr>
<tr>
<td>ROE</td>
<td>Average Return on Equity - the share of net profit on banks’ own capital</td>
<td>NBU</td>
<td>%</td>
</tr>
<tr>
<td>ROA</td>
<td>Average Return on Assets – the share of net profit on banks’ total assets</td>
<td>NBU</td>
<td>%</td>
</tr>
<tr>
<td>FOR</td>
<td>Proportion of foreign capital to total capital</td>
<td>NBU</td>
<td>%</td>
</tr>
<tr>
<td>CAR</td>
<td>Capital adequacy ratio (R2)</td>
<td>NBU</td>
<td>%</td>
</tr>
<tr>
<td>CONTR</td>
<td>Max amount of risk on one contragent (R7)</td>
<td>NBU</td>
<td>%</td>
</tr>
<tr>
<td>INV</td>
<td>Investment in securities</td>
<td>NBU</td>
<td>%</td>
</tr>
<tr>
<td>DS</td>
<td>Discount rate of Central Bank</td>
<td>NBU</td>
<td>%</td>
</tr>
<tr>
<td>OWN</td>
<td>Share of own capital to total assets</td>
<td>NBU</td>
<td>%</td>
</tr>
</tbody>
</table>

Source: Author’s elaboration

TOA – Total assets

Total assets include all nonfinancial and financial assets. We take this variable as a proxy to measure the size of bank. Data is obtained from NBU.

INF – Inflation rate (CPI index)

The consumer price index (CPI) is a measure that examines the weighted average of prices of a basket of consumer goods and services, such as transportation food and medical care. Taking price changes for each item of the predetermined basket of goods and averaging them calculates CPI. The goods are weighted according to their importance. The changes in CPI are used to assess price changes associated with the cost of living.

NPLC - Non-performing loans to capital ratio
A loan is non-performing when payments of interest and principal are past due by 90 days or more, or at least 90 days of interest payments have been capitalized, refinanced or delayed by agreement, or payments are less than 90 days overdue, but there are other good reasons to doubt that payments will be made in full.

**SPR - Spread (between loans and deposits)**

The spread corresponds to the difference in nominal terms between total loans and total deposits.

**GDP – GDP growth rate**

GDP growth rate is a measure of economic growth from one period to another in percentage terms. This measure does not adjust for inflation; it is expressed in nominal terms. In practice, it is a measure of the rate of change that a nation's gross domestic product goes through from one year to another.

**UNM – Unemployment rate**

Unemployment rate is defined as percentage of the total labor force that is unemployed but actively seeking employment and willing to work.

**ER – Exchange rate fluctuations**

The change in time of exchange rate, the price of nations' currency (hryvna) in terms of another currency (dollar).

**ROE – Return on Equity**

ROE measures the rate of return for ownership interest (shareholders' equity) of common stock owners. It measures the efficiency of a firm at generating profits from each unit of shareholder equity, also known as net assets or assets minus liabilities. ROE is calculated according to formula:

\[
ROE = \frac{Net\ Income}{Shareholder\ Equity}
\]

**ROA – Return on Assets**

ROA shows the percentage of how profitable a company's assets are in generating revenue. ROA is calculated according to formula:

\[
ROA = \frac{Net\ Income}{Average\ Total\ Assets}
\]
FOR – Proportion of foreign capital to total capital

FOR corresponds to the proportion of foreign capital in total bank capital.

CAR – Capital adequacy ratio (R2)

Economic R2 ratio established by the National Bank of Ukraine, which reflects the bank's ability to timely and fully pay for its obligations arising from trade, credit and other monetary operations. The higher values of sufficiency (adequacy) of regulatory capital, the greater share of the risk is taken by the owners of bank. Conversely, the lower the index, the greater the proportion of the risk is taken by creditors and depositors.

CONTR - Maximum amount of risk on one counterparty (R7)

R7 is set to limit the credit risk arising from the failure of individual contractors of their obligations. The credit risk exposure per counterparty is defined as the ratio of the amount of all claims of the bank to the counterparty and all off-issued by the bank to the counterparty (or a group of related counterparties) to the bank's regulatory capital. The value of the R7 is no more than 25%.

INV – Investments in securities (R11)

The ratio of investment in securities by each institution (R11) is set to limit the risk associated with investing in shares, stocks, shares, and investment certificates of a separate legal entity. The ratio of investment R11 is defined as the ratio of the amount of funds invested in the purchase of shares (parts) and investment certificates separately by each institution to the share capital. The normative values of R11 should not exceed 15%.

DS – Discount rate of NBU

Discount rate - one of the monetary instruments with which the National Bank of Ukraine sets of banks and other money market benchmark on the value of attracted and placed funds in the period. Discount rate is the base interest rate on other interest rates of the National Bank of Ukraine. It is used by National Bank of Ukraine both as a means of implementing monetary policy and the benchmark price of money. The dynamics of discount rate describes the basic directions of change monetary.

OWN – Share of own capital to total assets

The share of own capital to total assets also called shareholders ratio. It is a ratio, which determines how much shareholders would receive in the event of a company-wide
liquidation. The ratio, expressed as a percentage, is calculated by dividing total shareholders’ equity by total assets of the bank, and it is represents the total amount of assets on which shareholders have a residual claim.

**Expected Effect of Explanatory Variables**

The table below summarizes the expected effect/sign of the coefficients for all explanatory variables used in the model.

*Table 3 Expected effect of explanatory variables*

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
<th>Expected effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOA</td>
<td>logarithm of total assets of the banks in the industry</td>
<td>+</td>
</tr>
<tr>
<td>INF</td>
<td>Inflation rate (CPI index)</td>
<td>-</td>
</tr>
<tr>
<td>CRT</td>
<td>Credit Ratings (S&amp;P, Moody’s)</td>
<td>+</td>
</tr>
<tr>
<td>NPLC</td>
<td>Non-performing loans to capital ratio</td>
<td>-</td>
</tr>
<tr>
<td>SPR</td>
<td>Spread (between loans and deposits)</td>
<td>-</td>
</tr>
<tr>
<td>GDP</td>
<td>Growth rate of Growth domestic product</td>
<td>+</td>
</tr>
<tr>
<td>UNM</td>
<td>Unemployment rate</td>
<td>+/-</td>
</tr>
<tr>
<td>ER</td>
<td>Exchange rate fluctuations</td>
<td>-</td>
</tr>
<tr>
<td>ROE</td>
<td>Average Return on Equity - the share of net profit on banks' own capital</td>
<td>+</td>
</tr>
<tr>
<td>ROA</td>
<td>Average Return on Assets – the share of net profit on banks total assets</td>
<td>+</td>
</tr>
<tr>
<td>FOR</td>
<td>Proportion of foreign capital to total capital</td>
<td>+</td>
</tr>
<tr>
<td>CAP</td>
<td>Capital adequacy ratio (R2)</td>
<td>+</td>
</tr>
<tr>
<td>CAR</td>
<td>Max amount of risk on one contragent (R7)</td>
<td>-</td>
</tr>
<tr>
<td>INV</td>
<td>Investment in securities</td>
<td>-</td>
</tr>
<tr>
<td>DS</td>
<td>Discount rate of Central Bank</td>
<td>-</td>
</tr>
<tr>
<td>OWN</td>
<td>Share of own capital to total assets</td>
<td>+</td>
</tr>
</tbody>
</table>

Source: Author’s elaboration

The signs of expected effects showed in the table above were chosen with the following reasoning. We believe that amount of total assets of the bank in the industry would have a positive effect, since amount of the assets in bank should be closely related to stability and ability to fight the shocks. The expected effect of inflation according to our prediction is negative, because inflation reduces the real value of money, so banks may have problems with meeting their obligations. Non-performing loans to capital ratio we assume would have a negative sign, since the higher is value of non-performing loans, the higher will be value of the ratio. Non-performing loans brings threat for the banks, since they would not get repayments for the loan – no money to repay for the deposits. Spread – difference between loans and deposits, we suppose will affect liquidity.
negatively, since if spread is positive means that bank has more loans than deposits and it may find complications to pay its obligations to depositors. High growth rate of GDP implies growth in economy and presence of enough money in the economy, thus we assume the effect to be positive. We are not sure about the expected sign of unemployment variable. It might be negative due to fact that when a lot of people are not getting salaries, there would be fewer depositors to bring money to the bank and less businesses to provide cyclicity of money in the economy. However, higher level of unemployment may lead to decreasing amount of loans, which are the threats for liquidity if they are not repaid. Exchange rate fluctuations, we believe, have negative effect on liquidity because devaluation of the currency just makes liquidity more expensive. Return on equity and return on assets might have positive signs, since ROE and ROA are measures the profitability and the more profitable bank is, the easier is to keep the liquidity on the high level. The proportion of foreign capital to total capital to our mind is positively correlated with liquidity, as we believe that foreign capital gives banks extra support. If there is financial instability in one country, parent banks abroad or foreign investors have higher opportunity to find money for reinvestment. The expected effect from capital adequacy ratio is positive, since this ratio shows banks’ ability to repay its obligations. However, the maximum amount of risk on one contragent is negatively correlated with liquidity. If the risks are not diversified, the probability of failure of financial institution is rising. Similarly, investment in securities ratio was designed to diversify risks, thus the sign is assumed to be negative. Discount rate is simply the rate for which other banks take loans from central bank; the higher it is, fewer loans other banks will take. Thus the correlation between discount rate and liquidity according to our prediction is negative. The share of own capital to total assets is one of the stability measures, therefore the expected effect is positive.

Table 4 Summary statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>QLR</td>
<td>57,47</td>
<td>6,075</td>
<td>42,4</td>
<td>72,25</td>
</tr>
<tr>
<td>CLR</td>
<td>75,983</td>
<td>5,7731</td>
<td>64,49</td>
<td>91,49</td>
</tr>
<tr>
<td>STLR</td>
<td>67,497</td>
<td>26,636</td>
<td>29,92</td>
<td>100,85</td>
</tr>
<tr>
<td>CAP</td>
<td>15,833</td>
<td>3,2521</td>
<td>7,09</td>
<td>20,83</td>
</tr>
<tr>
<td>CAR</td>
<td>22,365</td>
<td>0,50838</td>
<td>20,76</td>
<td>23,78</td>
</tr>
<tr>
<td>INV</td>
<td>0,2325</td>
<td>0,30359</td>
<td>0</td>
<td>1,13</td>
</tr>
<tr>
<td>GDP</td>
<td>-0,28</td>
<td>8,050</td>
<td>-19,6</td>
<td>10,60</td>
</tr>
<tr>
<td>INF</td>
<td>1,1056</td>
<td>1,9083</td>
<td>-1,3</td>
<td>13,966</td>
</tr>
<tr>
<td>UNE</td>
<td>2,0058</td>
<td>0,48077</td>
<td>1,4</td>
<td>3,3</td>
</tr>
<tr>
<td>TOA</td>
<td>1 024 439 968</td>
<td>426 614 503</td>
<td>-429 870 801</td>
<td>2 722 403 098</td>
</tr>
<tr>
<td>OWN</td>
<td>12,974</td>
<td>1,9615</td>
<td>5,98</td>
<td>15,22</td>
</tr>
<tr>
<td>SPR</td>
<td>601,08</td>
<td>92,754</td>
<td>354</td>
<td>816</td>
</tr>
<tr>
<td>ROA</td>
<td>-1,1914</td>
<td>4,3408</td>
<td>-23,53</td>
<td>2,1</td>
</tr>
<tr>
<td>ROE</td>
<td>-13,279</td>
<td>48,906</td>
<td>-277,33</td>
<td>17,64</td>
</tr>
<tr>
<td></td>
<td>NPLC</td>
<td>DR</td>
<td>ER</td>
<td>FOR</td>
</tr>
<tr>
<td>-----</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>NPLC</td>
<td>82,453</td>
<td>101,83</td>
<td>9,16</td>
<td>352,44</td>
</tr>
<tr>
<td>DR</td>
<td>10,629</td>
<td>5,353 6</td>
<td>6,5</td>
<td>30</td>
</tr>
<tr>
<td>ER</td>
<td>8,8025</td>
<td>4,8093</td>
<td>4,5256</td>
<td>24,293</td>
</tr>
<tr>
<td>FOR</td>
<td>35,408</td>
<td>5,2729</td>
<td>19,5</td>
<td>43,3</td>
</tr>
</tbody>
</table>

Source: Gretl
6. Methodology

Ordinary Least Squares

Ordinary Least Squares or OLS is one of the methods of linear regression. The goal of OLS is to closely "fit" a function with the data. It does so by minimizing the residual sum of squares from the data. The formula for residual sum of squares can be expressed as:

\[
RSS = \sum_{i=1}^{n} (e_i)^2 = \sum_{i=1}^{n} (y_i - (\alpha + \beta x_i))^2
\]

The ordinary least squares estimator for \(\beta\) is:

\[
\beta = (X^TX)^{-1}X^Ty
\]

Gauss-Markov Assumptions

Following is a summary of the six classical linear model (CLM) assumptions for time series regression applications. Assumptions TS.1 through TS.5 are the time series versions of the Gauss-Markov assumptions (which implies that OLS is BLUE and has the usual sampling variances). We only needed TS.1, TS.2, and TS.3 to establish unbiasedness of OLS. As in the case of cross-sectional regression, the normality assumption, TS.6, was used so that we could perform exact statistical inference for any sample size.

- **Assumption TS.1 (Linear in Parameters)**

The stochastic process \(\{x_{t1}, x_{t2}, ..., x_{tk}, y_t\}: t = 1, 2, ..., n\} follows the linear model

\[
y_t = \beta_0 + \beta_1 x_{t1} + \beta_2 x_{t2} + \cdots + \beta_k x_{tk} + u_t
\]

where \(\{u_t : t = 1, 2, ..., n\}\) is the sequence of errors or disturbances. Here, \(n\) is the number of observations (time periods).

- **Assumption TS.2 (No Perfect Collinearity)**

No independent variable in the sample (and therefore in the underlying time series process) is a constant and not a perfect linear combination of the others.

- **Assumption TS.3 (Zero Conditional Mean)**

For each \(t\), the expected value of the error \(u_t\) given the explanatory variables for all time periods, is zero. Mathematically, \(E(u_t | X) = 0, t = 1, 2, ..., n\).
• **Assumption TS.4 (Homoskedasticity)**

Conditional on $X$, the variance of $u$ is the same for all $t$: $\text{Var}(u_t|X) = \text{Var}(u_t) = \sigma^2$, $t = 1, 2, ..., n$.

• **Assumption TS.5 (No Serial Correlation)**

Conditional on $X$, the errors in two different time periods are uncorrelated: $\text{Corr}(u_t, u_s|X) = 0$, for all $t \neq s$.

• **Assumption TS.6 (Normality)**

The errors $u_t$ are independent of $X$ and are independently and identically distributed as Normal $(0, \sigma^2)$. 
7. The model

In order to determine the correct form of model, we first need to perform stationarity test.

Stationarity

In addition to Gauss- Markov assumptions, we also require time series used in the regression model to be stationary.

It is important to run test for stationarity, otherwise we might be using non-stationary data and it will lead us to spurious regressions. If two stationary variables are generated as independent random series, when one of those variables is regressed on the other, the $t$-ratio on the slope coefficient would be expected not to be significantly different from zero, and the value of $R^2$ would be expected to be very low. This seems obvious for the variables that are not related to one another. However, if two variables are trending over time, a regression of one on the other could have a high $R^2$ even if the two are totally unrelated. If standard regression techniques are applied to non-stationary data, the end result could be a regression that ‘looks’ good under standard measures (significant coefficient estimates and a high $R^2$), but which is really valueless.

A stationary time series process is one whose probability distributions are stable over time in the following sense: if we take any collection of random variables in the sequence and then shift that sequence ahead $h$ time periods, the joint probability distribution must remain unchanged. The formal definitions of stationarity is as follows:

Stationary Stochastic Process. The stochastic process $\{x_t; t = 1, 2, \ldots\}$ is stationary if for every collection of time indices $1 \leq t_1 < t_2 < \ldots < t_m$, the joint distribution of $\{x_{t_1}, x_{t_2}, \ldots, x_{t_m}\}$ is the same as the joint distribution of $\{x_{t_1} + h, x_{t_2} + h, \ldots, x_{t_m} + h\}$ for all integers $h \geq 1$.

Nevertheless, for majority of purposes is enough to assume only weaker form for stationarity that requires only that 1st moment and autocorrelation do not vary over time. To formally test for the stationarity of time series used in analysis, we apply augmented Dickey-Fuller test.

Augmented Dickey-Fuller Test

In order to check stationarity of our model, we apply augmented Dickey-Fuller test. This test is just an augmented version of the original Dickey-Fuller test. The main difference of ADF test is that it accommodates more complex models with unknown orders. Similar to the original Dickey-Fuller test, the augmented Dickey-Fuller test checks for unit root in a time series sample.

The test statistics for the original DF tests are defined as

$$test \ statistic = \frac{\psi}{SE(\hat{\psi})}$$
Firstly, we apply Augmented Dickey-Fuller test for variables in original form. We use 2 versions (only with constant and with constant and trend term). For both forms, 3 lag terms are included in the equation. The p-values for all variables under both alternatives can be found below.

Table 5 P-values for Augmented Dickey-Fuller test - original values

<table>
<thead>
<tr>
<th>Variable</th>
<th>ADF, with constant – p-value</th>
<th>ADF, with constant and trend – p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log(TOA)</td>
<td>1.561e-005</td>
<td>0.0882</td>
</tr>
<tr>
<td>INF</td>
<td>4.456e-006</td>
<td>3.713e-005</td>
</tr>
<tr>
<td>NPLC</td>
<td>0.04294</td>
<td>0.22</td>
</tr>
<tr>
<td>SPR</td>
<td>0.5685</td>
<td>0.9499</td>
</tr>
<tr>
<td>GDP</td>
<td>0.0108</td>
<td>0.0240</td>
</tr>
<tr>
<td>UNM</td>
<td>0.0001606</td>
<td>1.742e-005</td>
</tr>
<tr>
<td>ER</td>
<td>0.9972</td>
<td>0.9772</td>
</tr>
<tr>
<td>ROE</td>
<td>0.3701</td>
<td>0.3246</td>
</tr>
<tr>
<td>ROA</td>
<td>0.3874</td>
<td>0.3616</td>
</tr>
<tr>
<td>FOR</td>
<td>0.1553</td>
<td>0.3393</td>
</tr>
<tr>
<td>CAR</td>
<td>0.8375</td>
<td>0.9687</td>
</tr>
<tr>
<td>CONTR</td>
<td>4.55e-005</td>
<td>0.0001</td>
</tr>
<tr>
<td>INV</td>
<td>2.032e-005</td>
<td>0.1095</td>
</tr>
<tr>
<td>DS</td>
<td>0.5008</td>
<td>0.5958</td>
</tr>
<tr>
<td>OWN</td>
<td>0.9291</td>
<td>0.9946</td>
</tr>
<tr>
<td>QLR</td>
<td>0.04771</td>
<td>0.2156</td>
</tr>
<tr>
<td>CLQ</td>
<td>0.1883</td>
<td>0.0663</td>
</tr>
<tr>
<td>STLR</td>
<td>0.6306</td>
<td>0.6779</td>
</tr>
</tbody>
</table>

Source: Gretl

Only time series of INF, GDP, UNM, and CONTR turns out to be stationary. Therefore, we proceed with first differencing to address non-stationarity of our data set. The p-values of both versions of test for all variables after differencing are summarized in the table below.
### Table 6 P-values for Augmented Dickey-Fuller test - variables after differencing

<table>
<thead>
<tr>
<th>Variable</th>
<th>ADF, with constant – p-value</th>
<th>ADF, with constant and trend – p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>dLog(TOA)</td>
<td>0.2246</td>
<td>0.0805</td>
</tr>
<tr>
<td>dINF</td>
<td>2.756e-014</td>
<td>9.234e-014</td>
</tr>
<tr>
<td>dNPLC</td>
<td>1.265e-015</td>
<td>1.262e-014</td>
</tr>
<tr>
<td>dSPR</td>
<td>0.06573</td>
<td>0.1856</td>
</tr>
<tr>
<td>dGDP</td>
<td>0.01286</td>
<td>0.0595</td>
</tr>
<tr>
<td>dUNM</td>
<td>3.831e-008</td>
<td>2.734e-007</td>
</tr>
<tr>
<td>dER</td>
<td>4.704e-017</td>
<td>2.283e-016</td>
</tr>
<tr>
<td>dROE</td>
<td>0.000155</td>
<td>0.0013</td>
</tr>
<tr>
<td>dROA</td>
<td>0.0002808</td>
<td>0.0022</td>
</tr>
<tr>
<td>dCAR</td>
<td>1.173e-016</td>
<td>9.26e-016</td>
</tr>
<tr>
<td>dFOR</td>
<td>0.002115</td>
<td>0.01632</td>
</tr>
<tr>
<td>dCONTR</td>
<td>2.71e-023</td>
<td>2.652e-011</td>
</tr>
<tr>
<td>dINV</td>
<td>0.0001</td>
<td>2.343e-023</td>
</tr>
<tr>
<td>dDS</td>
<td>3.4e-005</td>
<td>0.0002</td>
</tr>
<tr>
<td>dOWN</td>
<td>0.0003</td>
<td>3.215e-007</td>
</tr>
<tr>
<td>dQLR</td>
<td>1.915e-017</td>
<td>2.115e-016</td>
</tr>
<tr>
<td>dCLQ</td>
<td>1.136e-020</td>
<td>1.856e-021</td>
</tr>
<tr>
<td>dSTLR</td>
<td>7.839e-015</td>
<td>1.35e-016</td>
</tr>
</tbody>
</table>

Source: Gretl

After taking first differencing for all variables, all variables except log (TOA) and SPR, turns out to stationary. SPR and is clearly borderline cases. Nevertheless, we include it in regression model, but we treat its estimated coefficient with caution.

**General Model**

In order to identify determinants of liquidity of Ukrainian commercial banks, the time-serial regression analysis is used. Taking into account non-stationarity of our original time series data, we apply first differencing. Therefore, the general version of suggested model has the following form:

\[ \Delta LR_t = \beta_0 + \beta_1 \Delta x_{1t} + \cdots + \beta_i \Delta x_{nt} + \varepsilon_t \]

where,

- \( \Delta LR_t \) - difference between one of three liquidity ratios for all banks in the industry in time \( t \) and time \( t-1 \)
- \( \beta_0 \) - constant,
• $\Delta x_{it}$ - difference between value of i-th explanatory variable in time t and value of i-th explanatory variable in time t-1,
• $\beta_i$ - regression coefficient for i-th explanatory variable,
• $\varepsilon$ - the error term in time t.

Three different liquidity ratios are used as dependent variables: quick liquidity ratio, current liquidity ratio, and short-term liquidity ratio. Thus, three separate models are derived from the general version, using the model selection procedure described below.

**Model Selection**

In order to determine the set of explanatory variables relevant for each model and retain adequate parsimony, we apply backward-stepwise selection. Backward-stepwise selection starts with the full set of explanatory variables, and sequentially deletes the predictor that has the least impact on the fit. The candidate for dropping is the variable with highest p-value (or lowest t-statistics). This procedure proceeds until only significant regressors are left (we consider those with p-value below 0.1).

Based on the backward-stepwise selection procedure, we finally analyze the following 3 models:

**Model 1. Quick Liquidity Ratio**

$$\Delta QLR_t = \beta_0 + \beta_1 \Delta CAR_t + \beta_2 \Delta ROE_t + \beta_3 \Delta DS_t + \beta_4 \Delta FOR_t + \varepsilon_t$$

where,

• $\Delta QLR_t$ – difference between quick liquidity ratio in times t and quick liquidity ratio in times t-1
• $\Delta CAR_t$ – difference between capital adequacy ratio in times t and capital adequacy ratio in times t-1
• $\Delta ROE_t$ – difference between return on equity in times t and return on equity in times t-1
• $\Delta DS_t$ – difference between discount rate in times t and discount rate in times t-1
• $\Delta FOR_t$ – difference between proportion of foreign capital to total bank capital in times t

**Model 2. Current Liquidity Ratio**

$$\Delta CLR_t = \beta_0 + \beta_1 \Delta CAR_t + \varepsilon_t$$

where,

• $\Delta CLR_t$ – difference between current liquidity ratio in time t and current liquidity ratio in t-1
• $\Delta CAR_t$ – difference between capital adequacy ratio in time t and capital adequacy ratio in time t-1
Model 3. Short-term Liquidity Ratio

\[ \Delta STLR_t = \beta_0 + \beta_1 \Delta GDP_t + \epsilon_t \]

- \( \Delta STLR_t \) – difference between short-term liquidity ratio in time t and short-term liquidity ratio in t-1
- \( \Delta GDP_t \) – difference between growth of gross domestic product in time t and growth of gross domestic product in time t-1

Hypotheses
The main hypotheses, we would like to examine in this thesis are as follows:

1. The higher proportion of foreign capital to total bank capital leads to the better liquidity indicators.
2. The lower discount rate implies the higher liquidity in the banking system.
3. The boom stage of business cycle (measured by GDP growth) indicates improved liquidity situation in the banking sector. Therefore, liquidity is procyclical.
4. Higher capital adequacy ratio leads to better liquidity ratios
8. Testing for Gauss-Markov Assumptions

In this chapter we discuss and/or test for Gauss-Markov assumptions.

**Linearity**
We think that the linear regression is a reasonable approach considering the characteristics of our data set.

**Multicollinearity**
In order to test for multicollinearity, we show the values of variance inflation factor for all explanatory variables.

**Variance Inflation factor**
VIF quantifies the severity of multicollinearity in an OLS regression analysis. It provides an index that measures how much the variance of an estimated regression coefficient is increased because of collinearity. VIF is obtained directly from the equation

\[
\text{Var}(\beta_j) = \frac{\sigma^2}{\text{SST}_j(1-R^2_j)}
\]

The VIF for slope coefficient \( j \) is obtained as:

\[
VIF_j = \frac{1}{(1 - R^2_j)}
\]

VIF \( j \) is the factor by which \( \text{Var}(\beta_j) \) is higher because \( x_j \) is not uncorrelated with all other explanatory variables.

We checked possible collinearity problem only in the first model, since it is the only one with more than one explanatory variable. VIF value greater than 10 indicates collinearity problem. Based on the results, we have to exclude ROA from the model with QLR as a dependant variable.

**Exogeneity**
If the error \( u \) is correlated with one or more explanatory variables, we face endogeneity problem. It can arise from measurement error, simultaneity, or omitted variables.

We believe that measurement error does not occur in our data set as data collected from the National Bank of Ukraine are assumed to be correct and valid. We may deal with simultaneity in some cases. Although we do not expect that macroeconomic variables like GDP or inflation are dependent on liquidity, some variables like exchange rate may be affected by liquidity ratios. In addition, there might be some other omitted explanatory variables such as violent political incidences or corruption level explaining the changes in liquidity ratios. The proposed approach to alleviate endogeneity problem is discussed in Further Extensions.
Heteroskedasticity

To test for the presence of heteroskedasticity in our data, we employ both Breusch-Pagan and White's tests.

Breusch-Pagan test

The B-P test is build on a simple idea of linear dependence of variance on the independent variables. Breusch–Pagan LM test for known form of heteroskedasticity takes the following form:

\[ LM = \frac{T}{2} \sum_{i=1}^{n} \left( \frac{s_i^2}{s^2} - 1 \right)^2 \]

where,

- \( s_i^2 \) - sum of group-specific squared residuals
- \( s^2 \) - OLS residuals

White's Test

Homoscedasticity assumption, \( \text{Var}(u|x, \ldots, x) = \sigma^2 \), can be replaced with the weaker assumption that the squared error, \( u^2 \) is uncorrelated with all the independent variables \( (x) \), the squares of the independent variables \( (x^2) \), and all the cross products \( (x_jx_h, \text{for } j\neq h) \). This observation motivated White (1980) to propose a test for heteroskedasticity that adds the squares and cross products of all the independent variables to equation \( \hat{u}^2 = \delta_0 + \delta_1x_1 + \cdots + \delta_kx_k + \text{error} \). The test is explicitly intended to test for forms of heteroskedasticity that invalidate the usual OLS standard errors and test statistics.

In the same way as for B-P test, we apply the F test or the LM test with the null hypothesis of \( \delta_j = 0 \), \( \delta_k = 0 \), i.e. the null hypothesis of homoscedasticity.

The results of both versions of heteroskedasticity tests for all 3 models are summarized in Appendix (Table A 1 Model 1. B-P test, Table A 2 Model 1. White's test, Table A 3 Model 2. B-P test, Table A 4 Model 2. White's test, Table A 5 Model 3. B-P test, Table A 3 Model 3. White's test.)

We found some evidence of heteroskedasticity in the first model caused by \( \Delta CAR \) variable, although the results of two tests contradict each other. As White test is more general, we have stronger belief in its result. On the contrary there is no strong evidence of heteroskedasticity in the second model. Short-term liquidity ratio model is heteroskedastic, since both B-P and White's test statistics are statistically significant.

Autocorrelation

Autocorrelation is a common problem in time series analysis. In order to formally test for the presence of autocorrelation in our model, we conduct Breusch-Godfrey test.

Breusch – Godfrey Test for Autocorrelation

Unlike Durbin - Watson test, that checks only for the first order autocorrelation, Breusch-Godfrey test verifies autocorrelation of any order in the random error of
regression models. The test is asymptotic, i.e. for the reliability of the conclusions it requires a large sample size. We decide to use the version of test with 3 lags to detect any dependence in larger time span, compared to simple Durbin-Watson test. Due to the relatively small sample size (120 observations), we should be cautious about the interpretation of the results.

The results of the test for all 3 regression models are presented in Appendix (Table A 7 Model 1. Breusch-Godfrey test, Table A 8 Model 2. Breusch-Godfrey test, Table A 9 Model 3. Breusch-Godfrey test)

According to the result, there is no evidence of autocorrelation in QLR and STLR models since p-values are greater than 0.05. Thus, the hypothesis of zero autocorrelation is not rejected. However, there is some evidence of autocorrelation in the model with CLR as dependent variable.

Since there is some evidence of heteroskedasticity or serial correlation or even both in all 3 regression models, we apply HAC standard errors in each regression to address the violation of these G-M assumptions.

**Normality of residuals**

Finally we examine the normality of residuals. The plots of histograms of residuals against standard normal density curve can be found in Appendix (Figure A 4 Model 1. Normality, Figure A 5 Model 2. Normality, Figure A 6 Model 3. Normality) Although the violation of normality assumption is detected in QLR and CLR models, we are not that concerned as our estimates are still unbiased and consistent. Moreover, we do not need normality for best linear unbiased estimator(BLUE) of the coefficients given by OLS estimator.
9. Empirical Results

Model 1. Quick Liquidity Ratio

After running initial regression and using backward-stepwise selection procedure we came to the following model.

Table 7. Model 1. OLS

Model 1a: OLS including ∆ROA, using observations 2006:02-2015:12 (T = 119)
Dependent variable: ∆QLR

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>const</td>
<td>−0.09595</td>
<td>0.315055</td>
<td>−0.3045</td>
</tr>
<tr>
<td>∆CAR</td>
<td>1.16013</td>
<td>0.417362</td>
<td>2.7797</td>
</tr>
<tr>
<td>∆ROA</td>
<td>−5.08694</td>
<td>2.73604</td>
<td>−1.8592</td>
</tr>
<tr>
<td>∆ROE</td>
<td>0.47633</td>
<td>0.228126</td>
<td>2.0880</td>
</tr>
<tr>
<td>∆DS</td>
<td>1.21212</td>
<td>0.346517</td>
<td>3.4980</td>
</tr>
<tr>
<td>∆FOR</td>
<td>0.61833</td>
<td>0.278606</td>
<td>2.2194</td>
</tr>
</tbody>
</table>

Mean dependent var 0.089832  S.D. dependent var 3.564252
Sum squared resid 1258.481  S.E. of regression 3.337214
R-squared 0.160486  Adjusted R-squared 0.123340
F(5, 113) 4.320342  P-value(F) 0.001237

However, due to multicollinearity problem we drop ∆ROA variable. Moreover, heteroskedasticity was detected. As the consequence we re-run the previous regression without ∆ROA and we apply HAC standard errors. The final form of the model can be found below.

Table 8. Model 1. OLS with HAC standard errors

Model 1b: OLS, using observations 2006:02-2015:12 (T = 119)
Dependent variable: ∆QLR
HAC standard errors, bandwidth 3 (Bartlett kernel)

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>const</td>
<td>−0.038424</td>
<td>0.267637</td>
<td>−0.1436</td>
</tr>
<tr>
<td>∆CAR</td>
<td>1.15496</td>
<td>0.392216</td>
<td>2.9447</td>
</tr>
<tr>
<td>∆ROE</td>
<td>0.054955</td>
<td>0.0192738</td>
<td>2.8513</td>
</tr>
<tr>
<td>∆DS</td>
<td>1.05097</td>
<td>0.363657</td>
<td>2.8900</td>
</tr>
<tr>
<td>∆FOR</td>
<td>0.577354</td>
<td>0.288148</td>
<td>2.0037</td>
</tr>
</tbody>
</table>

Mean dependent var 0.089832  S.D. dependent var 3.564252
Sum squared resid 1296.979  S.E. of regression 3.372982
R-squared 0.134805  Adjusted R-squared 0.104447
F(4, 114) 10.07743  P-value(F) 5.08e-07
The above regression let us rewrite the model using the obtained coefficients:

$$\Delta QLR_t = -0.038 + 1.155 \cdot \Delta CAR_t + 0.055 \cdot \Delta ROE_t + 1.05 \cdot \Delta DS_t + 0.58 \cdot \Delta FOR_t$$

All of the explanatory variables have positive effect on the quick liquidity ratio. In terms of the magnitude of the effect, CAR and DS seem to be the most relevant factors in explaining changes in quick liquidity ratio. On average, increase in CAR by 1 percentage point is expected to increase quick liquidity ratio by roughly 1.15 percentage point. For DS 1 percentage point increase is assumed to affect quick liquidity ratio by roughly 1.06 percentage point increase on average. For variables FOR and ROE, 1 percentage point increase is predicted to cause 0.58 and 0.05 percentage point improvement in QLR respectively. Capital adequacy ratio, Return on equity and Discount rate are significant at 1% level. The proportion of foreign capital to total bank capital variable is significant at 5% level.

The figure in Appendix (Figure A 7 Model 1. Influence and leverage) shows the most influential observations along with the observations with the highest leverage. The period of 2014-2015 have the highest influence on our obtained results.

Model 2. Current Liquidity Ratio

After running initial regression and performing backward-stepwise selection procedure, we came to the following Current Liquidity model.

Table 9. Model 2. OLS

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>const</td>
<td>0.0782577</td>
<td>0.339294</td>
<td>0.2306</td>
</tr>
<tr>
<td>$\Delta CAR$</td>
<td>0.733444</td>
<td>0.386497</td>
<td>1.8977</td>
</tr>
</tbody>
</table>

Mean dependent var | 0.041092  | S.D. dependent var | 3.735592
Sum squared resid  | 1597.480  | S.E. of regression  | 3.695088
R-squared          | 0.029860  | Adjusted R-squared | 0.021568
F(1, 117)          | 3.601147  | P-value(F)          | 0.060204

During the testing procedure for Gauss-Markov assumption we found evidence of autocorrelation and heteroskedasticity in the model. Thus, we run regression once more with using HAC standard erors. The newly estimated model is presented below:

Table 10. Model 2. OLS with HAC standard errors

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>const</td>
<td>0.0782577</td>
<td>0.233096</td>
<td>0.3357</td>
</tr>
<tr>
<td>$\Delta CAR$</td>
<td>0.733444</td>
<td>0.468023</td>
<td>1.5671</td>
</tr>
</tbody>
</table>
Mean dependent var 0.041092 S.D. dependent var 3.735592
Sum squared resid 1597.480 S.E. of regression 3.695088
R-squared 0.029860 Adjusted R-squared 0.021568
F(1, 117) 2.455839 P-value(F) 0.119789

Model rewritten with coefficient estimated follows:

$$\Delta CLR_t = 0.0782 + 0.733 \times \Delta CAR_t$$

The coefficient estimate implies that 1 percentage point increase in capital adequacy ratio is expected to increase current liquidity ratio by 0.73 percentage point on average. Compared to the magnitude of the parameter estimate from the model with quick liquidity ratio as dependent variable (1.15), it seems that current liquidity is less sensitive to the changes in capital adequacy ratio. The variable capital adequacy ratio is significant at 10% level in regression without HAC standard errors, however not significant in regression with HAC standard errors. We can consider this case as a borderline one, since the p-values for this variable in both regressions are close to 0.1.

From the figure, presented in Appendix (Figure A 8 Model 2. Influence and leverage) we can conclude that observations not only from last crises are affecting the model. Observations from some other years, for example 2010, are crucial as well.

### Model 3. Short-term Liquidity Ratio

The Short-term liquidity model was estimated after running initial regression and applying backward-stepwise selection

**Table 11. Model 3. OLS**

Model 3a: OLS, using observations 2006:02-2015:12 (T = 119)  
Dependent variable: ΔSTLR

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>const</td>
<td>0.46519</td>
<td>0.51840</td>
<td>0.8974</td>
<td>0.3714</td>
</tr>
<tr>
<td>AGDP</td>
<td>1.19089</td>
<td>0.33916</td>
<td>3.5113</td>
<td>0.0006***</td>
</tr>
</tbody>
</table>

Mean dependent var 0.408824 S.D. dependent var 5.917538
Sum squared resid 3738.124 S.E. of regression 5.652413
R-squared 0.095331 Adjusted R-squared 0.087599
F(1, 117) 12.32911 P-value(F) 0.000634

The evidence for heteroskedasticity was found during the process of running B-P and White test, thus the regression is re-runned using HAC standard errors.
Table 12. Model 3. OLS with HAC standard errors

Model 3b: OLS, using observations 2006:02-2015:12 (T = 119)
Dependent variable: ΔSTLR
HAC standard errors, bandwidth 3 (Bartlett kernel)

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>const</td>
<td>0.46519</td>
<td>0.505845</td>
<td>0.9196</td>
<td>0.3596</td>
</tr>
<tr>
<td>ΔGDP</td>
<td>1.19089</td>
<td>0.739653</td>
<td>1.6101</td>
<td>0.1101</td>
</tr>
</tbody>
</table>

Mean dependent var | 0.408824  | S.D. dependent var | 5.917538
Sum squared resid   | 3738.124  | S.E. of regression  | 5.652413
R-squared           | 0.095331  | Adjusted R-squared  | 0.087599
F(1, 117)           | 2.592300  | P-value(F)           | 0.110079

Estimated Model 3 with coefficients is provided:

\[ \Delta STLR_t = 0.47 + 1.19 * \Delta GDP_t \]

The parameter estimate suggests that 1 percentage point increase in GDP growth rate leads to the 1.19 percentage point increase in short-term liquidity on average. Nevertheless, as well as in the previous model, variable GDP can be seen as a borderline case. It is significant at 1% level in the first regression, however in regression with HAC standard errors it is not, but still its p-value is close to 0.1. In any case, we find some evidence of its positive effect on short-term liquidity ratio.

The figure about influence and leverage, presented in Appendix (Figure A 9 Model 3. Influence and leverage), provides us with evidence that, in contrary to the two previous models we can conclude following thing. The observations that have the biggest influence come from year 2009/2010.
10. Conclusion

This thesis examines the causes of the liquidity crises in Ukraine. We build 3 econometric models for three different liquidity ratios taken as dependent variables, using time series data. The set of explanatory variables, which we apply for our analysis consists of both bank specific factors (ROA, ROE, capital adequacy ration, proportion of foreign capital to total bank capital, amount of total assets in the bank industry, etc.) and macroeconomical factors (GDP growth, inflation, discount rate, unemployment, etc.). Based on the results of the stationarity test, we apply first differencing and estimate the differenced equation by OLS. After the estimation, we check various Gauss-Markov assumptions, namely multicollinearity, serial correlation, heteroskedasticity, and normality. Furthermore, we discuss linearity and exogeneity assumption. Lastly, we also plot influential observations along with the observations with the highest leverage.

The results obtained using the available dataset did not prove all of our hypotheses. The analysis shows, that proportion of foreign capital in banks’ to total capital has a positive effect on liquidity. The evidence of this is supported by the sustainability of banks with foreign capital to sustain the crisis. As was mentioned in chapter related to policies discussion, banks with foreign capital appeared to handle the liquidity pressure better. Furthermore, the number of liquidated banks with foreign capital has been lower than for banks with domestic capital. The hypothesis of positive correlation between the capital adequacy ratio and liquidity ratios is supported by the results of the analysis. Since all of these ratios are prudential and are established in order to ensure soundness of the financial system, this conclusion is along with the initial expectation.

On the contrary, the effect of the discount rate appears to be in contradiction with our prediction. We assumed that higher discount rate would lead to lower volume of loans taken by commercial banks from central bank and thus to worse liquidity conditions. However, analysis provided us with evidences that there is positive correlation between the discount rate and liquidity.

The evidences concerning the hypothesis about procyclic character of liquidity are estimated by the research. However it should be defined with cautiousness due to the fact that evidences are not strong.

Based on the procedure of backword-stepwise model selection, none of the other explanatory variables turns out to have any significant effect on selected liquidity ratios.
11. Further Extensions

The set of explanatory variables used in the analysis could be extended – for instance, additional dummy variables could be included allowing for testing additional hypotheses and to avoid endogeneity problem (indicator of dates when credit rating of the Ukraine was changed or indicator of dates when financial aid from IMF was received), violent political incidences or corruption level. Moreover, the number of observations (120 observations) could be significantly increased by collecting weekly or even daily data. Furthermore, the quality of the data would be enhanced if time series were complete and thus linear interpolation could be omitted. As far as econometric methods are concerned, one could consider alternative approaches, namely vector autoregressive models (VAR) or Granger causality to address non-stationarity of the data set differently.

Due to some evidence of non-normality of the data, MLE or Generalized method of moments can be viewed as alternative for econometrics analysis. Last but not least, instrumental variable approach could be considered in order to address potential endogeneity problem due to simultaneity and omitted variables problem.
Bibliography


Appendix

Figure A1 Plots of Explanatory Variables - original values
Figure A.2 Plots of Explanatory Variables after First Differencing
Figure A 3 Plots of first differencing of dependent variables

Table A 1 Model 1. B-P test

<table>
<thead>
<tr>
<th>coefficient</th>
<th>std. error</th>
<th>t-ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>const</td>
<td>1.00212</td>
<td>0.167146</td>
<td>5.995</td>
</tr>
<tr>
<td>d_CAR</td>
<td>0.361177</td>
<td>0.222493</td>
<td>1.623</td>
</tr>
<tr>
<td>d_ROE</td>
<td>-0.0144091</td>
<td>0.0138621</td>
<td>-1.039</td>
</tr>
<tr>
<td>d_DS</td>
<td>-0.00459559</td>
<td>0.178859</td>
<td>-0.02569</td>
</tr>
</tbody>
</table>

Explained sum of squares = 11.6485
Test statistic: LM = 5.824272, with p-value = \( P(\text{Chi-square}(4) > 5.824272) = 0.212662 \)
### Table A 2 Model 1. White’s test

White’s test for heteroskedasticity  
Dependent variable: $uhat^2$

<table>
<thead>
<tr>
<th>coefficient</th>
<th>std. error</th>
<th>t-ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>const</td>
<td>10.8080</td>
<td>2.16650</td>
<td>4.989</td>
</tr>
<tr>
<td>d_CAR</td>
<td>7.31025</td>
<td>3.25319</td>
<td>2.247</td>
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<tr>
<td>d_ROE</td>
<td>-0.0705106</td>
<td>0.223765</td>
<td>-0.3151</td>
</tr>
<tr>
<td>d_DS</td>
<td>-0.657840</td>
<td>3.61932</td>
<td>-0.1818</td>
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<tr>
<td>d_FOR</td>
<td>0.0956139</td>
<td>2.10046</td>
<td>0.04552</td>
</tr>
<tr>
<td>sq_d_CAR</td>
<td>1.47899</td>
<td>1.99453</td>
<td>0.7415</td>
</tr>
<tr>
<td>X2_X3</td>
<td>-0.313216</td>
<td>0.276468</td>
<td>-1.133</td>
</tr>
<tr>
<td>X2_X4</td>
<td>-1.94477</td>
<td>2.31055</td>
<td>-0.8417</td>
</tr>
<tr>
<td>X2_X5</td>
<td>-1.62163</td>
<td>2.53880</td>
<td>-0.6387</td>
</tr>
<tr>
<td>sq_d_ROE</td>
<td>-0.00397568</td>
<td>0.00536655</td>
<td>-0.7408</td>
</tr>
<tr>
<td>X3_X4</td>
<td>-0.132518</td>
<td>0.188996</td>
<td>-0.7012</td>
</tr>
<tr>
<td>X3_X5</td>
<td>-0.0399347</td>
<td>0.164950</td>
<td>-0.2421</td>
</tr>
<tr>
<td>sq_d_DS</td>
<td>-0.388681</td>
<td>1.77790</td>
<td>-0.2186</td>
</tr>
<tr>
<td>X4_X5</td>
<td>-0.326893</td>
<td>1.81097</td>
<td>-0.1805</td>
</tr>
<tr>
<td>sq_d_FOR</td>
<td>-0.0977905</td>
<td>0.759843</td>
<td>-0.1287</td>
</tr>
</tbody>
</table>

Unadjusted R-squared = 0.077163  
Test statistic: $TR^2 = 9.182350$,  
with p-value = $P(\text{Chi-square}(14) > 9.182350) = 0.819195$

### Table A 3 Model 2. B-P test

Breusch-Pagan test for heteroskedasticity  
OLS, using observations 2006:02-2015:12 (T = 119)  
Dependent variable: scaled $uhat^2$

<table>
<thead>
<tr>
<th>coefficient</th>
<th>std. error</th>
<th>t-ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>const</td>
<td>1.00884</td>
<td>0.148267</td>
<td>6.804</td>
</tr>
<tr>
<td>d_CAR</td>
<td>0.174449</td>
<td>0.168895</td>
<td>1.033</td>
</tr>
</tbody>
</table>

Explained sum of squares = 2.78159  
Test statistic: $LM = 1.390797$,  
with p-value = $P(\text{Chi-square}(1) > 1.390797) = 0.238271$

### Table A 4 Model 2. White’s test

White’s test for heteroskedasticity  
OLS, using observations 2006:02-2015:12 (T = 119)  
Dependent variable: $uhat^2$

<table>
<thead>
<tr>
<th>coefficient</th>
<th>std. error</th>
<th>t-ratio</th>
<th>p-value</th>
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</thead>
<tbody>
<tr>
<td>const</td>
<td>13.1473</td>
<td>2.03132</td>
<td>6.472</td>
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<tr>
<td>d_CAR</td>
<td>4.03381</td>
<td>2.85118</td>
<td>1.415</td>
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<tr>
<td>sq_d_CAR</td>
<td>0.624598</td>
<td>0.637989</td>
<td>0.9790</td>
</tr>
</tbody>
</table>

Unadjusted R-squared = 0.017157  
Test statistic: $TR^2 = 2.041666$,  
with p-value = $P(\text{Chi-square}(2) > 2.041666) = 0.360295$
### Table A 5 Model 3. B-P test

Breusch-Pagan test for heteroskedasticity  
OLS, using observations 2006:02-2015:12 (T = 119)  
Dependent variable: scaled uhat^2

<table>
<thead>
<tr>
<th>coefficient</th>
<th>std. error</th>
<th>t-ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>const</td>
<td>1.06665</td>
<td>0.857294</td>
<td>1.244</td>
</tr>
<tr>
<td>d_GDP</td>
<td>1.40787</td>
<td>0.560875</td>
<td>2.510</td>
</tr>
</tbody>
</table>

Explained sum of squares = 550.535  
Test statistic: LM = 275.267645,  
with p-value = P(Chi-square(1) > 275.267645) = 0.000000

### Table A 6 Model 3. White’s test

White’s test for heteroskedasticity  
OLS, using observations 2006:02-2015:12 (T = 119)  
Dependent variable: uhat^2

<table>
<thead>
<tr>
<th>coefficient</th>
<th>std. error</th>
<th>t-ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>const</td>
<td>-19.4578</td>
<td>29.1908</td>
<td>-0.6666</td>
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<tr>
<td>d_GDP</td>
<td>58.7539</td>
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<td>3.425</td>
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<tr>
<td>sq_d_GDP</td>
<td>22.9645</td>
<td>6.12652</td>
<td>3.748</td>
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</table>

Unadjusted R-squared = 0.153618  
Test statistic: TR^2 = 18.280572,  
with p-value = P(Chi-square(2) > 18.280572) = 0.000107

### Table A 7 Model 1. Breusch-Godfrey test

Breusch-Godfrey test for autocorrelation up to order 3  
OLS, using observations 2006:02-2015:12 (T = 119)  
Dependent variable: uhat

<table>
<thead>
<tr>
<th>coefficient</th>
<th>std. error</th>
<th>t-ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>const</td>
<td>-0.0182777</td>
<td>0.318355</td>
<td>-0.05741</td>
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<tr>
<td>d_CAR</td>
<td>-0.0547699</td>
<td>0.425249</td>
<td>-0.1288</td>
</tr>
<tr>
<td>d_ROE</td>
<td>-0.0106931</td>
<td>0.0283903</td>
<td>-0.3766</td>
</tr>
<tr>
<td>d_DS</td>
<td>-0.0196021</td>
<td>0.347424</td>
<td>-0.05642</td>
</tr>
<tr>
<td>d_FOR</td>
<td>0.0120452</td>
<td>0.283963</td>
<td>0.04242</td>
</tr>
<tr>
<td>uhat_1</td>
<td>-0.106468</td>
<td>0.100899</td>
<td>-1.055</td>
</tr>
<tr>
<td>uhat_2</td>
<td>-0.115234</td>
<td>0.0993327</td>
<td>-1.160</td>
</tr>
<tr>
<td>uhat_3</td>
<td>-0.0246847</td>
<td>0.0985367</td>
<td>-0.2505</td>
</tr>
</tbody>
</table>

Unadjusted R-squared = 0.019407  
Test statistic: LMF = 0.732265,  
with p-value = P(F(3,111) > 0.732265) = 0.535  
Alternative statistic: TR^2 = 2.309418,  
with p-value = P(Chi-square(3) > 2.30942) = 0.511  
Ljung-Box Q’ = 1.89972,  
with p-value = P(Chi-square(3) > 1.89972) = 0.593
Table A 8 Model 2. Breusch-Godfrey test

Breusch-Godfrey test for autocorrelation up to order 3
OLS, using observations 2006:02-2015:12 (T = 119)
Dependent variable: uhat

<table>
<thead>
<tr>
<th>coefficient</th>
<th>std. error</th>
<th>t-ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>const</td>
<td>-0.0255171</td>
<td>0.314838</td>
<td>-0.08105</td>
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<td>d_CAR</td>
<td>-0.222720</td>
<td>0.365961</td>
<td>-0.6086</td>
</tr>
<tr>
<td>uhat_1</td>
<td>-0.412852</td>
<td>0.0949894</td>
<td>-4.346</td>
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<tr>
<td>uhat_2</td>
<td>-0.270546</td>
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<tr>
<td>uhat_3</td>
<td>-0.0275028</td>
<td>0.0967474</td>
<td>-0.2843</td>
</tr>
</tbody>
</table>

Unadjusted R-squared = 0.161493

Test statistic: LMF = 7.318633, with p-value = P(F(3,114) > 7.31863) = 0.000157

Alternative statistic: TR^2 = 19.217644, with p-value = P(Chi-square(3) > 19.2176) = 0.000246

Ljung-Box Q’ = 15.4574, with p-value = P(Chi-square(3) > 15.4574) = 0.00146

Table A 9 Model 3. Breusch-Godfrey test

Breusch-Godfrey test for autocorrelation up to order 3
OLS, using observations 2006:02-2015:12 (T = 119)
Dependent variable: uhat

<table>
<thead>
<tr>
<th>coefficient</th>
<th>std. error</th>
<th>t-ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>const</td>
<td>0.00144928</td>
<td>0.523443</td>
<td>0.002769</td>
</tr>
<tr>
<td>d_GDP</td>
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<td>0.346924</td>
<td>-0.05270</td>
</tr>
<tr>
<td>uhat_1</td>
<td>-0.0591531</td>
<td>0.0936988</td>
<td>-0.6313</td>
</tr>
<tr>
<td>uhat_2</td>
<td>-0.0309085</td>
<td>0.0944575</td>
<td>-0.3272</td>
</tr>
<tr>
<td>uhat_3</td>
<td>-0.0525771</td>
<td>0.0940851</td>
<td>-0.5588</td>
</tr>
</tbody>
</table>

Unadjusted R-squared = 0.006642

Test statistic: LMF = 0.254099, with p-value = P(F(3,114) > 0.254099) = 0.858

Alternative statistic: TR^2 = 0.790445, with p-value = P(Chi-square(3) > 0.790445) = 0.852

Ljung-Box Q’ = 0.754182, with p-value = P(Chi-square(3) > 0.754182) = 0.86
Figure A 4 Model 1. Normality

Test statistic for normality:
Chi-square(2) = 7.500 [0.0235]

Figure A 5 Model 2. Normality

Test statistic for normality:
Chi-square(2) = 4.089 [0.1295]
Figure A 6 Model 3. Normality

Figure A 7 Model 1. Influence and leverage
Figure A 8 Model 2. Influence and leverage

Figure A 9 Model 3. Influence and leverage