CREDIT RISK AND LIQUIDITY RISK: ARE THEY PRICED INTO OVERNIGHT CREDITS OF COMMERCIAL BANKS IN UKRAINE?

by

Natalia Tovstopyat

A thesis submitted in partial fulfillment of
the requirements for the degree of

Master of Arts in Economics

National University "Kyiv-Mohila Academy"
Economics Education and Research Consortium
Master's Program in Economics

2004

Approved by _____
Ms. Svitlana Budagovska (Head of State Examination Committee)

_____

_____

_____

Program Authorized
to Offer Degree Master's Program in Economics, NaUKMA _____

Date _____

National University "Kyiv-Mohila Academy"

Abstract

CREDIT RISK AND LIQUIDITY RISK: ARE THEY PRICED INTO OVERNIGHT CREDITS OF COMMERCIAL BANKS IN UKRAINE?

by Natalia Tovstopyat

Head of State Examination Committee: Ms. Svitlana Budagovska, Economist, World Bank of Ukraine

Proper risk management is one of the main pillars of financial health of the banks. But traditional techniques for credit risk assessment, widely used by commercial banks and other interested agents, have their limitations. One of such drawbacks is that they analyze credit risk of particular bank, based on information of previous periods, and not at the moment of the transaction. In light of the need for more operative indicators of bad risks, the results of this thesis would be very significant for commercial banking industry. In particular, the thesis investigates the significance of the relationship between credit and liquidity risks and interest rates on overnight credits of commercial banks in Ukraine. Panel data was used to determine the effect of credit risk on the bid price of overnight credits on inter-bank market. The results of the estimation show that overnight interest rates, set by banks in Ukraine, are indeed incorporating information both on credit and liquidity risks. This is an important finding for further development of risk management techniques, which could be used for providing new important source of information both for risk managers of commercial banks and for the Supervisors of the banking industry.

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

Number *Page*

Figures

Tables

LIST OF APPENDIX FIGURES AND TABLES

Number *Page*

Figures

Tables

ACKNOWLEDGMENTS

I would like to express my sincere gratitude to my advisor Prof. Iryna Lukyanenko for her careful supervision and friendly encouragement through the whole process of conducting research. I also thank Dr. Julie McKay and my research workshop professors Dr. Tom Coupe, Prof. Volodymyr Bilotkach, Dr. Israel Luski and Dr. Valentin Zelenyuk for their thorough reviews and valuable comments. I give my special thanks for Alpha Bank's Risk Manager Igor Shimansky for his kindness in providing necessary data for this research. I give my special thanks to God for His help and provision, and for my husband Andriy Tovstopyat for his gentle support while this not easy period of thesis writing.

GLOSSARY

Credit Risk is the risk of incurring losses by bank due to the default of counterparties (Bessis 1998);

Current Liquidity is the ratio of current liquid assets to sum of liabilities on demand and one month liabilities;

Market Risk is the risk of adverse deviations of market value of transactions due to market moves (Bessis 1998);

Current Liquidity is the ratio of current liquid assets to the sum of liabilities on demand and liabilities up to one month;

Overnight Credits – funds on the inter-bank market lent or borrowed for up to one day;

Federal Funds Market – inter-bank market in the United States of America.

Chapter 1

INTRODUCTION

The banking system is one of the most important financial intermediaries in the economy of Ukraine. Banks facilitate economic growth by transferring funds from people who have an excess of available funds to borrowers with productive investment opportunities.

Risk management is one of the key functions of the bank. Those banking institutions, which analyze risks more consciously, protect themselves from negative events, thus obtaining comparative advantage over competitors. That is why careful risk assessment is important both on macro- and micro-level.

Today, rapid evolution of risk management is one of the major world trends in the banking industry. Risks are better defined; control is more active; quantitative assessments of risks become more important. It is now possible to monitor number of banking risks, which could not be measured before because of the deficiencies of information systems. But still, a lot of research has to be done in the area of more careful risk measurement.

In this context, the **goal of this thesis** is to check *the significance of the relationship between credit and liquidity risks and interest rates on overnight credits*. It is an important issue, since traditional techniques, used for assessing credit risk of the banks have some drawbacks. One of them is that usually banks monitor other banks (counterparties) by

analyzing balance sheets, which are sent once a month. And when a manager of the bank assesses risks of the counter-parties at the current point in time (at the moment of transaction), he (or she) uses financial information only on the previous months. So, any additional information, which could help to determine the current level of credit and liquidity risks taken by banks, would be quite useful.

Early signals of an increase in credit and liquidity risks, taken by commercial banks would be useful for Supervisors of banking industry as well. Although Bank Supervisors conduct very detailed on-site examinations of commercial banks, they do it rather rarely. So, Supervisors could make better analysis of bank' performance, if daily information on overnight credits was a valuable contribution to credit and liquidity risks measurement.

The idea and economic intuition of our research question are based on the assumption that *interest rates* on overnight credits contain important *information*, which could be used by banks for more careful identification and measurement of risks taken by other banks (counterparties). This assumption, in turn, reflects the idea that market on overnight loans summarizes information, obtained through using commercial *banks as monitors of other banks*. Commercial banks may be viewed as peers; they are familiar with the general situation in the banking industry, as well as with trends in the behavior of particular banks. So, commercial banks are forced by market to set such bid and ask prices, which reflect true situation in particular bank.

It is logical to assume that the higher is the probability of having problems with bad credits and liquidity of a given bank, the higher is the credit risk of that bank at the moment of transaction. Also, it

means that such a bank would be more willing to get funds on the inter-bank market, and would propose higher price for getting needed funds (so the higher bid interest rate would be set).

A review of the literature discusses these and related ideas in the next chapter of thesis. Then, in Chapter 3, we present the theoretical model for testing the hypothesis of interest. Econometric methodology and empirical analysis will be described in Chapter 4, and conclusions, based on the results will be stated in Chapter 5.

To summarize, this thesis tests **two hypotheses**:

1) that credit risk is priced into overnight credits of commercial banks in Ukraine;

2) that liquidity risk is priced into overnight inter-bank credits.

No previous research has been done in this area for Ukraine. This paper provides the first empirical examination of the relationship between interest rates on overnight credits and the assessment of credit and liquidity risks of Ukrainian commercial banks.

If hypotheses are confirmed, it implies banks monitor other banks and it would be possible to propose a new approach for more careful assessment of credit risk of banks, which could be useful both for commercial bank managers and for supervisory agencies in Ukraine.

And if the results of the estimation reject either stated hypotheses, it would be useful to conduct an analysis of why a theoretically sound assumption is not confirmed in Ukraine.

Chapter 2.

LITERATURE REVIEW

In this Chapter we:

- Review the importance of the banking industry for the economy, and consider the role of adequate risk management;
- Provide basic definitions, used in literature for most important types of risk;
- Describe major world trends in risk management practices and policies;
- Evaluate methods of risk measurement and monitoring, considering their advantages and disadvantages;
- Review existing empirical evidence on the relationship between bank credit risk and overnight interest rates.

2.1. Importance of the Risk Management in Banking Industry

As Mishkin (2000) describes in his book, banking institutions are very important in facilitating economic development of the country. Banks help to overcome the major impediments to financial intermediation: the problems of adverse selection and moral hazard.

Adverse selection problem can be explained with the help of the following idea: those clients with the worst investment projects and

highest credit risks are the most active in their attempts to get a loan. Commercial banks examine carefully the credit history and financial statements of potential borrowers, thus eliminating adverse selection problem.

Moral hazard problem stems from the fact, that as borrowers get money, they tend to engage in risky projects and use loan for other than the agreed purposes. To eliminate this problem, banks impose substantial restrictions on the behavior of the borrower.

It should be mentioned, however, that banks themselves could evoke their own moral hazard problem. This problem is touched by Berger *et al.* (1998). As banks have collected money from depositors, they may take on too much risk with depositors' funds, since risky assets may induce higher profits. But risk also implies greater probability of loss. Thus, to avoid potential losses from risky projects, bank should develop efficient risk management procedures.

The role of adequate risk measurement has attracted the attention of researchers and practically oriented authors. The book by Bessis (1998), widely used in modern risk management, summarizes the nature, definitions and interrelation between major banking risks and states that "credit risk is paramount in terms of the importance of potential losses".

Bessis (1998) argues that the main financial risks are interest rate risk, market risk, liquidity risk and credit risk.

Interest rate *risk* is the risk of declines of earnings due to the movements of interest rates. Interest rates have an impact on revenues and costs generated by on-balance sheet or off-balance sheet items.

***Market** risk* is the risk of adverse deviations of market value of transactions due to market moves. It is now subject to capital constraint regulations imposed on banks.

***Liquidity** risk* is often defined in different meanings:

-extreme liquidity (fatal risk or bankruptcy risk, which, however, is often the outcome of other risks),

-the safety cushion provided by the portfolio of liquid assets (the risk that short-term asset values are not sufficient to match short-term liabilities or unexpected outflows),

- the ability to raise funds at a reasonable cost. (Such ability is actually the outcome of two types of factors: the market liquidity, which varies over time, and the liquidity of the bank. Both interact to determine the conditions of funding).

Credit risk is the risk of incurring losses due to the default of counterparties. It is the oldest and, perhaps, the most important risk for banks. Credit risk is also the risk of a decline in the credit standing of the counterparty. Such deterioration does not necessarily imply default, but means that the probability of default increases.

2.2. Trends and Methods issues

Credit risk is normally monitored through classical procedures in banks: putting a ceiling on the amount lent to customers within certain industry in a given country, careful examination of credit applications, conducted by credit officers or credit committees, who reach agreement before a risk-taking decision is made. Central reporting of

outstanding loans to customers is required to ensure that amounts "at risk" stay within set limits.

Similar balance sheet analysis procedures are used in the assessment of credit risk of banks-counterparties: setting limits on the amount loaned to given bank, monitoring of the quality of balance sheets and checking whether quantity of lending, is within the limit.

Bessis (1998) shows, that even though such procedures are well-developed and are assumed to be classical, they have several serious drawbacks, which, if ignored, could lead to critical problems in credit risk measurement.

One of these drawbacks is that balance sheet analyses can not provide operative enough immediate information for analyzing the measure of credit risk of the bank-counterparty. Since balance sheets are available only on monthly basis, the quality of balance sheets of borrowers at the time of default may not be known in advance and, therefore, the actual amount "at risk" can not be measured precisely.

Thus, the credit risk, the oldest of all risks for banks, is difficult to quantify and any additional information is quite useful.

Careful risk assessment is important both on micro- and macro-levels. The more accurate is the prediction of possible adverse effects on bank's performance – the healthier is the banking system, the better is financing of attractive investment projects and the greater is social welfare.

Banking institutions, as well as government supervisors, monitor the financial condition of banks. If depositors were able to monitor bank's

activities easily, they would immediately withdraw their money if a bank takes on too much risk. But since it is difficult for depositors to acquire and analyze effectively all necessary information on banks' activities, the supervision of commercial banks is an important task for government.

Major methods of bank supervision are chartering (screening of proposals of newly established banks) and regular on-site examinations of all banks. By monitoring the bank's compliance with capital requirements and restrictions on asset holdings, regulators acquire necessary information to decide whether they should use their imperative power to alter bank's behavior.

Traditionally, on-site examinations were based on assessment of the quality of the bank's balance sheet at a point in time. But, the development of new financial instruments and markets, as well as rapidly changing financial environment, imposes need for assessment of potential risks of banks. That is why today regulators put more attention on evaluating the soundness of risk management in banks (as described in the article by Sushko (2003)).

Zahra el MekKawy (2003) also emphasizes, that today, one of the major world trends is the increase in the role of evaluation of risk management practices in banks. He argues that "Promoting stronger risk management practices in banks" is the fundamental goal of the Basel Committee's efforts to revise Basel Capital Accord.

Many recent studies emphasize the role of market information in a more proper assessment of risks by government supervisors. Bergen, Davies and Flannery (1998) showed that although government supervisors may use confidentional information from on-site

examination of banks, their assessments are much less accurate overall than nongovernmental rating agencies' assessments of future performance of banks, but that supervisors may be more accurate, when inspections are recent.

Rating agencies, which represent interests of market participants, make use of public information sources, including regulatory reports of banks, and information from equity and bond markets. Bergen et al. (1998) suggest that since supervisors and market participants have different incentives of monitoring, they may place different relative weights on the current financial condition of the banks in their assessments. Government supervisors are more interested in preventing systematic failures, while rating agencies are primarily interested in the potential of profits. So if, for example, bank is in the poor financial condition, but it has started to improve its condition, government supervisor may not report that this bank has a good supervisory rating. Rating agencies, in contrast, put more weight on expected improvements in condition and are more likely to give higher rating to this bank.

Krainer and Lopez (2002) emphasize that both on-site monitoring (based on detailed examination of a bank's condition during about one on-site visit per year) and off-site monitoring (based on regular analyses of reporting forms) have their advantages and limitations.

Careful examinations by supervisors provide a good quantitative measurement of risk at a given point in time. But since such a detailed analysis is not conducted very often, it may not capture certain changes and trends in the risk profiles of banks. That is why Krainer

and Lopez find it useful to include financial market information, available on daily basis, into supervisory monitoring models.

2.3. Empirical Evidence Description

Empirical evidence from Czech Republic, presented by Hanousek and Roland (2001), supports the idea of the importance of including market-based information into the assessment of risks. These authors found that the differences in interest rates paid on deposits between sound and problematic banks were significant and increasing along with higher probabilities of default. Czech banks, in the situation of financial distress, were hiding information from the regulators, thus making it more difficult to detect the high probability of failure of those banks. At the same time, these problematic banks engaged in covering up bad loans and were offering a higher rate of interest in order to attract deposits. So, these authors suggest that higher deposit rate may act as an early warning signal of bank distress.

The importance of better analyses of so-called systemic risk (which reflects the probability of default of banks linked to other banks through inter-bank loans) is provided in a paper by Rochet and Tirole (1996). These authors show that bank' mutual claims, which they call "inter-bank loans" or "inter-bank transactions", have grown substantially in recent years. Inter-bank loans include intraday debits on payment systems, overnight and term inter-bank lending, etc. It is not clear, however, which type of inter-bank lending agreements could be best used for discovering information on credit risk of commercial banks.

Hamilton (1996) argues that overnight inter-bank lending represent the shortest-term security, that is actively traded, and, thus, form the base of any term structure relation.

Calomiris (1998) suggests reasons for using banks as monitors of other banks might help to reveal important market information for supervisors. Since commercial banks are homogeneous by nature, they can better identify the riskiness of other banks-counterparties. Furfine (2001) investigates whether peer monitoring of commercial banks can be effectively used. He provides the first empirical examination of the pricing of inter-bank lending agreements by using evidence from the overnight inter-bank loans in the USA. Furfine's paper is consistent with the idea of Hamilton (1996) in that using overnight market is a "particularly attractive place to examine the pricing of inter-bank lending", since overnight transactions are much less complicated than other inter-bank contracts.

Furfine found that differences in borrower credit risk are reflected in the interest rate charged. Banks with lower profitability, more problem loans and higher probability of financial distress offer higher interest rates when they borrow overnight.

Mishkin (2000), however, emphasizes that interest rates are not able to price credit risk adequately when the probability of default of the bank-counterparty is very high. Mishkin (2000) provides an argument of why, in case of very high probability of default, interest rates, offered for overnight credit by problematic bank, are not much different from those rates, offered by a bank with a healthy financial condition. Problematic banks do not want to give a clear signal to the market that they have serious difficulties.

This explanation might be seen as contradiction to the evidence of Czech Republic, presented by Hanousek and Roland (2001), where banks in face of very high probability of default offered higher interest rate in order to attract more deposits to cover bad loans. This strategy can be successful when bank attract clients, who are not so good experts in recognizing asymmetric information problem. But in case of inter-bank lending other banks can effectively recognize the very high possibility of default behind unusually high overnight interest rate offers, so banks are better not to be caught as outliers.

Another issue arises from the remarks of Furfine and Mishkin regarding the lack of reflection of extremely high default probability of commercial bank in the interest rates differences: why use a model which does not predict extreme outcomes of default? But the goal of this thesis is to determine whether credit and liquidity risks (in the meaning of the risk of a decline in the credit standing of a counter-party, which not necessarily imply default) is priced into interest rates on overnight inter-bank lending. That is why to develop and test the hypotheses; we made use of Furfine's (2001) findings

Chapter 3

THEORETICAL FRAMEWORK OF EMPIRICAL MODEL

3.1. The Basic Model and the Hypothesis

The main question we aim to answer in this thesis is` whether credit and liquidity risks are priced into overnight credits of commercial banks in Ukraine. Specifically, we state our two Hypotheses for testing as:

I) H_0: credit risk has no effect on bid quote of overnight interest rate;

H_1: credit risk has positive and significant effect on bid quote of overnight interest rate.

II) H_0: liquidity risk has no effect on the price of overnight inter-bank credit;

H_1: liquidity risk has positive and significant effect on the price of overnight inter-bank credit.

To test the stated hypotheses, we will employ the empirical model, in which the overnight interest rate (bid quote) is a dependent variable and the independent variables include credit and liquidity risk indicators. The study by Furfine (2001) provides a nice starting point for choosing model specification for our hypothesis.

Main Guidelines of Furfine's Model

We will explain why these variables are considered to be relevant, and what the expected signs of the coefficients are later, while

describing our own specification. For now, we will just briefly outline the general idea of the basic study by Furfine.

As the dependent variable Furfine uses the interest rate on the given transaction on the inter-bank (federal funds) market, specified in annual terms.

The Hypothesized Determinants of the Overnight Interest Rate of Transaction presented by several sets of independent variables:

- Credit Risk of Borrowing Bank. We have to note that there is no single measure of credit risk, so we use three different proxies (profitability of the commercial bank, its loan quality and capitalization of the bank) to capture different aspects of the notion "credit risk". Profitability reflects the general relationship between riskieness of bank operations and profits; loan quality emphasizes the nature of credit risk, while capitalization is used to control for wealth of bank in given month. So, even if we could suspect multicollinearity problem with this variables (called proxies for convenience), here it is not the case.

- Borrower and lender characteristics: The first set of control variables include the market share of particular borrowing bank; a dummy variable indicating whether or not the borrowing bank is also a dealer in the funds market (here dealer means that bank uses borrowed on inter-bank market funds to lend to other banks); also identical set of characteristics for lending bank was included into the regressions.

- Transaction characteristics. The third set of control variables measures the characteristics of the transaction: the size of the particular transaction, the share of given transaction in the whole amount of transactions for a given time, the duration of the federal funds loan.

- Borrower and lender relationships. The fourth set of control proxies for the relationship that may exist between borrower and seller of funds. The relationships were measured by the number of transactions between the given pair of banks and by the number of days on which the given pair transacted.

- Day of sample. Finally, dummy variables for each of the business days, considered in Furfine's study, were included in his model to isolate the effects of market movements, not captured by other variables, but influencing overnight interest rate.

So, Furfines uses very detailed sets of explanatory variables, which requires a huge amount of very detailed and accurate data. Unfortunately, we do not have access to such detailed data (see description of the data in the next Chapter), and that is why for our estimation we use our variant of this basic model. Specification of our Model for estimation follows.

3.2. 1 Specification of Model for Estimation (Hypothesis I)

Our goal is to check the significance of relationship between credit and liquidity risks and bid quote of overnight credits in Ukraine. We use a variant of model, proposed by Furfine to check the influence of credit risk on the bid overnight rate and stated our Hypothesis I:

I) H_0: credit risk has no effect on bid quote of overnight interest rate;

H_1: credit risk has positive and significant effect on bid quote of overnight interest rate.

Our model differs from the model, proposed by Furfine, in several important respects. First of all, we can not take into account some borrower and lender characteristics, because we do not have access to such detailed information. For the same reason we do not use variables for transaction characteristics and for relationships between banks. Such deficiency may lead to somewhat different results of our empirical estimation compared to results obtained by Furfine. But, since our primary interest is in estimating the effect of credit and liquidity risks on the bid price set by bank for overnight credit, we focus on those results.

Secondly, although Furfine includes market share of the bank on the inter-bank market, we think that this variable is not relevant for our data. Furfine has a lot of banks in his sample, while we have data only for 9 banks over 3 years.

Finally, it is important to note, that Furfine uses daily frequency of data and considers characteristics of each transaction between lender sand borrowers on inter-bank market. He uses information on such transactions from Fedwire – the large transfer system, operated by the Fed. So, Furfine considers not just the bid quote of transaction, but the actual rate, at which agreement between lending and borrowing bank was reached. Unfortunately, we do not have access to such detailed information, and can not consider actual rate of transaction. But we assume that since bid quote reflects the willingness of bank to get funds on the inter-bank market, it is a good indicator of riskieness

of the transactions for particular bank. Moreover, we may refer to the practice of commercial banks in Ukraine. As Risk Managers of Alfa Bank (Ukraine) say, usually funds are borrowed to the bank at that bank' bid quote for funds. So, recognizing deficiency of our data, we proceed with the bid quote for overnight credits as a dependent variable.

Now let us state our model formally. The benchmark equation for is:

$$Y_{it} = \mu_i + \beta 1*ROA_{it} + \beta 2*LQ_{it} + \beta 3*CAP_{it} + \beta 4*MSh_{it} + \beta_t d_{it} + u_{it} \quad (3.1)$$

where

Y_{it} – average interest rate on overnight credit (bid quote), set by bank *i* in period *t*;

ROA_{it} - profitability of commercial bank *i* in period *t* (measured as returns on assets);

LQ_{it} – loan quality of bank *i* in period *t* (measured as bad loans to total loans)*;

CAP_{it} – bank *i* capitalization in period *t* (measured as total capital to risk-weighted assets);

MSh_{it} – market share of bank *i* on the inter-bank market in period *t*;

d_{it} – dummy, indicating the month *i* of the sample for bank *i*;

μ_i – specific effect of bank *i*;

u_{it} – error term.

* See the precise definition of variables in the Table 1 below.

This model uses panel data for estimation. We incorporate into the model time specific dummies for each month considered in the sample in order to account for all other possible market influences on interest rate, set by commercial bank for getting an overnight credit. Also, we assume the presence of bank specific fixed effects in the model, due to heterogeneity of the banks (in the next Chapter we will conduct special test (F-test) for determining, whether such a fixed effect specification is correct).

There also exists a strong possibility of sample selection problem, since we could think that banks would borrow more funds on overnight market only if they face higher credit risks (so we might observe high interest rate only when there are high credit risk). But in our case this suspicion is not confirmed, since borrowing overnight on inter-bank market is widely practiced, is relatively cheap and common for practically all banks. So even if the bank does not face problematic credit risks, still it will be present on this market.

Now, let's look at our set of regressors for the Hypothesis I more carefully, and discuss the theoretically justified expected signs of the coefficients. Table 1 provides definitions of variables used in our model.

What is the expected impact of our regressors on the overnight interest rate?

- *Return on Assets* is expected to have positive impact on the quoted bid interest rate since it is widely accepted in finance indicator of the riskiness of the bank. And so, the greater risk the bank takes on, the more it seems eager to obtain funds, which should result in higher bid quote;

Table 1. Definitions of Variables for the Model

Variable	Definition
Borrower' Credit Risk	
Return on Assets	Net income divided by total assets
Loan quality	Loans past due more than 90 days and non-accruing loans of the bank as proportion of total loans
Capitalization	Ratio of a bank total capital to risk-weighted assets
Market Share	
Market Share of the bank on inter-bank market	Ratio of amount of credits received by bank on inter-bank market to total size of inter-bank market

- *Loan quality* is defined as share of relatively "bad" loans to total amount of loans, so it reflects negatively the quality of bank loans. This is the most important variable of interest for us, as we are trying to determine the impact of credit risk on price of overnight credits. So, we expect to observe positive influence on the rate (the higher is the proportion of bad loans to total amount of loans, the higher is credit risk, thus banks should impose higher bid rate. Note, that we could suspect multicollinearity problem here (since return on assets could capture some effect of the loans quality, as it seems that the higher return on assets, the better was the quality of loans). But, as we already mentioned, these two variables reflect different aspects of credit risk, and, also, the higher return on assets not necessarily imply better loan quality (in fact, the impact is ambiguous: on the one hand, better quality of loans reduces potential and actual losses

of the bank, but, on the other hand, more risky loans pay more, thus increasing return on assets). So, we leave both variables in our model;

- *Capitalization* is expected to have negative impact on the bid quote of interest rate, since the higher the capitalization ratio, then the lower the risk for loans in overcoming credit risk problems. Hence, inverse relationship between the stated bid price on overnight credits and capitalization is expected;

- In the model, proposed by Furfine, *Market Share* also is expected to have negative influence on the interest rate. But we think that for our sample of data, which includes only 9 banks, this variable should not have significant impact on the dependent variable. So, in our final specification we drop this variable. But, in order to compare our results with results of Furfine, we leave market share as one of the regressors in the first specifications of our model.

3.2. 2 Specification of the Model for Estimation (Hypothesis II)

In our second hypothesis we assume that the price of the overnight credits set by bank should reflect not only credit risks, taken by bank, but also liquidity risk. This is because liquidity problems, which a bank may face, are serious for short-term operation management. Such banks are eager to get money as fast as possible to increase short-term liquidity, borrowing overnight. This proposition was not considered by Furfine explicitly, but we expect that the short term nature both of overnight inter-bank market and of liquidity risk will influence the quoted bid price. Thus, this additional specification of our model follows.

Hypothesis II:

H_0: liquidity risk has no effect on the price of overnight inter-bank credit;

H_1: liquidity risk has positive and significant effect on the price of overnight inter-bank credit.

Note, that there are three basic ways to measure liquidity risk: we can consider instantaneous liquidity, current liquidity or common liquidity (see Table 2 for exact definitions of these three measures of liquidity).

Table 2. **Possible Ways to Measure Liquidity**

Variable	**Definition**
Liquidity	
Instantaneous liquidity	Ratio of highly liquid assets (assets, which can be transfered into cash in 1-2 days) to liabilities on demand
Current liquidity	Ratio of current liquid assets (assets, which can be transferred into cash in up to one month) to sum of liabilities on demand and one month liabilities
Common liquidity	Share of current liquid assets in total amount of net assets

Although we have data on all this three indicators, we argue that the most relevant here is current liquidity. Firstly, it considers amount of liabilities (in the denominator) up to one month, and we aggregate data on overnight rate on monthly basis. Secondly, in contrast to common liquidity, current liquidity shows how much liquid assets bank has to cover

its short-term liabilities, while common liquidity shows just a proportion of liquid assets in total assets. Thus, current liquidity better reflects the risk of not paying back the liabilities of bank, and we are interested in the determining the influence of risk on bid rate of overnight credits. Finally, since all these three measures are highly correlated, we cannot include all of them in our model, because we want to avoid multicollinearity problems. We will discuss econometric issues in more detail in next Chapter, and here provide additional theoretical specification of our Model for testing Hypothesis II:

$$Y_{it} = \mu_i + \beta 1*ROA_{it} + \beta 2*LQ_{it} + \beta 3*CAP_{it} + \beta 5*LC_{it} + \beta 4*MSh_{it} + \beta_t d_{it} + u_{it} \quad (3.2)$$

where

Y_{it} – average interest rate on overnight credit (bid quote), set by bank *i* in period *t*;

ROA_{it} - profitability of commercial bank *i* in period *t* (measured as returns on assets);

LQ_{it} – loan quality of bank *i* in period *t* (measured as bad loans to total loans)*;

CAP_{it} – bank *i* capitalization in period *t* (measured as total capital to risk-weighted assets);

LC_{it} – current liquidity of bank *i* in period *t*;

MSh_{it} – market share of bank *i* on the inter-bank market in period *t*;

d_{it} – dummy, indicating the month *i* of the sample for bank *i*;

μ_i – specific effect of bank *i*;

u_{it} – error term.

The expected sign of our new variable – current liquidity - is negative. The higher is the ratio of current liquid assets to short-term liabilities for a given bank; the lower is it's the liquidity risk. Thus, bank would set lower bid quote on the overnight credits on inter-bank market.

[*] See the precise definition of variables in the Table 1 below.

Chapter 4

EMPIRICAL ANALYSIS

4.1. Data Description

We test two hypotheses in our paper:

1) that credit risk is priced into overnight credits of commercial banks in Ukraine;

2) that liquidity risk is priced into overnight inter-bank credits

Panel data for 9 Ukrainian commercial banks for the period of 36 months (from years 2001 to 2003) was used to test the hypotheses of positive influence on quoted bid price on overnight credits. The banks were chosen based on available data.

The data for empirical estimation comes from three sources. The financial web-site www.finance.com.ua provides information on interest rates for overnight, short-term and long-term funds for Ukrainian banks. This data was used for determining the monthly average interest rate on overnight credits, set by borrowing banks.

Monthly balance sheet data of 9 Ukrainian banks obtained from the risk department of commercial bank "Alfa Bank (Ukraine)" are necessary for determining the proxies for credit and liquidity risks of the bank.

Finally, the web-site of the Association of Ukrainian Banks, www.aub.com.ua provides information on the market share of particular banks on inter-bank market. We should notice here, that we

consider market share variable irrelevant for our data, as we have too small number of cross-sectional units in our sample. But to be able to compare our results with Furfine's findings, we leave this variable at first stages of estimation and then, finally, drop it at all. As additional reason to drop market share variable from our sample, we consider the fact that information on the amount of inter-bank lending of commercial banks is not publicly available on a monthly basis, so we have to use a proxy to account for the influence of market share. The amount of overnight borrowing by bank have is proxied by the amount of inter-bank lending. We managed to get information on the amount received and given by banks at the year 2000[1], and analyzed the correlation between ranks of 15 banks on the borrowed and lent amount of funds on inter-bank market. The results are presented in Table 3.

Table 3. Correlation between the Ranks of the Banks on the Borrowed and Lent Amount of Funds on Inter-bank Market.

	Rank of the banks for borrowed funds	Rank of the banks for lent funds
Rank of the banks for borrowed funds	1.0000	
Rank of the banks for lent funds	0.3697	1.0000

As we see, correlation is not so high, so we can suspect to get biased estimates for desired market share coefficients, but still correlation is not too low for not using proposed proxy. In further analysis we leave

[1] *Analytical Overview of Banks Statistics*. Financial Risks Journal, Kyiv, no. 4 (28), 2001.

the proxied market share to compare our results with Furfine's findings, and in the final specification we drop it at all.

It is also important to check for possible problem - selection bias due to size of banks in the sample. The larger is size of the bank (by the amount of capital), the more financially healthy it is considered to be. So, the bias could arise if we had only the largest or the smallest banks. In first case we would observe weak impact of credit risk on the interest rate for overnight credits, and in the second case we could observe higher impact of risks on the bid quote. So, using the data of Analytical Overview of Banks Statistics[2], we check for the size of 9 banks in our sample (see Table 4 below).

Table 4. Distribution of banks in terms of size

SIZE OF THE BANK	BANKS IN THE CATEGORY
Capital more than 50 mln EURO*	Aval, UkrSibBank
Capital more than 10 mln. EURO**	Vabank, UkrKreditniy, Forum, Khreshchatyk
Capital more than 3 mln. EURO***	Finance&Credit, Premier, Mriya

* The group of largest size banks in Ukraine

** The group of large size banks in Ukraine

*** The group of medium size banks in Ukraine

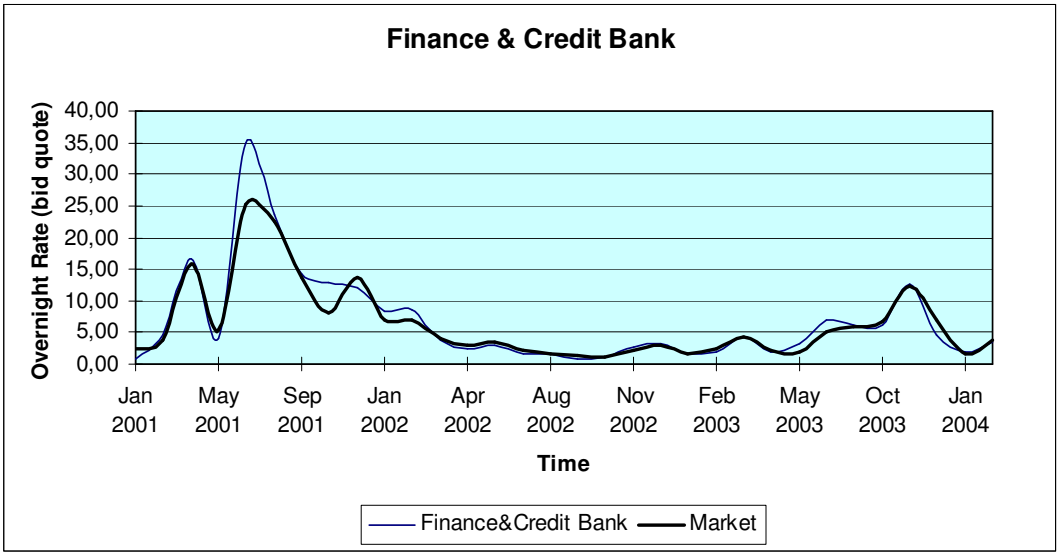
[2] *Analytical Overview of Banks Statistics*. Financial Risks Journal, Kyiv, no. 4 (28), 2001.

As we see from the table, our sample comprises two banks from the group of largest banks in Ukraine (with capital more than 50 mln. EURO), four banks from the group of large size banks and three banks from the group of medium size banks. Although we do not have small size banks in our sample, the other three out of four groups of banks are presented in our sample, so we conclude that results of our estimation would not be influenced much by selection bias.

The summary statistics of the data are presented in the Table A1 of the Appendix.

As we already mentioned, we include time-specific dummies in the model to account for other shocks and trends, present in the market. Importance of accounting for such trends can be illustrated with the help of the figure, depicting trends of the market movements of interest rates. We present time-trend graphs for all banks in the Appendix (see Figure A1), and the Figure 1 below depicts such a trend for one bank from our sample.

Figure 1. Movements of Overnight Rates over Time



As we can see, although in general rates move together (and that's why we introduce time dummies), there are differences between market interest rate and rates, set by particular banks.

In the next section we will describe econometric methodology for using combination of cross-sectional and time-series data for testing the hypotheses of positive significant influence of credit and liquidity risks on the bid price of overnight credits of Ukrainian commercial banks.

4.2. Econometric Methodology

Panel data analysis requires special techniques to account for time-series and cross-section dimensions of the data. We found excellent description of the particularities of panel data and of the methods to work with them in the work by Kudlyak (2002). So we use her findings to elaborate main steps to proceed with our estimation. So, following Kudlyak (2002) and Greene (2000), we will use different techniques for estimation and will choose among them based on specific econometric tests to find a model, which fits our data best.

We could simply pool our data and run ordinary least squares (OLS) regression, but there is not enough theoretical justification for such a model choice. Instead, as was discussed in the Chapter 3, we should account for individual effects of cross-section units (banks) and use panel data techniques to obtain higher precision of the estimates.

In fact, there are two main ways to account for individual-specific effects in the panel data – fixed and random effects models. The first approach accounts for the difference in the cross-section units by assuming different constant terms for each bank. And the second

approach assumes that individual-specific effects vary randomly across cross-sections.

So, the basic model for panel data based on the following equation:

$$Y_{it} = \mu_i + \beta' X_{it} + \varepsilon_{it}, \qquad (4.1)$$

where Y_{it} is an actual value of the bid quote on overnight loans for bank *i* at month *t,* X_{it} is a vector of explanatory variables; β is a vector of the slope coefficients; and ε_{it} is an unexplained error term for bank *i* at month *t*. μ_i is the bank-specific component.

Pooled regression implies that individual components μ_i are not only constant for each bank across all time periods, but are the same for all banks. In contrast, fixed effects model assumes that $\mu_i \neq \mu_j$ for all i, j = 1 to N, where N is the number of banks in the sample.

As mentioned earlier in Chapter 3, this study uses fixed effects model for estimation to account for bank-specific effects. Econometric tests will determine which model really fits the data best.

To determine whether the individual effects across banks are significant, we used the F-test. The null hypothesis of the F-test is that the common intercept of pooled regression is statistically significant across sample. If the null hypothesis cannot be rejected, we could proceed with pooled regression; otherwise, we should use fixed or random effects model.

To choose among fixed and random effect models we will use Hausman specification test, whish tests the orthogonality of the random individual effects and the regressors. Technically, Hausman test compares two estimators: one of which is consistent both under

random and fixed effects hypotheses, and the other is consistent and efficient only under random effects (null hypothesis) (Kudlyak 2002, p. 29). Significant difference between the two estimators would show that the null hypothesis should be rejected and we should use fixed effects model for estimation.

Our econometric estimation is described in section 4.3.

4.3. Econometric Analysis of Impact of Credit Risk on Overnight Rate

This section presents the results of the empirical estimation of the impact of measured credit risk on the bid price of overnight inter-bank interest rates.

Basic (Furfine) Model Testing (Testing Hypothesis I)

We start with a test of the basic model for estimation, proposed by Furfine. F-test rejects the hypothesis of common intercept, thus we proceed with estimating the panel data models. Both random and fixed effects models were estimated. Hausman test was used then to choose between them. The Hausman test rejects the hypothesis of consistency and efficiency of random effects; thus we use fixed effects model as most appropriate fit for our data.

Table A2 in the Appendix presents the whole table of estimation results (including all month dummies), and here, for convenience, we present the results only for variables of our interest (see Table 5).

Table 5. **Fixed Effect Regressions for Basic (Furfine) Model**

Number of observations	285	Number of groups		9
R-squared:		Observations per group:	min	30
within	0.9055		average	31.7
between	0.1168		max	32
overall	0.8756	F(35,241)		65.99
corr (u_i, Xb)	-0.0511	Prob > F		0.0000

Dependent variable: overnight rate (bid quote)

	Coefficient	Standard. Error	t	P>|t|	[95% Conf. Interval]	
Return on Assets	0.6500711	0.338414	1.92	0.056	-0.0165558	1.316698
Loan Quality	0.1002031	0.048222	2.08	0.039	0.0052128	0.1951934
Capitalization	-0.0168666	0.0558747	-0.30	0.763	-0.1269318	0.0931986
Market Share	1.237554	0.8821704	1.40	0.162	-0.5001943	2.975303

So, we obtained the following equation[*]:

$$\hat{Y}_{it} = \mu_i + 0.65^{*} * ROA_{it} + 0.1^{**} * LQ_{it} - 0.02 * CAP_{it} + 1.24 * MSh_{it} \quad (4.1)$$

(0.338414) (0.048222) (0.0558747) (1.140164)

As we see, the effect of return on assets is as we expected and indeed has positive impact on the bid quote of interest rate. So, as return on assets increases by 1%, overnight rate increases by 0.65%. Theoretically, it is explained by the direct relationship between

[*] We do not present coefficients in equations here and later on for dummies for the sake of exposition

riskiness of bank operations and its returns. This coefficient is significant at 10% significance level.

Loan quality coefficients sign is positive and significant at 5%. As ratio of bad loans to total loans increases by 1%, the bid quote of interest rate increases by 0.1%. This impact is theoretically justified, since, as the reader should remember, by loan quality we imply the ration of "bad" loans to total amount of loans. So, the higher the portion of bad-quality loans in the bank credit portfolio, the higher credit risk it faces, and, thus, it needs to borrow more money and bids higher interest rate.

Capitalizations seem to have negative influence on interest rate, as was predicted in the theoretical part of the thesis, but estimated coefficient is not significant. There are several possible explanations of insignificance of the coefficient for capitalization. First possible reason is that maybe this is what just data shows and this factor is not important for the pricing of overnight credits for commercial banks in Ukraine. Second explanation is that there could be just not enough number of observations to discover significant impact of this factor. And, finally, such result might be because we omit some important variable. We will consider this last explanation as additional motivation for checking our own version of the basic model.

As for the market share influence, it does not show predicted by Furfine influence (the sign of the coefficient is positive instead of predicted negative), but it is insignificant. As was discussed above, we predicted that this could be due to weak theoretical justification for including this variable in our model (because of only 9 cross-sectional units in our sample).

Our Model Estimation (Testing Hypothesis II)

Let us proceed to the estimation of our modified model. The modification is the addition of another variable which, in our opinion, is relevant for explaining overnight interest rate changes – the current liquidity.

Table 6. **Fixed Effect Regressions for Our Model**

Number of observations	285	Number of groups		9
R-squared:		Observations per group:	min	30
within	0.9074		aerage	31.7
between	0.1158		max	32
overall	0.8802	F(35,241)		65.30
corr (u_i, Xb)	-0.0486	Prob > F		0.0000

Dependent variable: overnight rate (bid quote)

	Coefficient	Std. Err.	t	P>|t|	[95% Conf. Interval]	
Return on Assets	0.606032	0.3363786	1.80	0.073	-0.0565993	1.268663
Loan Quality	0.10606	0.0479209	2.21	0.028	0.0116607	0.2004592
Capitalization	-0.0669028	0.0599596	-1.12	0.266	-0.1850171	0.0512115
Current Liquidity	-0.0555786	0.025369	-2.19	0.029	-0.1055529	-0.0056042
Market Share	1.253778	0.8753287	1.43	0.153	-0.47053	2.978086

As with Furfine model testing, to choose the best fit of the model, both F-test and Hausman were used. Both tests show that fixed effects model is the best fit for our data (see Tables A3-A5 in the

Appendix for detailed estimation results and tests results). Here, in Table 6, we represent results for variables of our interest.

So, we obtained the following equation:

$$\hat{Y}_{it} = \mu_i + 0.6^{*} * ROA_{it} + 0.1^{**} * LQ_{it} - 0.07 * CAP_{it} - 0.06^{**} * LC_{it} + 1.25 * MSh_{it} \quad (4.2)$$

(0.3363786) (0.0479209) (0.0599596) (0.025369) (0.876)

As we see, adding as an explanatory variable the current liquidity makes sense not only in theoretical meaning, but also in the econometric sense.

The sign of the coefficient for the current liquidity is negative, which is theoretically justified (the higher is the bank's liquidity, the lower liquidity risk it takes on, and, consequently, the less the bank needs money, and quotes lower interest rate on overnight credits).

As current liquidity increases by 1%, the bid quote of price on overnight credit decreases by 0.06%. In addition, the estimated coefficient is significant at 5% level of significance.

The coefficient for market share remains insignificant, which again supports our idea of non-relevance of this regrssor in our model.

Finally, we drop Market Share from our model. Table 7 (and Table A6 in Appendix) shows the estimation results of the final specification of our model.

Table 7. **FE Regressions for Our Model (dropping Market Share)**

Number of observations	285	Number of groups		9
R-squared:		Obs. per group:	min	30
within	0.9066		avg	31.7
between	0.0431		max	32
overall	0.8885	F(35,241)		65.82
corr (u_i, Xb)	-0.0131	Prob > F		0.0000

Dependent variable: overnight rate (bid quote)

	Coefficient	Std. Err.	t	P>|t|	[95% Conf. Interval]	
Return on Assets	0.5799525	0.3366175	1.72	0.086	-0.0831355	1.243041
Loan Quality	0.092138	0.0470271	1.96	0.051	-0.0004986	0.1847747
Capitalization	-0.0726241	0.0599568	-1.21	0.227	-0.1907304	0.0454822
Current Liquidity	-0.0552712	0.0254234	-2.17	0.031	-0.1053516	-0.0051907

$$\hat{Y}_{it} = \mu_i + 0.58^{*} * ROA_{it} + 0.09^{**} * LQ_{it} - 0.07 * CAP_{it} - 0.06^{**} * LC_{it} \qquad (4.3)$$

(0.3366175) (0.0470271) (0.0599568) (0.025434)

As we see, the results remain almost the same, thus we conclude that market share of borrowing bank on inter-bank market is indeed irrelevant here.

Summarizing our estimation results, we suggest the importance of both credit and liquidity risk factors in the determination of bid quote of interest rates on overnight credits.

Chapter 5

CONCLUSIONS AND IMPLICATIONS

Risk management techniques, which are used by most Ukrainian commercial banks for determining and assessment the risks, have an important limitations in sense that they analyze credit risk of counterparties only at the end of the period, and not at the moment of the transaction. The goal of this thesis was to investigate whether we can find more operative information for more immediate monitoring of risks, incurred by a particular bank. In particular, we tested the hypotheses of whether the credit and liquidity risks are priced into overnight credits of commercial banks in Ukraine.

Based on the results of our empirical estimation, we reject the null hypotheses of no impact of credit and liquidity risk measures on the overnight rate. In particular, we have found that:

1) The higher is credit risk, taken by particular bank, the higher is the interest rate (bid quote) for overnight credits.

2) Liquidity risk also has significant positive influence on the bid price for the credits on the shortest-term inter-bank market.

In addition, we found that we cannot make any conclusion about the statistical significance of the market share and capitalization of the bank on the bid quote of interest rate.

On the basis of our study, we could suggest the following implications:

- on micro level, risk managers of commercial banks can use daily information on bid interest rates for overnight credits to examine, whether the particular bank-counterparty is facing decreased or increased measured amount of risks;

- on the macro-level, Supervisors of the banking system in Ukraine may use early signals of increase in credit and liquidity risks of particular banks, observed on the overnight inter-bank markets to assist in more operational and careful monitoring and supervision of banks. This could aid the financial health of the banking industry in Ukraine.

For further research we suggest investigating the impact of credit and liquidity risks on other dependent variables, which could be observed on inter-bank markets and be used as easily observed indicators. For example, we could use as a dependent variable the difference between the average market rate and the bid rates by particular banks, or investigate more properly bid-ask spread of the rates, imposed by banks. It would also be interesting to see how volatility of the rates, observed on the market, reflect the changes in the risks, taken by banks. Thus, there is a room for further useful research.

BIBLIOGRAPHY

Berger, Allen N.; Davies, Sally M.; and Flannery, Mark J. (1998*). Comparing market and supervisory assessments of bank performance: Who knows what when?* Finance and Economics Discussion Series no. 1998-32. Federal Reserve Board of Governors: Washington, D.C.

Bessis, Joel. (1998). *Risk management in banking*. John Wiley &Sons Ltd, Chichester.

Calomiris, Charles W. (1998). *Blueprints for a new global financial architecture*. Text of speech available on www.aei.org. American Enterprise Institute for Public Policy Research: Washington, D.C.

Campbell, John Y. *The econometrics of financial markets*. Princton, 1997.

Furfine, Craig H. (2001). *Banks as Monitors of Other Banks: Evidence from the Overnight Federal Funds market*. The Journal of Business 74, no. 1:33-57.

Greene, Williame H. (2000). *Econometric Analysis*. 4-th ed. Upper Saddle River, New Jersey.

Hamilton, James D. (1996). *The daily market for federal funds*. Journal of Political Economy 104, no. 1:26-56.

Hanousek, Jan, and Roland, Gerald. (2001). *Banking Passivity and Regulatory Failure in Emerging Markets: Theory and Evidence from the Czech Republic*. William Davidson Working Paper Number 424, July 2001.

Kudlyak, Marianna. (2002*). Foreign Aid and Growth: do the transition economies have different story to tell?*. Economics Education and Research Consortium.

Krainer, John, and Lopez, Jose A. (2002). *Incorporating Equity Market Information Supervisory Monitoring Models*. Federal Reserve Bank of San Francisco, Economics Research Deparment.

Lukyanenko, Iryna, Gorodnichenko, Yuriy. (2002). *Modern econometric methods of analysis of financial operations*. Kyiv, Znannya.

Mishkin, Frederic S. and Eakens, Stanley G. (2000*). Financial markets and institutions*. 3rd ed., Addison Wesley Longman, Inc.

Rochet, Jean-Charlies, and Tirole, Jean. (1996). *Interbank lending and systematic risk*. Journal of Money, Credit, and Banking 28, no. 4: 733-62.

Sushko, V. I. *The Estimation of the Efficiency of Banks with respect to Risk Management Practices*.

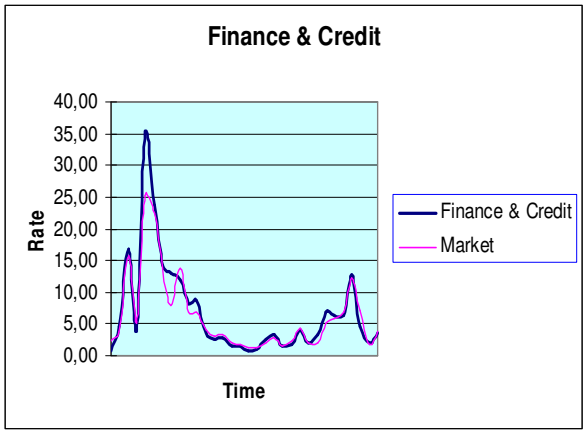
Financial Risks Journal, Kyiv, no. 3-4 (34), 2003: 97-107.

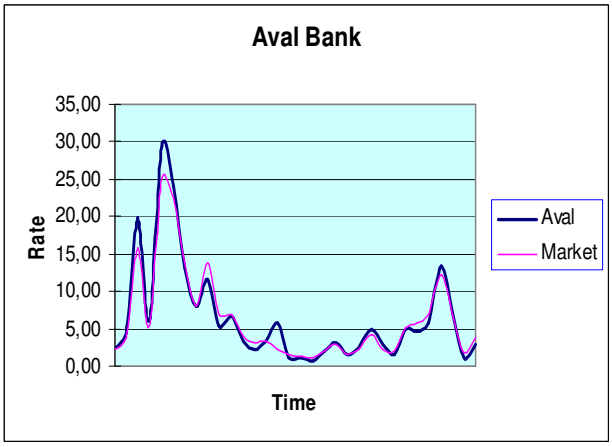
Analytical Overview of Banks Statistics. Financial Risks Journal, Kyiv, no. 4 (28), 2001.

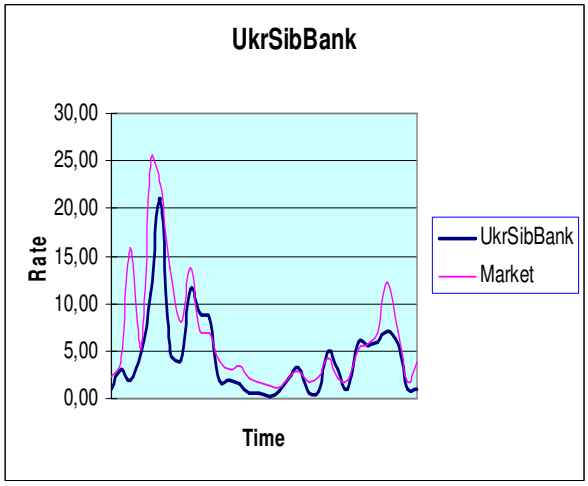
Zahra el MakKawy. *The new Basel Accord and US Implementation.* Global Association of Risk Professionals Risk Review, July/August, 2003, issue 13: 6-11.

APPENDIX

Figure A1. Movements of Overnight Rates over Time







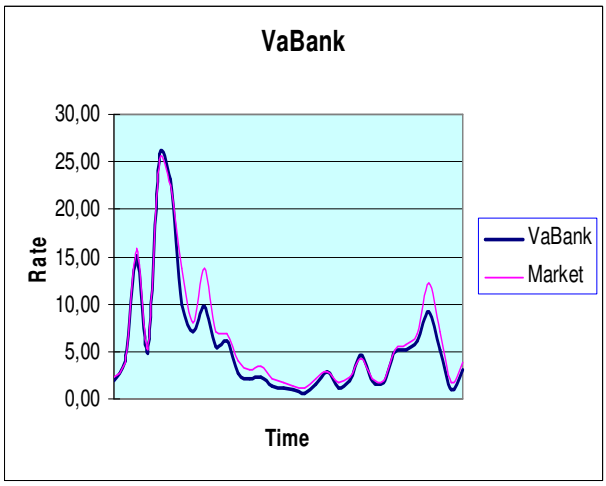
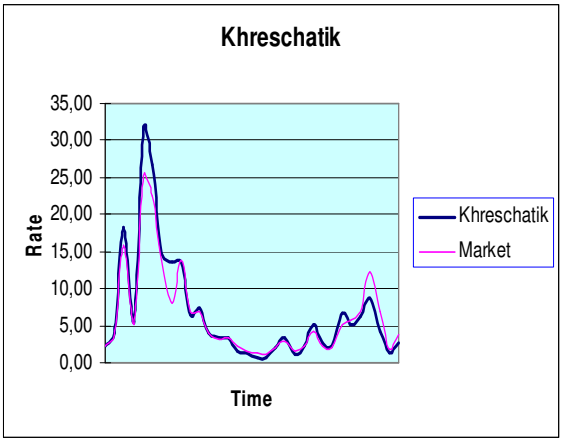
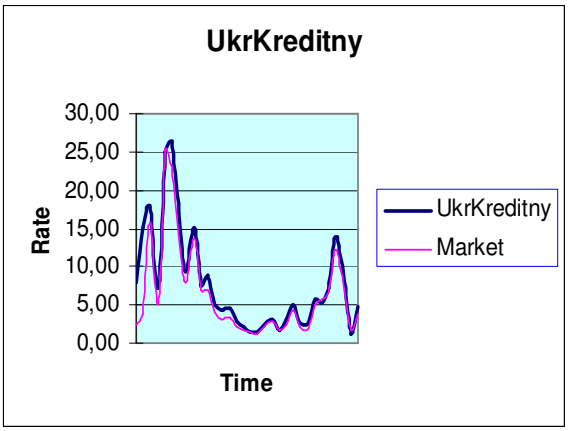
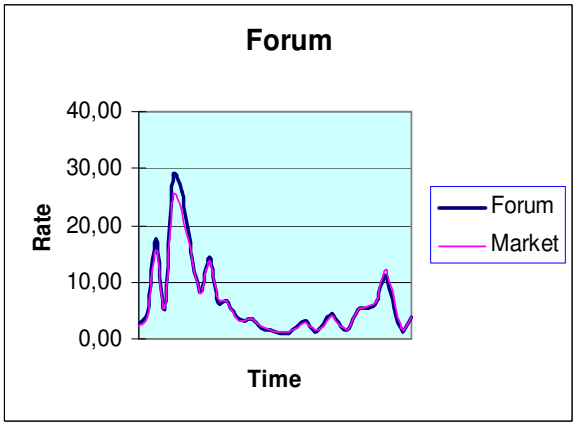
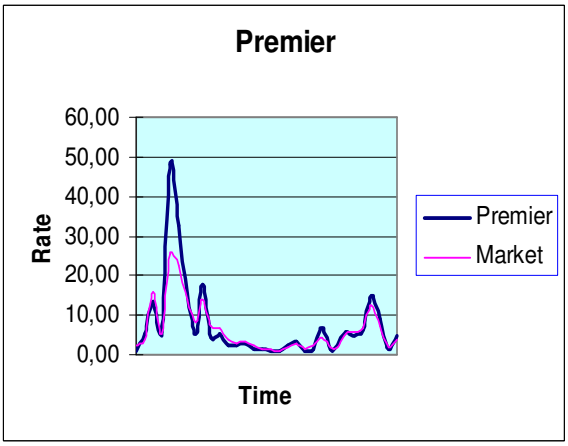


Figure A1. Movements of Overnight Rates over Time (Cont)









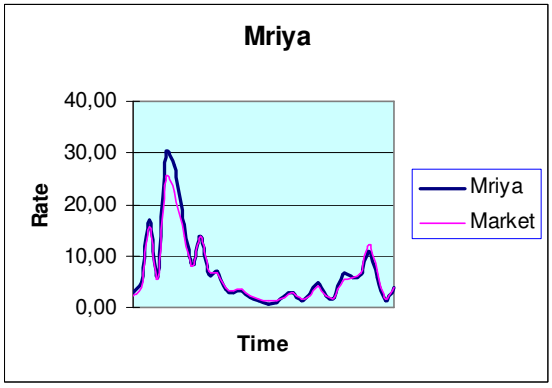


Table A1. Summary Statistics

Variable	Number of observations	Mean	Standard Deviation	Min	Max
Overnight rate	287	6.422613	7.062111	0.1	48
Return on Assets	286	0.6040909	0.7024396	0	3.6
Loan Quality	288	7.275069	5.173952	0.3	21.4
Capitalization	288	11.39444	4.501905	4.1	29.4
Market Share	288	0.370918	0.4195791	0.0167808	2.208818
Current Liquidity	288	22.94434	8.223155	2.9	56.6
Instantaneous Liquidity	288	19.67594	6.915462	8.9	49.4
Common Liquidity	288	17.09941	6.96887	8.6	47.8

Table A2. Fixed Effect Regressions for Basic (Furfine) Model•

Number of obs.	285
R-squared:	
within	0.9055
between	0.1168
overall	0.8756
corr (u_i, Xb)	-0.0511

Number of groups		9
Obs. per group:	min	30
	average	31.7
	max	32
F(35,241)		65.99
Prob > F		0.0000

Dependent variable: bid quote of overnight interest rate

	Coefficient	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Return on Assets	0.6500711	0.338414	1.92	0.056	-0.0165558	1.316698
Loan Quality	0.1002031	0.048222	2.08	0.039	0.0052128	0.1951934
Capitalization	-0.0168666	0.0558747	-0.30	0.763	-0.1269318	0.0931986
Market Share	1.237554	0.8821704	1.40	0.162	-0.5001943	2.975303
var011	-3.787761	1.207655	-3.14	0.002	-6.166667	-1.408856
var012	-0.9801065	1.22046	-0.80	0.423	-3.384237	1.424024
var013	8.67122	1.198163	7.24	0.000	6.311011	11.03143
var014	-1.164032	1.201964	-0.97	0.334	-3.531728	1.203664
var015	22.67616	1.189913	19.06	0.000	20.3322	25.02012
var016	19.01762	1.186053	16.03	0.000	16.68127	21.35398
var017	6.665262	1.177561	5.66	0.000	4.345636	8.984888
var018	1.790391	1.195758	1.50	0.136	-0.5650794	4.145862
var019	6.457954	1.187826	5.44	0.000	4.118107	8.7978
var0111	0.5637102	1.19746	0.47	0.638	-1.795113	2.922534
var0112	1.215345	1.199997	1.01	0.312	-1.148476	3.579167
var021	-2.759926	1.18281	-2.33	0.020	-5.089892	-0.4299595
var022	-3.569758	1.19086	-3.00	0.003	-5.915582	-1.223934
var023	-3.561638	1.19348	-2.98	0.003	-5.912622	-1.210654
var024	-4.688249	1.194546	-3.92	0.000	-7.041333	-2.335165
var026	-5.434174	1.198669	-4.53	0.000	-7.795379	-3.07297
var027	-5.910495	1.196613	-4.94	0.000	-8.267651	-3.55334
var028	-6.052994	1.215368	-4.98	0.000	-8.447095	-3.658894
var029	-4.738592	1.200153	-3.95	0.000	-7.102721	-2.374462
var0210	-3.458489	1.176835	-2.94	0.004	-5.776685	-1.140292
var0211	-4.95862	1.190464	-4.17	0.000	-7.303663	-2.613577
var0212	-4.214962	1.229044	-3.43	0.001	-6.636002	-1.793922
var031	-1.218727	1.171233	-1.04	0.299	-3.525889	1.088434
var032	-3.729373	1.156152	-3.23	0.001	-6.006825	-1.45192
var033	-3.687623	1.176614	-3.13	0.002	-6.005383	-1.369864
var034	-0.5240587	1.147359	-0.46	0.648	-2.784191	1.736073
var035	0.5683334	1.153814	0.49	0.623	-1.704514	2.841181
var039	5.594243	1.159795	4.82	0.000	3.309615	7.878872
var0310	0.2661115	1.145636	0.23	0.817	-1.990627	2.52285
var0311	-4.261162	1.148336	-3.71	0.000	-6.52322	-1.999105
var0312	-2.225605	1.150801	-1.93	0.054	-4.492517	0.0413078
Constant	4.935836	1.140164	4.33	0.000	2.689878	7.181795

`F test that all u_i=0:  F(8, 241) =  6.51  Prob > F = 0.0000`

•var 011, var 012, etc. are the dummy variables for the month of the sample. First two figures denote the corresponding year, and the next figure indicates the number of month.

Table A3. Fixed Effect Regressions for Our Model[•♣]

Number of observations	285
R-squared:	
within	0.9074
between	0.0158
overall	0.8802
corr (u_i, Xb)	-0.0476

Number of groups		9
Obs. per group:	min	30
	average	31.7
	max	32
F(35,241)		65.30
Prob > F		0.0000

Dependent variable: bid quote of overnight interest rate

	Coefficient	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Return on Assets	0.606032	0.3363786	1.80	0.073	-0.0565993	1.268663
Loan Quality	0.10606	0.0479209	2.21	0.028	0.0116607	0.2004592
Capitalization	-0.0669028	0.0599596	-1.12	0.266	-0.1850171	0.0512115
Current Liquidity	-0.0555786	0.025369	-2.19	0.029	-0.1055529	-0.0056042
Market Share	1.253778	0.8753287	1.43	0.153	-0.47053	2.978086
var011	-3.100328	1.238649	-2.50	0.013	-5.54034	-0.6603164
var012	-0.1695208	1.266214	-0.13	0.894	-2.663834	2.324792
var013	9.397895	1.234234	7.61	0.000	6.966582	11.82921
var014	-0.3923596	1.243527	-0.32	0.753	-2.841981	2.057262
var015	23.34803	1.219823	19.14	0.000	20.9451	25.75095
var016	19.64432	1.211081	16.22	0.000	17.25862	22.03003
var017	7.164993	1.190445	6.02	0.000	4.819938	9.510047
var018	2.408453	1.219522	1.97	0.049	0.0061203	4.810785
var019	7.037759	1.207921	5.83	0.000	4.658278	9.417239
var0111	1.021413	1.206359	0.85	0.398	-1.35499	3.397816
var0112	1.575139	1.201921	1.31	0.191	-0.7925215	3.942799
var021	-2.5282	1.178352	-2.15	0.033	-4.849432	-0.2069676
var022	-3.22883	1.191786	-2.71	0.007	-5.576527	-0.881134
var023	-3.350615	1.188092	-2.82	0.005	-5.691035	-1.010195
var024	-4.406007	1.19222	-3.70	0.000	-6.754559	-2.057455
var026	-5.121006	1.197889	-4.28	0.000	-7.480726	-2.761287
var027	-5.655232	1.192993	-4.74	0.000	-8.005307	-3.305157
var028	-5.779922	1.212324	-4.77	0.000	-8.168075	-3.391768
var029	-4.562805	1.193503	-3.82	0.000	-6.913884	-2.211727
var0210	-3.08275	1.180195	-2.61	0.010	-5.407613	-.7578875
var0211	-4.67154	1.188435	-3.93	0.000	-7.012636	-2.330444
var0212	-4.238004	1.219514	-3.48	0.001	-6.640322	-1.835687
var031	-1.196571	1.162152	-1.03	0.304	-3.485892	1.09275
var032	-3.753708	1.147198	-3.27	0.001	-6.013571	-1.493846
var033	-3.601916	1.168102	-3.08	0.002	-5.902957	-1.300875
var034	-0.6882731	1.140885	-0.60	0.547	-2.935699	1.559153
var035	0.2301572	1.155184	0.20	0.842	-2.045438	2.505752
var039	5.645794	1.150999	4.91	0.000	3.378443	7.913145
var0310	0.4358207	1.139347	0.38	0.702	-1.808576	2.680218
var0311	-4.155844	1.140403	-3.64	0.000	-6.402321	-1.909366
var0312	-2.21958	1.141838	-1.94	0.053	-4.468885	0.0297251
_cons	6.464682	1.329205	4.86	0.000	3.846285	9.08308

F test that all u_i=0: F(8, 240) = 6.12 Prob > F = 0.0000

[•♣•] var 011, var 012, etc. are the dummy variables for the month of the sample. First two figures denote the corresponding year, and the next figure indicates the number of month

Table A4. Random Effect Regressions for Our Model[•♥♣]

Number of observations	285
R-squared:	
within	0.9072
between	0.0000
overall	0.8857
corr (u_i, Xb)	0 (assumed)

Number of groups		9
Obs. per group:	min	30
	avg	31.7
	max	32
Wald chi2(36)		2381.50
Prob > chi2		0.0000

Dependent variable: bid quote of overnight interest rate

	Coefficient	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Return on Assets	0.5741059	0.322417	1.78	0.075	-0.0578198	1.206032
Loan Quality	0.0933925	0.0457122	2.04	0.041	0.0037982	0.1829868
Capitalization	-0.0602375	0.0559205	-1.08	0.281	-0.1698397	0.0493646
Current Liquidity	-0.0568666	0.0245352	-2.32	0.020	-0.1049547	-0.0087784
Market Share	0.7253053	0.7418987	0.98	0.328	-0.7287895	2.1794
var011	-3.075799	1.220087	-2.52	0.012	-5.467125	-0.6844725
var012	-0.1180382	1.245483	-0.09	0.924	-2.559141	2.323064
var013	9.487604	1.21654	7.80	0.000	7.103228	11.87198
var014	-0.3408591	1.226585	-0.28	0.781	-2.744921	2.063203
var015	23.3848	1.205299	19.40	0.000	21.02246	25.74715
var016	19.6509	1.195385	16.44	0.000	17.30799	21.99382
var017	7.17921	1.176964	6.10	0.000	4.872403	9.486017
var018	2.428606	1.204326	2.02	0.044	0.06817	4.789042
var019	7.088734	1.194284	5.94	0.000	4.747981	9.429486
var0111	0.9890107	1.189942	0.83	0.406	-1.343233	3.321254
var0112	1.540161	1.186372	1.30	0.194	-0.7850849	3.865406
var021	-2.535518	1.165713	-2.18	0.030	-4.820274	-0.2507617
var022	-3.219719	1.177797	-2.73	0.006	-5.528159	-0.9112789
var023	-3.295785	1.17562	-2.80	0.005	-5.599958	-0.9916111
var024	-4.317888	1.179366	-3.66	0.000	-6.629403	-2.006373
var026	-5.019377	1.184174	-4.24	0.000	-7.340316	-2.698438
var027	-5.586045	1.181004	-4.73	0.000	-7.90077	-3.271321
var028	-5.663403	1.198583	-4.73	0.000	-8.012583	-3.314223
var029	-4.468411	1.181856	-3.78	0.000	-6.784806	-2.152017
var0210	-3.021869	1.169105	-2.58	0.010	-5.313274	-0.7304652
var0211	-4.631611	1.17497	-3.94	0.000	-6.93451	-2.328712
var0212	-4.174326	1.205773	-3.46	0.001	-6.537598	-1.811053
var031	-1.173747	1.151904	-1.02	0.308	-3.431437	1.083943
var032	-3.763743	1.138135	-3.31	0.001	-5.994447	-1.533039
var033	-3.667999	1.158573	-3.17	0.002	-5.938761	-1.397237
var034	-0.7065858	1.132079	-0.62	0.533	-2.92542	1.512248
var035	0.1706801	1.144175	0.15	0.881	-2.071862	2.413222
var039	5.576958	1.140943	4.89	0.000	3.340751	7.813165
var0310	0.4322754	1.131409	0.38	0.702	-1.785246	2.649797
var0311	-4.204017	1.132123	-3.71	0.000	-6.422937	-1.985098
var0312	-2.279811	1.133086	-2.01	0.044	-4.50062	-0.0590032
Constant	6.71647	1.36459	4.92	0.000	4.041924	9.391016

[•♥♣] var 011, var 012, etc. are the dummy variables for the month of the sample. First two figures denote the corresponding year, and the next figure indicates the number of month

Table A5. Hausman Test

Number of observations	285	Number of groups	9
R-squared:		Obs. per group: min	30
within	0.9072	Obs. per group: avg	31.7
between	0.0000	Obs. per group: max	32
overall	0.8857	Wald chi2(36)	2381.50
corr (u_i, Xb)	0 (assumed)	Prob > chi2	0.0000

Dependent variable: bid quote of overnight interest rate

	(b) fixed	(B) -	(b-B) Difference	Sqrt (diag(V_b-V_B)) S.E.
Return on Assets	0.606032	0.5741059	0.0319261	0.0959053
Loan Quality	0.10606	0.0933925	0.0126675	0.0143807
Capitalization	-0.0669028	-0.0602375	-0.0066653	0.0216346
Current Liquidity	-0.0555786	-0.0568666	0.001288	0.0064505
Market share	1.253778	0.7253053	0.5284726	0.4645284
var011	-3.100328	-3.075799	-0.0245293	0.213634
var012	-0.1695208	-0.1180382	-0.0514827	0.2281888
var013	9.397895	9.487604	-0.0897083	0.2082355
var014	-0.3923596	-0.3408591	-0.0515005	0.2045727
var015	23.34803	23.3848	-0.0367779	0.1876738
var016	19.64432	19.6509	-0.0065821	0.1943492
var017	7.164993	7.17921	-0.014217	0.1786468
var018	2.408453	2.428606	-0.0201531	0.1919146
var019	7.037759	7.088734	-0.050975	0.180996
var0111	1.021413	0.9890107	0.0324026	0.1983415
var0112	1.575139	1.540161	0.0349785	0.1927065
var021	-2.5282	-2.535518	0.0073181	0.1721198
var022	-3.22883	-3.219719	-0.0091115	0.1820655
var023	-3.350615	-3.295785	-0.0548303	0.1716989
var024	-4.406007	-4.317888	-0.0881192	0.1745994
var026	-5.121006	-5.019377	-0.101629	0.1807484
var027	-5.655232	-5.586045	-0.0691867	0.1687126
var028	-5.779922	-5.663403	-0.1165188	0.1820091
var029	-4.562805	-4.468411	-0.094394	0.1663339
var0210	-3.08275	-3.021869	-0.0608811	0.1614088
var0211	-4.67154	-4.631611	-0.0399293	0.1783919
var0212	-4.238004	-4.174326	-0.0636782	0.1825503
var031	-1.196571	-1.173747	-0.0228238	0.1539994
var032	-3.753708	-3.763743	0.0100348	0.1439141
var033	-3.601916	-3.667999	0.0660833	0.1488946
var034	-0.6882731	-0.7065858	0.0183127	0.1414756
var035	0.2301572	0.1706801	0.0594771	0.1591038
var039	5.645794	5.576958	0.0688363	0.1518181
var0310	0.4358207	0.4322754	0.0035453	0.1342579
var0311	-4.155844	-4.204017	0.0481737	0.1371791
var0312	-2.21958	-2.279811	0.0602317	0.1411053

Ho: difference in coefficients not systematic	
chi2(36) = (b-B)'[(V_b-V_B)^(-1)](b-B)	1.90
Prob>chi2	1.0000

Table A6. FE Regression (dropping MktShare)•♥♣♠

Number of observations	285	Number of groups	9
R-squared:		Obs. per group: min	30
within	0.9066	Obs. per group: avg	31.7
between	0.0431	Obs. per group: max	32
overall	0.8885	F(35,241)	66.82
corr (u_i, Xb)	-0.0131	Prob > F	0.0000

Dependent variable: bid quote of overnight interest rate

	Coefficient	Std. Err.	t	P>|t|	[95% Conf. Interval]	
Return on Assets	0.5799525	0.3366175	1.72	0.086	-0.0831355	1.243041
Loan Quality	0.092138	0.0470271	1.96	0.051	-0.0004986	0.1847747
Capitalization	-0.0726241	0.0599568	-1.21	0.227	-0.1907304	0.0454822
Current Liquidity	-0.0552712	0.0254234	-2.17	0.031	-0.1053516	-0.0051907
var011	-3.158484	1.240681	-2.55	0.012	-5.602448	-0.7145201
var012	-0.1920311	1.268876	-0.15	0.880	-2.691535	2.307473
var013	9.464947	1.236034	7.66	0.000	7.030139	11.89976
var014	-0.4406169	1.24578	-0.35	0.724	-2.894625	2.013391
var015	23.27089	1.221289	19.05	0.000	20.86513	25.67666
var016	19.5555	1.212128	16.13	0.000	17.16778	21.94322
var017	7.105317	1.192308	5.96	0.000	4.756641	9.453993
var018	2.328953	1.220913	1.91	0.058	-0.0760698	4.733976
var019	7.033575	1.21055	5.81	0.000	4.648966	9.418184
var0111	0.8756392	1.204678	0.73	0.468	-1.497403	3.248681
var0112	1.410707	1.199033	1.18	0.241	-0.9512161	3.77263
var021	-2.623887	1.179021	-2.23	0.027	-4.946388	-0.3013863
var022	-3.2976	1.193414	-2.76	0.006	-5.648454	-0.9467468
var023	-3.344532	1.190674	-2.81	0.005	-5.689989	-0.9990756
var024	-4.337627	1.19386	-3.63	0.000	-6.689361	-1.985894
var026	-5.025292	1.198631	-4.19	0.000	-7.386422	-2.664162
var027	-5.651946	1.195591	-4.73	0.000	-8.007089	-3.296803
var028	-5.689628	1.213322	-4.69	0.000	-8.079698	-3.299557
var029	-4.510082	1.195535	-3.77	0.000	-6.865115	-2.15505
var0210	-3.093366	1.182744	-2.62	0.009	-5.423201	-0.7635312
var0211	-4.677324	1.191019	-3.93	0.000	-7.02346	-2.331189
var0212	-4.173703	1.221343	-3.42	0.001	-6.579574	-1.767832
var031	-1.237175	1.164339	-1.06	0.289	-3.530754	1.056405
var032	-3.847874	1.147809	-3.35	0.001	-6.108892	-1.586856
var033	-3.772619	1.164539	-3.24	0.001	-6.066593	-1.478645
var034	-0.787224	1.141273	-0.69	0.491	-3.035368	1.46092
var035	0.0409638	1.150109	0.04	0.972	-2.224586	2.306514
var039	5.40521	1.14116	4.74	0.000	3.15729	7.65313
var0310	-4.308181	1.140617	0.32	0.752	-1.88624	2.607464
var0311	0.360612	1.137908	-3.79	0.000	-6.549695	-2.066666
var0312	-2.397943	1.137502	-2.11	0.036	-4.638658	-.1572278
_cons	7.162242	1.239471	5.78	0.000	4.720663	9.603821

```
F test that all u_i=0:     F(8, 241) =     5.91                 Prob > F = 0.0000
```

•♥♣♠ var 011, var 012, etc. are the dummy variables for the month of the sample. First two figures denote the corresponding year, and the next figure indicates the number of month