VAR-METHODOLOGY IN RISK-MANAGEMENT OF THE BANK'S INTEREST RATE AND EXCHANGE RATE: IS IT POSSIBLE, USEFUL AND VALID IN THE UKRAINIAN BANK MARKET?

by

Olha Venchak

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Abstract

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

This thesis is devoted to risk-management in Ukrainian banks. Value-at-Risk methodology, which is widely used in developed countries, is not popular among Ukrainian risk-managers. The main stone on the road was the transition conditions inside the country, which disturbs market mechanisms. Today the situation is changed!

On the example of one of Ukrainian commercial banks “Kredyt-Bank (Ukraine)” I applied VaR to calculating exchange rate risk and interest rate risk. In calculating exchange rate risk I used untraditional approach. Simulations in VaR for both kinds of risk were made by standard (variance-covariance) and historical simulations methods. Results, which I got, are very useful for planning the stable, profitable and prosperous future of the bank.

By Basel Committee (2004), banks that want to cooperate on the open financial market and to be a strong competitor to developed banks must use in its risk-management VaR methodology.

It is the time to be on the same level with leading countries!

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GLOSSARY

Adequacy of Capital – the possibility of bank to cover its loans with the own capital.

Future value – capital's value after the certain period of time with the interest rate profit.

GAP-method - the difference between some group of assets with respective interest and the same group of loans with respective interest: $GAP_t = A_t - L_t$, it shows positive or negative gap.

Present value - today's value of future cash flows.

Value-at-Risk - tool for estimation the exposure to different kinds of risk, which gives the worst expected loss at a given confidence level with the probability of 95% or 99%.

Chapter 1

INTRODUCTION

Each year banking sector problems attract greater attention on the Ukrainian financial market. Today, the banking system is the main "blood system" between borrowers and lenders; it is the way of almost all possible business finance communications. Its solidity, stability and security show the healthiness of the whole country's economy.

The main issue in this sphere is the improvement of the financial stability and increasing the bank's financial result. "Life is risky", everyone knows this, and hence, one of the basic determinants which directly influence the stability and the result, is risk. Nevertheless, in finance almost everyone would like to benefit from taking additional risk, since every additional risk can be rewarded by the risk premium. Where is the risk coming from? The answer is that the risk has its origin in many sources: human-created (business cycles, inflation, wars) and natural phenomena. It also can be created from the long-term economic growth, technological innovations and so forth. Financial markets cannot be completely protected against all risks (Jorion 2000). Banking risk means the probability of loss according to the specific operation that the credit institution is engaged in. So, the main task of risk-managers is seeking security and maintaining the equilibrium between chances to win (earn excess profit) and risks attached to these profits. To do this the risk-managers should be able to identify, quantify and foresee risks.

There is a wide classification of risks. Banking risks are divided into market risk (interest rate risk, exchange rate risk, equity risk, liquidity, commodity risk and derivative market risk), credit risk (stock and individual) and operational risk (human risk, process risk, external event risk, and

technology risk). But this classification can be flexible, every bank can decide about its own risk classification according to the market conditions it is working with.

Market risk is the next important group of banking risks after credit risk and it means the possibility of a change in the economic condition of the financial institution due to the influence of some market factors. This kind of risk covers about 25% of risk capital in bank (Kumar 2003). He wrote: "Market risk needs more attention in most banks, because if everything seems under control, you're just not going fast…"

In this thesis, I would like to pay the main attention to the risk of interest rate and to the risk of the exchange rate, the most significant types of market risks. The first one means the danger of possible loss because of the volatility of market interest rates and the related change in the values of credits, loans and their present values. The second is the probability of losing capital due to changes in the exchange rates of foreign currency to the domestic currency during the period from the signing of the contract to the real transaction.

Every bank tries to hold interest rate risk under control through the high quality of its management. Consequently, to ensure the most productive way of managing risk, instead of dictating capital and risk-management requirements through a uniform supervisory approach, banks are allowed by the Basel Committee1 to use their own models and expertise for computing the capital required and the risk value (Lucas 2001). This rule extends to all European countries, including Ukraine, but every bank in different countries should adjust its measures with the requirements of its Central Bank (National Bank of Ukraine in our case). Nevertheless, during long time and till now, the Basel Committee advises to use the *Value-at-Risk (VaR)* as the best method of

[1] *Basel Committee on Banking Supervision (1988) is a Committee of banking delegated supervisory authorities, established by the central bank Governors of the group of ten leading countries: Belgium, Canada, France, Germany, Italy, Japan, Luxembourg, Netherlands, Spain, Sweden, Switzerland, United Kingdom and the United States.*

measuring banking risk in the money equivalent. This method predicts the possible losses that will not exceed (1-p) %. But, in 2007, when the Basel II[2] will come into effect, VaR will be not only the recommended methodology, but also the required one for risk measuring in the accounts in those banks, which operate on the interbank market. At that time VaR-measuring will be obvious, but it will not forbid the parallel internal risk measuring, other than VaR. Hence, in the nearest future the National Bank of Ukraine will also require the VaR methodology. This information became available in the guidelines after the Basel Committee of Banking Supervision II. Also, those Polish professionals who already use the VaR-methodology and currently are cooperating with Ukraine's banking system speak about the transformation of the standard system of our risk measuring (the largest Polish bank "PKO", which cooperates with the "Kredyt-Bank (Ukraine)").

Modern European and USA financial markets offer enough instruments that allow full study of behavior of the interest rate and exchange rate and provide predictability of their movement through time. My paper will be the first attempt to describe the evaluation of the exchange rate risk through the VaR-method for the Ukrainian banking market. It will be also the first work in evaluating the interest rate risk through the method based on the VaR methodology and can be considered as the similar to VaR method. There were no attempts for measuring the interest rate risk through the methods based on the VaR in Ukrainian banks till now. As to the exchange rate, it is possible to calculate VaR for it, but almost no bank (the exception are foreign banks) did this till now.

The attractiveness of VaR-methodology is in the simplicity of its idea and realistic predictions. It makes possible to provide single statistic estimating the potential loss to which a bank is exposed during a given period of time with a given degree of confidence (99%) according to the type of

[2] *Basel II (2004) is the document (package) of recommendation for the Central Banks how to calculate the necessary amount of capital to cover bank's risks.*

operation or the portfolio under some market risks. The value of VaR ensures covering of possible losses x during time t with probability p, Pr (VaR>x) = p. This VaR-methodology can be used for measuring different kinds of risk, measuring all of them by this methodology makes it possible for a bank to see the total value of capital under risk. Still banks in Ukraine did not use this method in prediction of possible capital loss because official regulations did not require such risk measuring. Moreover, to have the precise results of calculating VaR the market mechanisms should work well. As far we know market mechanisms in Ukraine are not high developed still. That is why, market interest rate in Ukraine still have very weak correlation with the real interest rate in Ukrainian banks.

The main condition for calculating VaR is simultaneous change of the capital value in response to a change in some factors (e.g. the exchange rate changes, the value of foreign capital changes too at the same time). It is impossible to calculate the traditional VaR for the interest rate risk, because there is no such immediate change of the capital after the change of the market interest rate (today we have already signed contracts of deposits and credits with adjusted interest rates). So the main investigation of this work will be in attempt to build the method based on VaR, which will show the risk of change the market interest rates for the present value of bank's capital.

To use this VaR-modeling for exchange rate, I will need daily data on exchange rates for all foreign currencies included in a bank portfolio of foreign currencies. To apply my model, based on VaR, for calculating the interest rate risk I will also need daily data across different interest rates: quantity of credits and deposits of certain duration (1 month, 3 months, 6 months and so on), of certain amounts; interest rates, given by the NBU, and the Association of the Ukrainian Banks. All of this data will be used in terms of present values. Needed data is available from the "Kredyt-Bank (Ukraine)", from the NBU and from the Association of the Ukrainian Banks.

So, my work is an effort to use VaR methods to calculate exchange rate and the interest rate risks, using data from one of Ukrainian commercial banks – "Kredyt-Bank (Ukraine)" and www.finance.com. Basing on the results, obtained after calculating VaR I will be able to answer on some next questions. Will this methodology give us some useful results for recommending the more likely bank credit and loan policy? What economic meaning the calculated results will have for the bank? It will be possible to make the conclusion about whether Ukrainian financial market and national risk-managers are ready to follow the Basel's requirements and work at the same level with developed countries

Chapter 2

LITERATURE REVIEW

2.1 History of the Risk-Measurement

Financial liberalization, intensification of the competition and the diversification of markets create new problems for banks and good conditions to developing of the new risks. Taking the risk upon the banks is one of the essential principles of banking. But the banking is considered to be successful only in the case when accepted risks are under control, if they are sensible, under the financial abilities and jurisdiction. Achieving this goal provides the basis of internal policy of accepting risks and managing them.

There are always a lot of problems with the aggregation and the measuring the amount of capital under risk and the controlling of such risks (Rogov 2001). The VaR approach, in contrast to other ones, allows the aggregation of different risks to which bank exposures into a one amount. According to Jorion (1997), "VaR measures the worst expected loss over a given horizon under normal market conditions at a given level of confidence". Moreover, VaR method allows the comparison of different types of risks: "Risk can only be compared when they are measured with the same yardstick" (Morgan 1995).

The VaR methodology has been widely adopted for measuring the market risk in bank trading portfolios among European countries and USA during the 1990. According to Holton (2002), the beginning of VaR can be traced back to the New York Stock Exchange in 1922 imposing the capital requirements on the member firms. The earliest work about VaR measure was published in 1945, when the portfolio theory was established. Probably,

the first VaR measure was published by Leavens (1945), when he offered the quantitative example, discussing the portfolio construction. He did not mention VaR, but he spoke about the "spread between probable loses and gains", which means the standard deviation of portfolio market value.

Nowadays, VaR is defined as a method of measuring the value of all kinds of risk. Holton (2002) investigates the fixed holding portfolio, which has known current market value and the future market value could be shown as a random variable, so we can describe this methodology as a probability function. Also we can discern the VaR metrics, as the function of the distribution and the portfolio's current market value (variance of return, standard deviation and 0.95-quantile of loss) and VaR measure as any procedure that, under a given VaR metrics, assigns values for that metrics to portfolios.

According to Holton (2002), VaR has its roots in the portfolio theory and capital requirements (NYSE capital requirements of the early 20-century). In 1952, Marcowitz and later Roy independently published VaR measures. Their works were based on selecting portfolios to optimize them for a given level of risk. The aim of these two authors was the same – to calculate the VaR, but the methods were different: Marcowitz used the simple return metrics and Roy used the metric of shortfall risk that represents an upper bound on the probability of the portfolio's gross return, which could be less than particular specified extreme return. In 1972, Lietar showed the practical VaR measure for foreign exchange rate: he supposed that the depreciation occurred randomly, its conditional magnitude being normally distributed. His work is assumed to be the first in applying the Monte-Carlo method to the VaR measure. During the 1970s and the 1980s markets became more volatile, which required highest leverage and stronger financial risk measure. The resources necessary for calculating VaR through different methods became available in that time too. These factors stimulated VaR methodology to improve. In that time firms demanded the way to measure the market risk

across the incompatible asset categories, but they did not know how VaR might help in those problems. So US managers did a difficult work in adopting VaR methodology for vide use (Holton 2002). During the early 1990's the main issue in developing the VaR-methodology was concerned with the financial risk management due to increasing number of derivative instruments (forwards, futures, options). So far, Ukrainian risk managers do not know precisely how to apply and explain VaR models on the Ukrainian financial market.

The appearance of the name "value-at-risk" has a specific history too, during 1990's it was «dollars-at-risk» DaR, «capital-at-risk» CaR, «income-at-risk» IaR, «earnings-at-risk» EaR and «value-at-risk» VaR. Seems that users did not know exactly, what was "at risk" (Holton 2002).

2.2 Risk Classification

So, VaR (or similar methods) makes it possible to evaluate different types of risk, to see the total amount of capital under risk and to compare the value of different risks. There are different approaches in VaR-methodology, which help to provide risk measure. Before confirming this, I will however define the classification of banking risks (by Mandagelli, 2001):

- *Credit risk* relates to the potential loss due to the impossibility of the partner to cover its duties of repaying the loan and interest. It has three basic components: credit exposure, probability of default and loss in the event of the default.

- *Operational risk* takes into account the errors and potential problems that can be made by the banking workers or equipment in instructing payments or setting transactions, and includes the risk of fraud and regulatory risks.

- *Market risk* estimates the uncertainty of the future earnings due to the changes in the market conditions; this is the risk that the value of assets or liabilities will be affected by movements in equity and interest rate markets, currency exchange rates and prices of the commodities. Market risk can be divided into such main categories (by the Basel Committee on Banking Supervision, 2004):

    1. *Interest rate risk* is the exposure of a bank's financial conditions to adverse movements in interest rates. If bank accepts this risk as a normal part of banking, it can be a huge resource of profitability and the high value for the shareholders. Changes in the interest rates change the net interest income, operating expenses, which affects a bank's profit. Interest rate can affect the bank's balance sheet in three ways: net interest margin, assets and liabilities (excluded cash) and trading positions.

    2. *Equity risk* arises in the case when assets that are included in the portfolio have a market value (securities). The change of the market price of such assets will affect the respective bank's portfolio value.

    3. *Exchange rate risk* is the risk of money loss or asset and/or capital depreciation after some adverse changes of the exchange rates. It consist of the risk of depreciated value of foreign assets portfolio after the adverse changes in the exchange rates and the risk of sign financial agreements of future converting the foreign value, when future exchange rates are stated.

- *Liquidity risk* is caused by the unexpected large negative cash flow over a short period. If the bank has highly liquid assets and suddenly needs some additional liquidity, it may sell some of its assets at a discount.

Main questions I examine in my work apply to the two brunches of market risk – *interest rate risk* and *exchange rate* risk. According to the Basel Committee of banking supervision (1997), interest rate risk is the exposure of a bank's financial condition to adverse movements in interest rates and the exchange rate risk is the risk of loss when a bank in a foreign exchange transaction pay the currency it sold but does not receive the currency it bought. Bank products, which are under the interest rate risk, can be divided into the tradable (transactions, which are shown in banking trade book; include such operations as swaps, spots, forwards and interbank credits) and non-tradable goods (which are reflected in the banking book; here could be simple credits and deposits). In the countries with well-developed stock markets traded goods have speculative character, high risk, but also high proceeds. Nevertheless they take only approximately 10% of total amount of interest rate risk (Rogov 2001). Non-traded interest rate risk is often the larger source of market risk, because every bank carries both fixed rate and floating rate assets. To have cleverer picture about this, let's consider an example: a balance sheet consists of more short-term liabilities than fixed rate assets. Such bank will have losses if when the interest rate rises. If the balance sheet would consists of more fixed rate liabilities and floating rate assets than short time liabilities and interest rates rise as well – the bank will have a gain. My work is focused on the non-traded interest rate risk.

2.3 Basel Committee and Value-at-Risk

Basel Committee affirms that market risks are potentially very significant and should be integrated into the capital framework of risk measurement. New Accord (by Basel Committee) proposed a wide variety of methodologies that could be employed in the internal risk measurement systems based on the VaR. The traditional VaR is applicable to the exchange rate risk, but the interest rate risk needs a little bit different approach, based on the present value of the capital. Actually, it is possible to calculate VaR for interest rate risk but only for tradable goods, their value is constructed on the

stock exchange and every time when the stock price is changed the value of bank capital is changed too. Ukraine's stock exchange market is still very weak, so this risk is also very high. Nevertheless, applied VaR to interest rate risk for portfolio of tradable goods can give unreliable results, because of still weak market mechanisms in Ukraine.

Resent years a lot of discussions were related to the management of market risk on the appropriateness of Value-at-Risk models, which are designed to estimate for a given portfolio the maximum amount of possible lose. The VaR-methodology, as investigated by Bo (2002), is the most popular tool used to estimate exposure to market risk. Bams and Wielhouwer, (2000) stated that this method is not only an internal management tool to check whether traders are within their limits, but it is also a risk measure for the (international) supervisor. Cormac Butler (2001) says: "The indicator of the high volatile VaR portfolio will be also very high, and it's the notice for investors and control organizations that in reality the possibility to have some losses for some certain institution is more dangerous".

2.4 Value-at-Risk Classification and Methodologies

During recent years, techniques used to generate Value-at-Risk measures were divided in two parts:

1. Approach, which determines estimates of volatility under the assumption of normality (local valuation), named also as *parametric approach*;

2. Approach of full-valuation procedures, which tries to model the entire return or revenue distribution named as *non-parametric approach*.

There are many disagreements about which method is better. As Manfredo and Leuthold (1997) indicate, the use of parametric procedures for

developing VaR measures under of assumption of conditional normality3 has been often referred to as the *delta-normal method*. They consider that this is the most correct methodology among the parametric models of VaR in the Risk Metrics theory. It uses the weighted average approach for estimating the standard deviation and correlation among portfolio asset. Rogov (2001) says that under the valuation VaR through delta-normal method it is also possible on the basis of historical data to calculate volatility and correlation of the data to estimate future covariance matrixes. It is the easiest way of calculating the VaR, it is not time-consuming, and in many cases it is adequate. But it has some criticisms, the major relates to the assumption of normality of the return series for estimating volatility and correlation. Another criticism of this method is in forecasting for long horizons at the time when even one-day forecast can fail (Manfredo 1997). Rogov (2001) investigates also such shortcomings as fat tails (VaR estimation in this case will be either underestimated, or overestimated) and inadequacy estimation of the nonlinear instruments, such as option (the option's price is not derived linearly or quadratic, this is the derivative security).

Using the non-parametric (full-valuation) procedures includes such methods of computing as the simple historical simulation, full Monte-Carlo simulation and bootstrapping methods (Manfredo, 1997). In 2001, Rogov underlined also such method as stress-testing.

Historical simulation seems to be the easiest full-valuation procedure. It is built on the assumption that the market will be stationary in the future. Its main idea is to follow the historical changes of price (P) of all assets (N). For every scenario a hypothetical price P* is simulated as the today price plus the change of prices in the past. Evaluation the whole portfolio through simulated prices and portfolio values are ranked from smallest to largest and the designated risk tolerance level becomes the VaR estimate (Manfredo

[3] *Conditional normality means that each return is normally distributed, but the parameters of this distribution may be conditional on the point of time. Thus, the return distribution over the whole sample period is not necessarily normal.*

1997). Rogov (2001) considers that historical simulation method has a lot of advantages:

- It permits non-normal distribution;
- This method is very good for non-linear instruments;
- The entire estimation can be achieved by the easiest way – through the past data;
- Applicable for all types of price risk;
- The presence of the model risk (estimating an inadequate model) is almost impossible;
- It is very easy and the Basel Committee chose it in 1993 as the fundamental method for estimating VaR.

And such disadvantages:

- As a result, the price trajectory is the same for every commodity;
- The assumption that the past can show the future is wrong, but this method is based on such assumption;
- Computation periods are too small and there is a big possibility of making the mistakes of dimension;
- No information about correlation with risk factors;
- There is no difference between the old and the last observation.

These drawbacks can lead to higher possibility of picking up more extreme market events associated with the “fat tails” of the probability

distribution; this causes the overestimation of the VaR. Also, the assumption that the returns are distributed identically and independently, during the long period may be violated (Manfredo 1997). By Jorion (1997), this full-estimated model is more set forth to the estimation error since it has larger standard errors than parametric methods that use estimates of standard deviation.

Monte-Carlo simulation method is based on the modeling of random variable sample with certain characteristics. In contrast to the historical simulation method the changes of asset prices are collected randomly according to some characteristics. This method requires a lot of calculations. Rogov says in his paper that with higher number of observations the accuracy of the method is higher. Jorion (1997) claims it as the most flexible of all VaR estimation techniques. But this flexibility can also bring some problems with the estimation. Other researchers such as Jorion (1997) proposed that Monte-Carlo simulation method is very disposed to specification error, especially with combined portfolios. There are also some other drawbacks pointed out by Manfredo (1997): there is no ability in this method to obtain the definite var-cov matrix for analyzing the marginal impact of an asset on the overall portfolio risk. It could be difficult for risk-managers to understand this method and to make right conclusion.

As an alternative method to the Monte-Carlo simulation the *bootstrapping technique* for VaR estimation is proposed. "Bootstrapping techniques are fundamentally similar to historical simulation but sample past returns with replacement in building the return distribution", considered Manfredo (1997) and Jorion (1997) were sure that this approach can help take into account fat-tailed distributions. But, if we have the lack of observations this method becomes very similar to the historical simulation and Monte-Carlo methods.

Rogov (2001) developed another method of full-valuation – *stress testing.* It is the opposite method to the historical simulation. It simulates scenarios

that are not shown in the retrospective data, but some expected shock events. This is the main advantage of the method. It is applicable for the market structure with some stresses, jumping and shocks. At the same time, this method also makes it possible to calculate the amount of maximum loss for markets with underlined conditions.

The author stressed such advantages of this method:

- It lets to consider different scenarios;
- Stress-testing makes it possible to see the influence of separate factors;
- It answers the question: "If usual VaR shows what can happen in 99%, what can happen in the residual 1%".

And such disadvantages:

- Scenarios are very subjective;
- Scenarios are determined by the consistency of the portfolio and do not include risk, which could be possible for changed portfolio;
- This method can estimate only the amount of possible loses, but not their probability;
- It is not applicable for big portfolios with large number of risk factors.

Dowd (1999) and Ho (2000) proposed one more non-parametric approach to VaR – the *Extreme Value Theory (EVT).* It is based on the indicating the maximal and minimal returns of return distribution series. EVT uses the statistical techniques that focus only on those parts of sample of return data that carry information about the extreme cases. Dowd (1999) defined such pluses of EVT in calculating the VaR:

- Traditional models lead to accommodation of central observations, rather than the tail observations that are more important for VaR. EVT designs tail estimation;

- Parametric approaches usually impose distributions on the return data that makes no sense when used for tail estimation;

- Non-parametric approaches leads to less efficient VaR estimates, because they do not care about how tails should look like;

- EVT can help to solve the problem of how to estimate the extreme quantiles, using restricted data.

But this theory will work only in the case of extreme events. It is always difficult to extrapolate it on the real data and it is sometimes hard to explain the results.

All these approaches do not need the same initial input (circumstances). Delta-normal method needs normal distribution of the evaluated parameters. Historical simulation – supposes that the market will be stable in the nearest future. Stress-testing needs high volatility of the parameters and periods of market stress for reliable results. Monte-Carlo do not necessary need normal distribution of the parameter, it also supposes that the data will be chosen randomly. EVT needs for true prediction some extreme events on the financial market. If the chosen model is not adequate (has a lot of mistakes) then so-called *model risk* is possible. We can verify the presence of this kind of risk through the *back-testing.* Suppose, c – confidence interval, T – number of observations, $T(1-c)$ – expected number of exceptions; than we will accept VaR model if the number of exceptions is in the range $-a\sqrt{Tc(1-c)}+T(1-c) \prec x \prec a\sqrt{Tc(1-c)}+T(1-c)$, and reject it otherwise (Jorion 2001).

Ho (2000) tried to do some comparison between some of these methods indicating which one is the best for Asian market under volatile market conditions. They compared EVT approach with the var-cov method and historical simulation method. The analysis of actual losses, which exceeds VaR, showed that in all Asian countries both under confidence level 95% and 99% the prediction of expected loss was most accurate under the EVT approach. Here, exceed losses, comparing with predicted amount of capital under the risk, were almost everywhere 0 (see Ho, Burridge 2000). They showed that the result obtained through the var-cov method seriously underestimated VaR and conclude that the EVT is more conservative approach for markets with high volatility. So, the result showed that standard methods of VaR, which are focusing on the probability density function, will show less satisfactory results comparing with those methods, where the probability includes some extreme events, like EVT. Results of my work of my work became opposite, because of absence on our market during last 3 months extreme events, our market is rather stationary.

In spite of the fact that there are many different suggestions from foreign banking experts about which methodology is better, there is no real implementation of VaR theory in Ukrainian banks by our specialists. Currently, interest rate risk is measured in Ukrainian banks though the GAP-method But this method is too primitive, it does not give the cumulative sum of risks and the sum of capital needed for covering the risk is always incorrect and exaggerated (Rogov 2001). The situation with exchange rate is very similar to the interest rate: banks try to hold the safety ratio of open short and long positions of different currencies oriented only on the National Bank required standards. Such risk measuring does not make possible to see the amount of lost capital. But in some banks, mostly with foreign capital or foreign banks, VaR methodology is used for calculating exchange rate risk; so far, this is very rare situation. Risk-managers do it only when they should make a report for the foreign owners.

So, as we can see, the VaR methodology is very useful in banking activity to maintain the high quality of its business, despite of some problems with it; its final result can bring to the banking risk-managers a lot of needed information. Nevertheless, this methodology is not the perfect one and can't help us in some cases of banking activity, such as, for example, the risk of interest rate changes for non-traded goods. That is why I decided to make one additional step on the way of improving VaR-methodology – to construct the "similar" methodology, which allows viewing the current situation with the banking balance sheet, according to the assumption that the interest rates on Assets and Loans will be changed. It will also help to the risk-managers to see the risk of lost present value of capital.

Chapter 3

METHODOLOGY

Among many economic processes more and more attention is paid to the economic analysis of the financial activity of commercial banks in Ukraine. We can underline such main points of this analysis:

- Estimation of the financial situation in the bank and the results of the bank's activity;
- Comparison of the financial situation with expenditures;
- Analysis of the results to make correct management decisions about improvement of the financial activity.

Risk accompanies every financial activity; therefore it should be economically explained and predicted. The methodology I am writing about can help to do this. VaR can provide economic analysis of the exchange rate risk and the interest rate risk for the bank's portfolio of non-tradable goods.

3.1 Classical VaR Computation

The classical VaR can be calculated through:

- *Distribution of portfolio return* $-VaR = a\,d - m$, where a – corresponding confidence level; d and m standard deviation and mean, respectively, of the portfolio's return. The result shows the lowest return in the worst case.

- *Rate of portfolio return* - $VaR = P_0 * (a\,d - m)$, where P_0 is the initial value of portfolio, a – corresponding confidence level; d and m - standard deviation and mean respectively of the portfolio's return.

- *Portfolio* VaR – (if portfolio consists of N assets and the return on portfolio consists of linear combination of all assets in the portfolio) – $VaR_p = a\,d * P_0$.

First of all, I would like to specify steps of calculating the standard VaR model, which is the fundamental point of my research. For simplicity, let's assume that we need to calculate the VaR of a $100 million equity portfolio over 10 days at 99% confidence level and the estimated measure of variability of risk factors is (standard deviation) s. So, such steps are required for VaR:

- Current equity portfolio ($100 mil);
- Measure of variability of the risk factors (s = 15%);
- Set the time horizon (to 10 days);
- Set the confidence level (e.g. 99% or 2.33 (the critical value corresponding to it) for normal distribution);
- Calculate the worst loss by accumulation all above information (VaR = $7 mill).

Or such simple calculation:

$\$100 mill * 15\% * \sqrt{10} * 2.33 = \$7 mill$, (Jorion 2000).

In other words, VaR is an upper limit for potential losses occurring between dates t and t+1. Thus, the estimation of VaR depends on (1) the "*time horizon*" over which the portfolio's change in value is measured and (2) the "*degree of confidence*" chosen by the risk manager (J.P. Morgan, 1995). Widely used are confidence levels of 95%, 98% and 99%. The time horizon, as Jorion states, represents the time required to hedge the market risk; longer horizons lead to higher default frequencies and to reduced number of independent

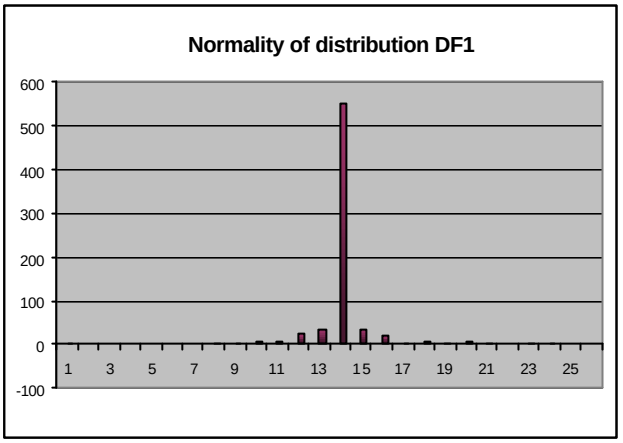
observations. By the Basel Committee, internal models approach should impose 99% confidence level over the 10-business-day time horizon. Also, by the Basel Committee the optimal time horizon is 10-day, which makes possible to detect the potential problem and to compare the tradeoff between this benefit and costs of frequent monitoring. Also, they choose the 99% confidence level, because it reflects the tradeoff between the desire to stay safe and the adverse effect of capital requirements on banks returns (Jorion 2000).

3.2 Parametric and Non-Parametric Approaches for VaR

There are really a lot of approaches for calculating VaR, which depend on the result we are looking for. But each of them also depends on the methodology applied to the VaR. In my paper I verified two of them: *historical simulations method*, as one of non-parametric approaches and *delta-normal valuation (variance-covariance or standard) approach* as one of the parametric methods. There is not one the best method, each of them has its pluses and minuses (look at the Table 1, Appendix). For historical simulations, the choice of the returns (deviations) distribution does have a significant consequence for VaR estimate. It is common to estimate quantiles by assuming normal distribution. The variance-covariance approach assumes normal distribution of parameters and does, therefore, not take into account a possible non-linearity of price-yield relationship. If returns are not normally distributed, then correlation coefficients are seriously weakened and may give misleading answers. The normal distribution hypothesis can not be rejected for liquid markets (stock market), at the same time the illiquid markets (market for credits and deposits) have often very moderate value changes in a number of successive days, which leads to a high concentration of values around the mean. So, I decided to choose these two approaches, because in the case of our country we would see the difference in prediction by the parametric and non-parametric methods (look in the literature review). Moreover, the normal distribution of deviations of interest rates and exchange rates (with high

concentration around the mean) supports my choice. On the Figure 1 we can see the see the normality of distribution deviations of deposits from Individuals up to one month. There are the similar distributions for every other type of variable.

Figure 1**. Normality of Distribution of Deposits from Individuals Up To 1 Month.**



3.3 Method of Historical Simulations

Method of historical simulations is one of non-parametric methods. It supposes the transferability and validity of historic data for the future. This means that the market in the future will be stationary, which is assumed in the case of Ukraine. Historical simulation will never estimate VaR to be larger than the worst loss observed in the sample. This is the major shortcoming of this method. The historical data may looks fine, but on the market the history has no great influence, especially in the liquid markets, where the situation can change every minute. To use this method, we need to choose the time period

T, during which we can obtain historical changes of prices P on all assets N, which are included in the portfolio.

$$\Delta P_{i,t} = P_{i,t} - P_{i,t-1},\ i = 1,2,...,N,\ t = 1,...,T$$

For every one of this scenarios T we should simulate hypothetical ?* of every asset in the future, as its current price plus the changed price according to the scenario:

$$P_{i,t}^{*} = P_{i,0} + \Delta P_{i,t}\ \ i = 1,2,...,N,\ \ t = 1,...,T$$

We also need to estimate whole portfolio respective to the simulated prices and for every scenario we should calculate how today value of the portfolio (V^t) can change:

$$\Delta V_t = V_t^{*} - V_0,\ t = 1,2,...,T\ ,$$

V_t^{*} is the value of portfolio with simulated exchange rates, V_0 - value of the initial portfolio.

We need to sort T observations of changed portfolio by the diminishing rule (from the highest growth to the lowest deviation) and number them from 1 to T. According to the confidence level α, calculated VaR shows the maximum loss that will not exceed α? times.

This method is very easy to use if we have daily data. The more observations we have, the more accurate estimation we will receive, because the old data will not have a great influence on the new tendency on the market.

3.4 Delta-Normal Method (Variance-Covariance Method)

The first and basic assumption for the delta-normal method is that the portfolio's yields or the deviations of interest rates are normally distributed. This assumption is sometimes very convenient, because the portfolios of normal variables are themselves normally distributed. Jorion (2000) published the simple technique of how to calculate VaR by var-cov matrix approach. As this method is appropriate only for linear combinations of risk factor/the value of instrument, the first step will be to calculate the value of portfolio in the initial point

$V_0 = V(S_0)$, where S is a risk factor.

Taking the derivative of the value in the point, we can define the sensitivity of portfolio to changes in prices, evaluated in the current position V_0. This should be called a modified duration (Δ_0), so, the value of potential loss in dV can be computed as:

$dV = \frac{\partial V}{\partial S}\Big|_0 dS = \Delta_0 * dS$, where dS involve the potential change in prices.

In this case (this technique is most appropriate for exchange rate risk evaluating), the portfolio VaR will be calculated as:

$VaR = (\Delta_0 * V) * (a * d)$, (Jorion 2000).

It should be underlined that with the shorter horizon, Delta-Normal approximation becomes better, because the quality of approximation depends on the type of instrument, its maturity, volatility of risk factors and the VaR horizon (Jorion 2000).

The simulation by the standard local valuation method – Variance-Covariance should contain such steps:

1. Find the relative deviations of interest rates across my hole data $\Delta i = \frac{i_2 - i_1}{i_1}$;

2. Calculate the mean square deviation (the standard deviation) $d_i = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n(n-1)}}$, which is calculated on the basis of relative deviations;

3. Calculate the maximum possible deviation of the interest rate, which is expected by the risk-managers with the probability of 99% during 10 days. It will be the maximum possible forecast.

The absolute (maximum possible) deviation calculates as: $\Delta i_p = 2.33 * \sqrt{10} * d_i * i_{Max}$.

4. Calculate the forecasted values for credits and deposits not longer than 10 days (the time horizon established by the Basel Committee).

3.5 Calculation of the Exchange Rate Risk through the VaR

As I have already stated, we can calculate different predictions of possible loss by the VaR. Exchange rate risk is one of the most significant market risks, so the prediction of possible loss according to this risk is an important duty of risk-managers. Every bank, which has a license of the NBU, may hold its capital in different currencies, operate and speculate with them, trying to earn additional profit. This means that every bank is exposed to the exchange rate risk. To have a good prediction of the possible loss, risk-manager should have a good prediction of the possible change of the exchange rates. Till now, Ukrainian banks did not built the prediction of the possible loss and tried to adhere to the National Bank standards of foreign currency measuring. In my paper, I did a one step further – built the prediction of the possible loss, which shows that the forecasted possible

maximum should not exceed the calculated amount with 99% of confidence level. The most important difficulty of this task is in the prediction of the possible changes in the exchange rate. So, I will simulate the exchange rate changes on the basis of the NBU (www.finance.com) database. In Bank, which I analyze, exchange rate risk depends on the portfolio of such currencies as Hryvna, American Dollar, Euro, Polish Zloty, Canadian Dollar, Great Britain Pound Sterling and Russian Ruble. The work contains such steps:

- simulation of possible change the exchange rates (USD/UAH, EUR/UAH, CAD/UAH, GBP/UAH, RUB/UAH, PLN/UAH). The simulation for every exchange rate I will do by the 2 methods, which I described above – historical simulations and variance-covariance methods;

- estimation of the exchange rate currency position;

- multiplying of the simulated change of the exchange rate on the estimated currency position by every foreign currency, which is in the banks' portfolio;

- $VaR = Pos_c * \Delta d_c * 2.33 * \sqrt{10}$, where

Pos_c - estimated banks' position, according to every currency; c=USD, EUR, CAD, GBP, RUB, PLN;

Δd_c - simulated change of exchange rate, according to every currency; c= USD, EUR, CAD, GBP, RUB, PLN ;

2.33 – coefficient, correspondent to the 99% of confidence level;

$\sqrt{10}$ - fixed time horizon.

After calculating VaR for every currency separately, we would like to see the total amount of capital under the exchange rate risk. There are two possible strategies to do this: we can add together obtained results for every currency or we can calculate the total matrix of correlation of all exchange rates. Because of correlation, results should be lower than after simple adding, because the influence of different factors, which influences one on other in a single whole, diminishes the influence of separate factors.

3.6 Similar Method to VaR, Based On Historical Simulations and Delta-Normal Simulations

As I have already mention, traditional VaR is very good for calculating the possible loss of the bank's assets where the revaluation of the worth of the capital is immediate after the factor has changed caused to the asset. For example, I decided to calculate traditional VaR through Historical simulation and Delta-Normal simulation for the exchange rates risk. As the exchange rate changes, so the value of the foreign currency position in the banking balance sheet changes too. Thus, the classical VaR method is applicable in this case

But what should we do if there is no immediate revaluation? Such situation can be shown in my next example with interest rates on the non-traded banking goods (asset and loans). Really, we can't adjust the interest rate according to the today's market ones on the assets and loans, because we have already signed agreements about the interest rate on certain duration in the past. But still we have a risk today; respective to the new market rates the bank will have the revenue or the loss. That is why the analysis of present value of bank's assets and loans should be under the permanent control. Also, risk-managers should predict possible range of changes the interest rates on assets and loans in the future. According to this prediction they can also give some recommendation about what amounts of credits and deposits can be used and under what interest rates the bank can operate today to hedge the

balance of unprofitable and profitable levels. Also, in many foreign studies the traditional measures of risk of interest rate deviations were focused on the influence of changes of the interest rate on the net interest margin. But today's research provides new assumption that changes of interest rate affect not only the net interest margin, but also the value of assets and liabilities in the present time (Buschegen 1998). So, instead of investigating the effect of interest rate changes on profits, recent methods focus more on the present value of a bank's capital.

That is why I am sure that this approach will find its users and strong support among risk-managers in different financial institutions.

On the basis of analyzed data I did the evaluation of volatility of interest rates according to historical simulation and variance-covariance simulation approaches. My data consists of 24 816 observations (almost 3 years of daily observations for UAH, USD and EUR for deposits and credits up to 1 month, 3 months, 6 months and 12 and more). These are the main steps that I have done calculating the interest rate risk:

1. For every balance item of assets and loans under the interest rate I will calculate the present value (PV) as

$$PV_{t\to\infty} = \frac{S_j}{(1+i)^t}, \text{ where}$$

S^j – balance value of the ?-item,

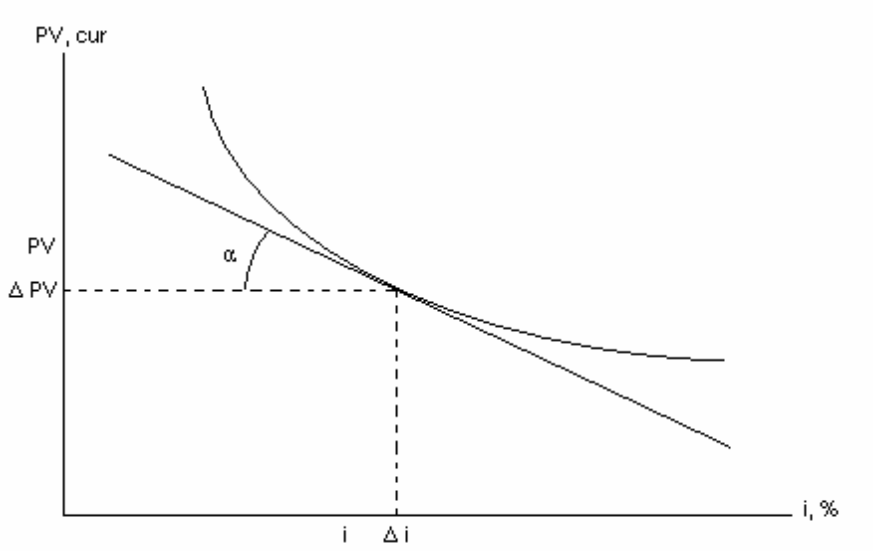
i – weighted average interest rate of this item,

t - time.

So, instead of evaluating the influence of interest rate changes on the profit, we have to focus more on the bank's present value.

2. Now it is possible to calculate the changed present value of the capital according to the changed interest rate. According to the picture I derived the equation below:

3. Figure 2. **Dependence of Present Value and Interest Rate**



$$tga = \frac{dPV}{di}$$

$$\left(\frac{S}{(1+i)^t}\right)' = \frac{S'*(1+i)^t - S((1+i)^t)'}{(1+i)^{2t}} = -\frac{St(1+i)^{t-1}}{(1+i)^{2t}} = -\frac{S}{(1+i)^t}\frac{t}{(1+i)} = -PV\frac{t}{(1+i)}$$

Where $\frac{t}{(1+i)}$ - modified duration in case of calculating interest rate risk (Jorion 2000).

4. The fourth step is to calculate the VaR (PV) separately for assets and liabilities. Here can be calculated so called classical approach: how the present value of capital or portfolio will be changed if the interest rate will change on one percentage point (0.01%)?

$$\Delta PV_{\Delta i} = -PV * \frac{t}{(1+i)} * \Delta i$$

.

So, I calculated VaR in my work through this equation

$VaR\ (PV\ ) = -PV\ * \frac{t}{(1+i)} * \Delta i_p$, where Δi_p is the deviation of market interest rate.

The main task of my work was to simulate the possible change in the interest rate (Δi_p) correctly. The simulation was made also by two methods, which I have already described – Historical and standard Variance-Covariance method of simulations.

There is a problem with the data: the official market interest rate is only for deposits and credits with duration 1 month, 3 months, 6 months and 12 and more months. At the same time every bank has wider spectrum of interest rates – up to 1 month, 1-3 months, 3-6 months, 6-12 months and more than 12 months. I decided to redistribute the base of interest rates from bank's classification to the market classification.

Now, calculate the VaR (Total) – VaR of the portfolio of Asset-Loans under the interest rates. For this, let's assume that we have k of different market interest rates for k duration. V - vector, which consists of VaR (PV) for the portfolio of Assets and Liabilities under interest rates, M - the matrix of correlation of all market interest rates of the distributed Assets and Liabilities.

$$VaR(Total) = \sqrt{V^T MV}$$

Result is maximal expected change of the present value of the bank's capital according to the possible changes market-given interest rate during 10 days with the probability of 99%.

3.7 Back-Testing

VaR models make sense only in case when they predict risk reasonably well. According to Jorion, Back-testing is a formal statistical framework that consists of verifying that actual loss is in line with projected loses. It consists of the systematic comparison of historical VaR forecasts with the associated portfolio returns. If the Back-testing shows perfect or acceptable results, we can conclude that the model we chose is good for forecasting. If not, the model should be reexamined for the correct assumptions, other parameters or other model approach. The Back-testing mechanism was the basic point for the Basel Committee to allow for internal capital requirements in bank use VaR models. Such controlling measure can help to avoid the situation, when bank underestimates its risk in order to cooperate on the international level. Though, system of Back-testing verification should be designed in such a way as to maximize the probability of detecting banks which would like to understate their risk (Jorion 2001).

If the model gives a good fit, the number of observations that fall outside the VaR should correspondent to the chosen confidence level. These observations that are out of the line are known as the exceptions. If there are too many exceptions, the model underestimates risk. Here the greatest problem is hidden, because bank can allocate too little capital to cover the risk. On the other hand, if the model shows too little exceptions, it can indicate excess or inefficient capital allocation.

Basel Committee derived its own rules for Back-testing directly from the failure rate test. There are two possible types of errors: type 1 error means that the correct model is rejected and the type 2 errors means that the wrong model is accepted. You can see these results below:

Table 1. **Types of Errors According to Type of Decision**

Decision	*Model*	
	Correct	Incorrect
Accept	***OK***	***Type 2 error***
Reject	***Type 1 error***	***OK***

Also, Basel derived the possible number of exceptions according to every confidence level. Basel Committee requires from the banks which want to work on the open market to calculate their VaR with 99% confidence level. These results are represented below:

Table 2. **Basel Committee Requirements to Exceptions**

Probability Level p	VaR Confidence Level	Nonrejection Region for Number of Failures N		
		T= 255 days	**T= 510 days**	**T=1000 days**
0.01	***99%***	***N<7***	***1<N<11***	***4<N<17***
0.025	***97.5%***	***2<N<12***	***6<N<21***	***15<N<36***
0.05	***95%***	***6<N<21***	***15<N<36***	***37<N<65***
0.075	***92.5%***	***11<N<28***	***27<N<51***	***59<N<92***
0.1	***90%***	***16<N<36***	***38<N<65***	***81<N<120***

This table was constructed by Jorion (2000).

At the same time Basel constructed 3 categories of results, obtained by banks. Green zone banks are those that admitted 0-4 exceptions, Yellow zone – 5-9 exceptions, 10 and more – Red zone. Basel Committee allows to cooperate on the open market only the banks from the Green zone and sometimes, according to the market conditions, from the Yellow zone.

The conclusion about the adequacy of chosen model (historical simulation or variance-covariance simulation) I made on the basis of back-testing. I compared the predicted deviations of exchange rate and interest rate with real deviations on the graph, supposed to be lost with the probability 99% with the actual loss. If the back-testing shows acceptable results, the VaR model is correct. The best forecast with VaR-method is made up to 10 days, assuming that during this time the situation on the market shouldn't change dramatically and the results could be easily adjusted. For the exchange rate risk the back-testing showed how good the simulated exchange rates fit to the real. In the case of interest rate risk the back-testing showed how suitable are simulated numbers of interest rates to the real ones.

We can see Back-test results in numbers, comparing predicted simulations with real numbers or the obtained results we can see on the graph. The second way of checking the model is easier and correct, so in my work I will check the results through the graphs.

If the Back-testing shows good results on the historical numbers, this means that the future prediction should be good too. Obtained final results will be used by the risk-managers, as additional method for forecasting the possible troubles for the bank.

Chapter 4

DATA DESCRIPTION

For calculating the exchange rate risk through the VaR method I need the data of daily exchange rates of the currencies in the bank's portfolio (USD/UAH, EUR/UAH, CAD/UAH, GBP/UAH, RUB/UAH, PLN/UAH or other currencies, which the bank is operating with) and the corresponding daily currency positions. The classical VaR can easily calculate the possible loss/gain from this type of risk and I will do it on the basis of exchange rates data collected on www.finance.com from NBU.

For calculating the amount of capital under the interest rate risk, the main source I will use is the www.finance.com (Ukraine data). Here, the obtained data (market interest rates) is calculated in most cases as the mathematical average of interest rates (by the types), which is collected from the commercial banks every day. Association of Banks in Ukraine estimates the market interest rate in such a way too. Also, I will need the bank's interest rates for every type of credits and deposits for individuals and corporate bodies. Also, for simplicity of explanation my results, I did not calculate the VaR for the real bank's portfolio, nevertheless this methodology will be valid in real conditions. I assumed that the portfolio consists of equal sums (UAH 1000, USD 1000 and EUR 1000) of Credits and Deposits under different interest rates. This will make easier the process of understanding the methodology, comparing amounts of possible loss that are under different interest rates of Credits and Deposits, and the explanation of the estimated results.

I will need the daily data of market interest rate and bank's interest rate by credits and loans for individuals and for corporate bodies. So, the data will include:

- Market interest rates on credits for individuals (1 month, 3 months, 6 months, 12 months) and bank's interest rates on credits for individuals (up to 1 month, 1-3 months, 3-6 months, 6-12 months and more than 12 months);

- Market interest rates on credits for corporate bodies (1 month, 3 months, 6 months, 12 months) and bank's interest rates on credits for corporate bodies (up to 1 month, 1-3 months, 3-6 months, 6-12 months and more than 12 months);

- Market interest rates on deposits from individual (1 month, 3 months, 6 months, 12 months) and bank's interest rates on deposits from individual (up to 1 month, 1-3 months, 3-6 months, 6-12 months and more than 12 months);

- Market interest rates on deposits from corporate bodies (1 month, 3 months, 6 months, 12 months) and bank's interest rates on deposits from corporate bodies (up to 1 month, 1-3 months, 3-6 months, 6-12 months and more than 12 months).

This data is in three types of currency – UAH, USD and EUR and 730 days data is observed.

Whole data set was collected daily from 01.01.2003 to 01.01.2005.

In the summary statistics, which are represented in the Appendix, the maximal, minimal and mean observations are stated. The total number of observations is calculated too.

Chapter 5

ESTIMATED RESULTS

5.1 Back-Testing

Obtained results I presented in the form of graphs and tables. As I wrote before, to calculate the VaR of interest rate risk I need to have simulated deviations of the interest rates. The conclusion about accuracy of simulation procedure is based on the back-testing. So, for example, on the graphs below you can see the results of provided back-testing for the simulated deviations of interest rate on credits for individuals up to 1 month (UAH) and the simulated deviations of interest rate on deposits from individuals up to 12 months (EUR). Graphs for every other simulated variable you can see in the Appendixes.

On the first graph you can see three trends: the real trend of interest rate deviations on credits for individuals up to 1 month (firm line), the trend of simulated deviations of this interest rate by the historical simulation rule (darker dotted line) and the trend of simulated deviations of this interest rate by the variance-covariance (standard) method (lighter dotted line).

As we can see both simulations showed almost the same results, these both lines are above then the real trend. Why they are above? The simulation should include all possible worst cases that can happen with the bank. According to the previous suggestions about present value I can conclude: if the market interest rate on the credits will rise, the present value of banks' capital will decline. This is negative situation for the bank. That is why the simulated changes of interest rate on credits are above the real trend. Standard method gave results that are slightly above those given by the historical simulation method. This means that under the standard method of simulation

the bank is more assured from negative events then under the historical simulation method. In this case banks' risk-managers should be more oriented on the standard simulation method, which gives more secure results. Of course, if bank are ready to risk, it can choose historical simulation method, to have higher revenue. Looking on these trends, we can see two interceptions with the real data deviations. These interceptions should be called exceptions. According to the Basel Committee requirements, for the 99% confidence level prediction and 510 days is permitted to have up to 11 such exceptions (Table 2). So, my forecast gives reliable results.

Figure 3. **Back-testing: Credits for Individuals Up To 1 Month**

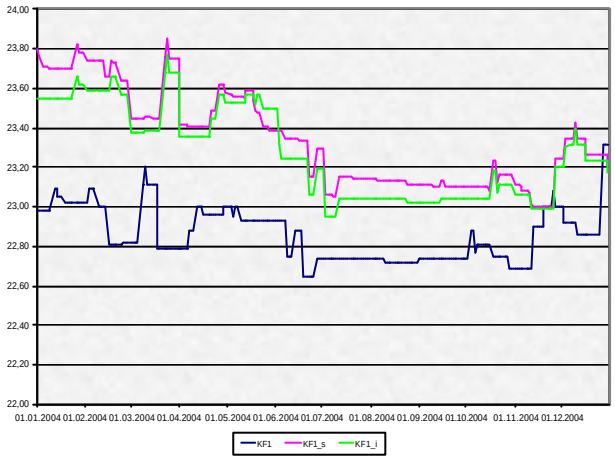
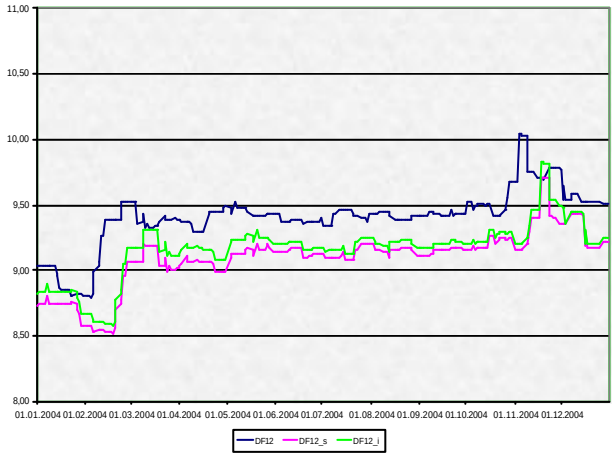


Figure 4. **Back-Testing: Deposits from Individuals Up To 12 Month**



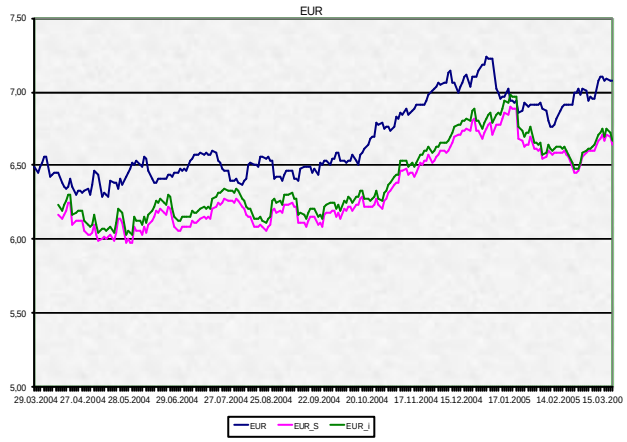
On the second graph is the similar situation, only the simulated deviations are for the deposits from individuals up to 12 months. The

simulated trends are below the real data deviations. Such situation is because for every bank the worse situation is if the market deposits interest rate decreases. This means that the bank's capital present value falls and bank will have less profit. Simulated trends on this graph show almost the same predictions too. Again the variance-covariance method gives more secure results of the simulated deviations. In this case bank should be oriented on the standard method to be surer in the capital safety. Moreover, the standard simulation method has no exceptions and the historical simulation method has one exception.

Similar results of back-testing we can observe for every other variable.

For checking the exchange rate deviations for accuracy I did the back-testing too. On the graph below back-testing for EUR/UAH exchange rate is represented. The firm line shows the real exchange rate deviations.

Figure 5. **Back-Testing: EUR/UAH Exchange Rate**



Darker dotted line represents historical simulations; it is closer to the real data. With the lighter dotted line the standard deviations are marked; it is represents results with higher reserve of safety. In the case of exchange rate deviations, it is less likely for bank to have decrease exchange rate; it means the devaluation of the currency and the loss for the bank. As we can see, in

the case of Euro exchange rate deviation simulations the standard method showed only one exception, which means that this is a good prediction according to the Basel Committee requirements.

5.2 Value-at-Risk Results, Interest Rate Deviations

Lets look on the estimated results of possible loss of present value the banks' capital resulting from the deviations of the interest rate. I will explain the results I have received on the example of the calculated VaR for the credits to firms in UAH. The table with these results you can see below.

The first line contains real data – real market interest rate on the 31.12.04 for different duration. Delta-rate (variance-covariance and historical simulations) means the simulated deviations of the market interest rate by the chosen methods – standard and historical simulations.

The next section contains data from the "Kredyt-Bank (Ukraine)" (interest rates and durations). But I decided to take portfolios for every type of credits and deposits in the same amounts for the simplicity of explanation. So, the sum of credits and deposits will be unreal, equal for different deposits and loans. Interest rates that are represented in the line below are the real bank' interest rates on credits of different duration. Duration means the number of days in a certain time period. The next line contains the calculated future value of every portfolio under the certain interest rate and the corresponding number of days.

As we can see, the market data includes four columns for 1 month, 3 months, 6 months and 12 months. At the same time, the bank's data is five time-periods. To solve the problem of this disparity, I recalculated the market data (4-segment data) according to the bank's data (5-segment data).

By the same principle I recalculated the obtained deviations of the interest rate to have five time-periods. The next line, as we can see, is the

calculated present value of the portfolio. I will need this index to calculate the Value-at-Risk. So, the next line is my first result – calculated VaR by the formula described in the methodology and according to my data. VaR 1 by the segments contains calculated results by the variance-covariance simulation method for time-segments, acceptable to bank. VaR 2 means calculated VaR by the historical simulation method. VaR 1 and VaR 2 by the duration include same results recalculated to the market standards. In order to see the possible loss of present value the portfolio of credits to firms in UAH with probability 99% for 10 days time horizon, I constrained the matrix from vectors of correlation of the calculated VaRs. Finally, I received VaR 1 (by the variance-covariance method of simulation) that is equal 5.49 and VaR 2 (by the historical method of simulation) that is equal 4.75 from total amount of capital 5000 UAH. This loose is equal 0.11% (0.095%) of total sum. According to the back-testing, the first method should give us more secure results, then the second. Our forecast became true, because VaR 1 is larger then the VaR 2.

Table. 3 **VaR for the Credits to Firms, UAH**

Market Data	**1M**	**3M**	**6M**	**12M**
Market Interest Rate (Last)_31.12.04	22,45%	23,00%	23,73%	24,23%
Delta-Rate (Var-Cov. sim)	0,36%	0,32%	0,23%	0,22%
Delta-Rate (Hist. sim)	0,30%	0,29%	0,20%	0,19%

Credits	<1m	1-3m	3-6m	6-12m	>12m	**Sum**
Input Data						
Sum	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	**5 000,00**
Interest Rate	*21,23%*	*21,33%*	*20,97%*	*20,78%*	*19,78%*	**19,18%**
Durarion	*24*	*40*	*150*	*300*	*600*	
FV	1 012,74	1 023,38	1 086,18	1 170,79	1 325,15	**5 618,24**
Waighted Average Market Interest Rate	22,45%	22,52%	23,46%	24,05%	24,23%	
Waighted Average Delta-Rate (Var-Cov)	*0,36%*	*0,35%*	*0,s26%*	*0,22%*	*0,22%*	
Waighted Average Delta-Rate (Hist.sim)	*0,30%*	*0,30%*	*0,24%*	*0,19%*	*0,19%*	
PV	999,34	1 000,85	996,06	980,73	927,62	**4 904,60**
PV/S	**0,9993**	**1,0008**	**0,9961**	**0,9807**	**0,9276**	**0,9809**
VAR 1 (PV) by the Diapasons	**-0,19**	**-0,32**	**-0,87**	**-1,45**	**-2,68**	**-5,50**
VAR 2 (PV) by the Diapasons	**-0,16**	**-0,27**	**-0,78**	**-1,25**	**-2,30**	**-4,76**

VAR 1 (PV) by the Durations	**-0,46**	**-0,36**	**-1,07**	**-3,60**		**-5,50**
VAR 2 (PV) by the Durations	**-0,40**	**-0,32**	**-0,94**	**-3,10**		**-4,76**

Matrix of Correlation Market Interest Rates

-0,46	**-0,36**	**-1,07**	**-3,60**	
1,0000	*0,9787*	*0,9699*	*0,9632*	**-0,46**
0,9787	*1,0000*	*0,9969*	*0,9922*	**-0,36**
0,9699	*0,9969*	*1,0000*	*0,9978*	**-1,07**
0,9632	*0,9922*	*0,9978*	*1,0000*	**-3,60**

VAR 1 (Credit Portfolio)	**5,49**

Matrix of Correlation Market Interest Rates

-0,40	**-0,32**	**-0,94**	**-3,10**	
1,0000	*0,9787*	*0,9699*	*0,9632*	**-0,40**
0,9787	*1,0000*	*0,9969*	*0,9922*	**-0,32**
0,9699	*0,9969*	*1,0000*	*0,9978*	**-0,94**
0,9632	*0,9922*	*0,9978*	*1,0000*	**-3,10**

VAR 2 (Credit Portfolio)	**4,75**

What these results mean? According to the Value-at-Risk definition, assumed portfolio, real rates and their simulations: "Kredyt-Bank (Ukraine)" is exposed to the loss of 0.11% (0.095%) of total portfolio with the probability 99% during 10 days time horizon if the market interest rates on credits to firms will deviates as the standard method (historical simulation method) predict.

The similar explanation is acceptable for every table with estimated results in Appendixes.

The last step in calculating of the possible loss according to the interest rate deviations was to construct the huge matrix of correlation of all VaRs calculated for every credit and deposit in every currency. The matrix gave such results: VaR by the standard method shows the possible loss UAH 168.23 and the VaR by the historical method shows the possible loss UAH 155.18, which means that the bank with assumed portfolio is exposed to loose 0.28% (0.25%) of total (5000 UAH, 500 EUR and 5000 USD) capital that is under the interest rate risk. This is not the great loose, but nevertheless we should be secure of this risk. Taking the real "Kredyt-Bank (Ukraine)" portfolio, which is equal to 1 250 mln UAH, the possible loss of capital

according to interest rate is equal 3.36 mln UAH by the standard method and 3 mln by historical simulations method.

5.3 Value-at-Risk, Exchange Rates Deviations

In Appendix we can see the table with calculated possible loss according to the risk of the exchange rate deviations on the example of the "Kredyt-Bank (Ukraine)". Such risk is possible if bank has open position in currency with possible risk of volatility. I again assumed that the open position in every currency is equal to the same sum 1000. This is impossible situation in reality, but such assumption makes easier the explanation of the VaR. The next two lines (sigma standard and sigma historical) contain forecasted deviations of the exchange rates according to the standard method and historical simulation respectively.

According to the formula from the methodology I calculated VaR for every currency by these two methods. To see the total picture of possible loss of capital according to the deviations of the exchange rates I constructed the matrix of correlation of VaRs for every currency. These results also confirmed the back-testing forecast that variance-covariance method gives more secure results. So, VaR by the standard method is equal UAH 957.42 and the VaR by the historical simulation method is equal 831.72. We can understand these results as bank with such exchange rates and such portfolios is exposed to the loss 3.19% (2.77%) of total (1000 USD, 1000 EUR, 1000 PLN, 1000 CAD, 1000 GBP, 1000 RUB) capital from combined portfolio with the probability 99% during 10 days time-horizon according to the predicted change of the exchange rates by the standard method (historical simulation method).

Chapter 6

IMPLICATIONS

In this paper I have evaluated interest rate and exchange rate risks through the recommended methodology by Basel Committee II – VaR.

Which results I got and how can I extrapolate them to give a piece of good advice to the Asset and Loan Administration? First of all, let's look to the final results. VaR showed me that the "Kredyt-Bank (Ukraine)" is exposed to loose 3.6 mln UAH by var-cov method (3 mln UAH by historical method) according to the real interest rates, bank's rates and portfolio. Calculated VaR shows the waste capital because of volatility of interest rates. These both sums show the cumulated loss of all interest rates deviations. Hence, we can say that the interest rate risk in "Kredyt-Bank (Ukraine)" is equal to 3.6 mln UAH (3 mln UAH) with probability 99% for 10 days time horizon according to asset-loan portfolio.

Cumulated exchange rate risk is equal to the total VaR for all currencies from the assumed portfolio. In the case of "Kredyt-Bank (Ukraine)" I could not calculate total VaR because the information about open positions (long and short) are closed information. But the final proportions of possible loss will be the same: total amount of capital under the risk is equal to 3.19% of total portfolio by standard method (2.77% by historical simulation method). Such results I got after calculating VaR for the portfolio of foreign currencies (1000 every currency) and real exchange rates.

Besides these results I have calculated VaR for every interest rate for loans and deposits, individuals and firms; also I have calculated VaR fore every currency.

How can I manage these results?

National Bank in Ukraine determines different quotes to the commercial banks. Commercial banks should cooperate within these quotes; otherwise they will have different penalties or could be announced as bankrupts.

One of these quotes is the ratio of Capital Adequacy. It is calculated as Required Capital divided on the Bank's Assets, adjusted to the risk on every loan. National Bank of Ukraine decided measure this index not less than 10% (according to the Basel Committee, for developed world banks this ratio should be not less than 8%). We have this ratio slight higher, because in calculating loans adjusted on risk only credit risk should be included by the Ukrainian legislation. By the Basel Committee requirements, all risks should be included into this quota. Hence, constructing the internal model of risk-measurement the manager can include calculated amount of interest rate risk and exchange rate risk in calculating Capital Adequacy. This index will become lover, approaching our banks to the Basel requirements. Moreover, now "Kredyt-Bank (Ukraine)" will be insured the market risk and at the same time it will be more compatible to other banks, having better index of Capital Adequacy. So, managers' task should be to keep this index so close to 10%, as possible, but not less. Bank in that case will have the possibility to earn more and to have under the control interest rate risk and exchange rate risk.

Now, how managers can manage the amount of risks? According to obtained results by VaR we can see the picture, what is the most risky and what is less risky. My results showed that the biggest amount of capital under the risk is in the sector of Deposit from Individuals in EUR, where VaR of 5000 EUR portfolio is equal to 9.87 EUR (0.197%) by the standard method

and 9.34 (0.19%) by the var-cov method. Minimal amount of capital can be lost according to the interest rate risk in the sector of Credits to Firms in UAH. – 5.49 UAH (0.11%) by the standard method and 4.75 UAH (0.095) by the historical simulation method of 5000 UAH portfolio. Looking on results of the exchange rate risk, you can see the smallest possible loss in 1000 RUB – 2.4 RUB (0.04% of total portfolio) by the standard method (2.91 RUB (0.05 %) by the historical simulation method) and the maximal possible loss in 1000 GBP – 423.58 GBP (7.05% of total portfolio) by the standard method (368.54 GBP (6.14%) by the historical simulation method).

Hence, looking on these results, risk-manager can advice to the Asset and Loan Administration to reduce the amount of Deposits from Individuals in EUR (or to hold them under very strong control) and increase amount of Credits to Firms in UAH. Also, the bank should increase amounts contracts in RUB and decrease amount of contracts in GBP. Such steps will lead to diminished amount of total VaR and to correct and rational ratio of Capital Adequacy. In the nearest future this internal bank's policy can make easier transition to the Basel Committee (and developed world) standards of risk-measurement!

Chapter 7

CONCLUSION

Today Ukraine stands on the new level of its development. The possibility of cooperation on the open financial market, as the full-right partner opens before the native commercial banks. But to be strong competitors and loyal partners they should reconsider some basic standards. One of these standards is risk-management. Because of high effectiveness of VaR methodology, it is widely used in the world. It helps to see the risky of the business process, diversify the portfolio of assets. Also it helps to attract big investors.

VaR modeling for the assessment of interest rate risk and exchange rate risk has an advantage of comparability of sensitivity of assets or portfolio on different risk factors. Also, it can be calculated the total amount of capital under the risk.

However, the precision of VaR prediction depends on the underlying conditions. For analysis the empiric data revealed that traditional VaR calculating is not always the best method for calculating possible loss. For example, for calculating amount of capital under the interest rate risk in bank, the better solution will be to calculate VaR through the PV.

The performance comparison of historical simulations and var-cov-simulation methods for VaR prediction for both risks (interest rate risk and exchange rate risk) are suitable for implementation on such market, as Ukraine. However, here is a great shortcoming; still our market interest rate is not adjusted with the market processes. That is why the correlation between

the market interest rate and real bank interest rate can be very weak. However, for developed markets VaR remains a very useful too; for evaluating, controlling and management all kinds of risk.

Currently Ukrainian market should find VaR very useful for evaluation the risk of bank's activity. Ukrainian banks are ready to apply Basel's required methodology in their risk management. New approach will turn over the traditional view on risk management. VaR will make our financial institutions more compatible on the open financial market, will raise clients' trust and will gain world's confidence. So, VaR-measurement should be a very important point in the today's policy of changes.

Nevertheless, VaR and all methodologies for its calculating are not the "panacea" for bank's health. Everybody has a right to choose something very individual or new if it will bring him needed information for good management.

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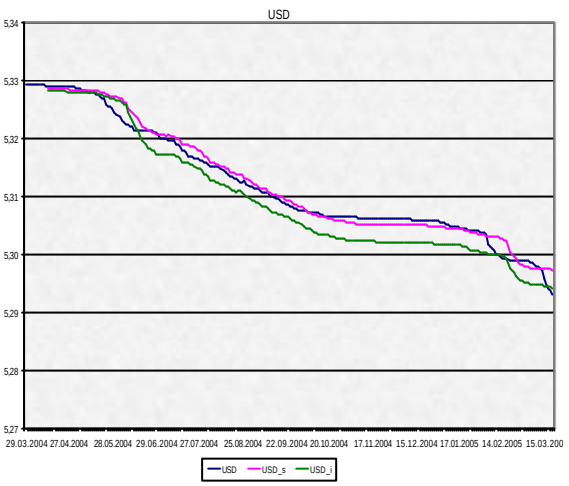
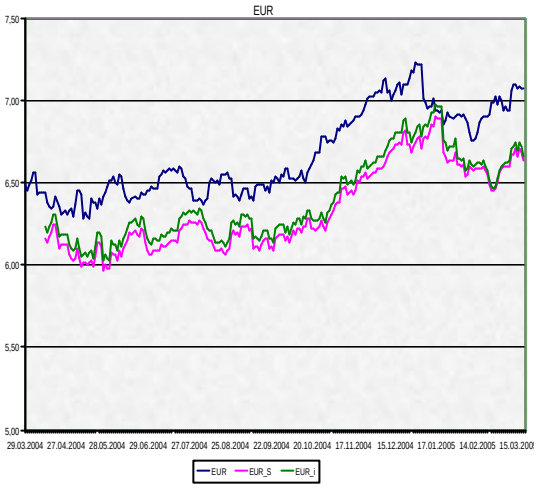
APPENDIX

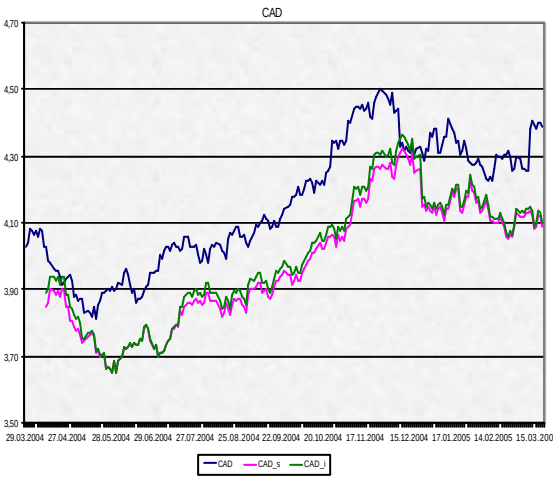
Figure A1. *Back-testing for the Exchange Rate Risk*



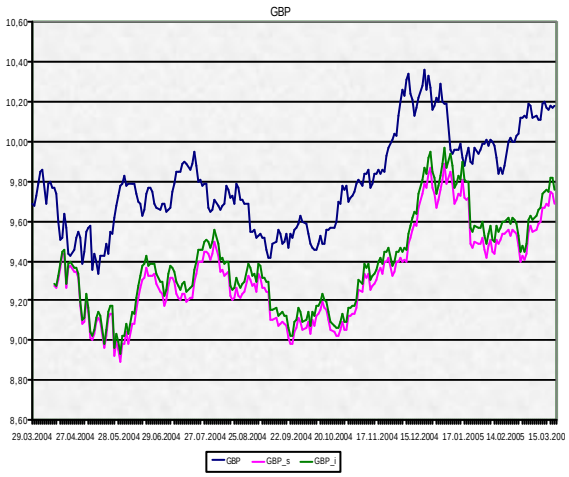
USD



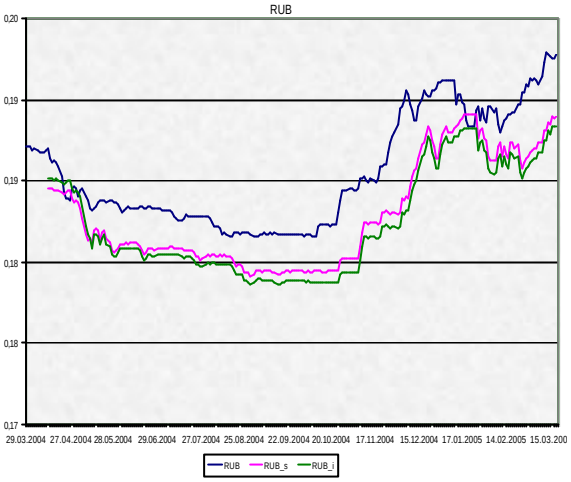
EUR



CAD



GBP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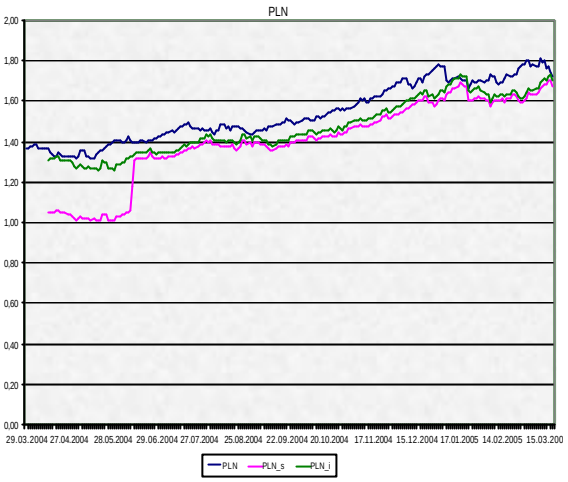
0,19
0,19
0,18
0,18
0,17
29.03.2004 27.04.2004 28.05.2004 29.06.2004 27.07.2004 25.08.2004 22.09.2004 20.10.2004 17.11.2004 15.12.2004 17.01.2005 14.02.2005 15.03.200
RUB
RUB_s
RUB_i

RUB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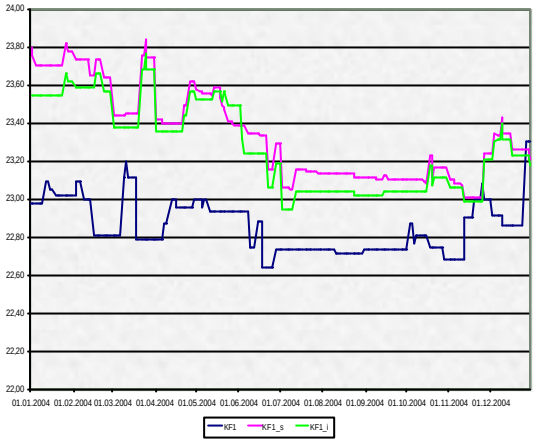
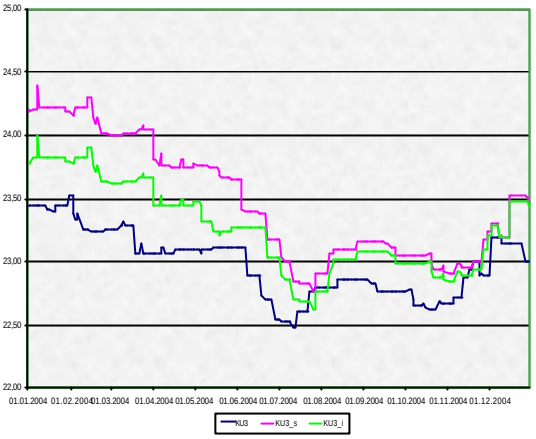
1,60
1,40
1,20
1,00
0,80
0,60
0,40
0,20
0,00
29.03.2004 27.04.2004 28.05.2004 29.06.2004 27.07.2004 25.08.2004 22.09.2004 20.10.2004 17.11.2004 15.12.2004 17.01.2005 14.02.2005 15.03.200
PLN
PLN_s
PLN_i

PLN

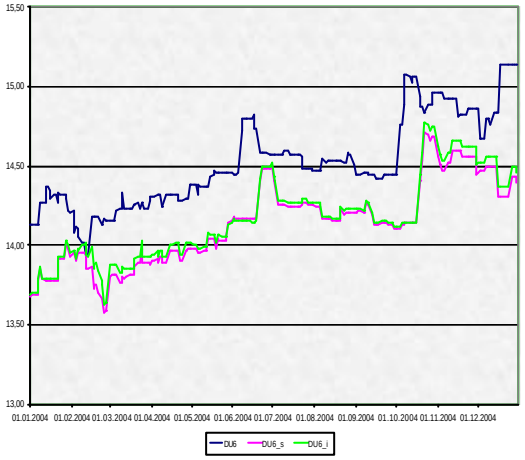
Figure A2. *Back-testing for the Interest Rate Risk, UAH*



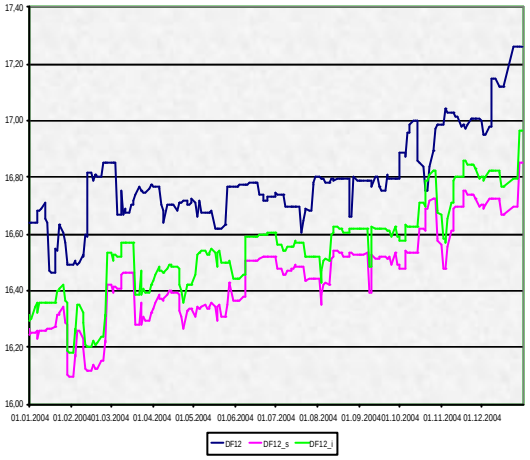
Credits for Individuals up to 1 month



Credits for Firms up to 3 months



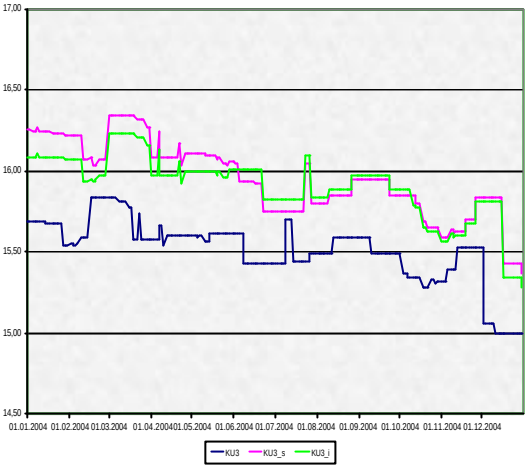
Deposits from Firms up to 6 months



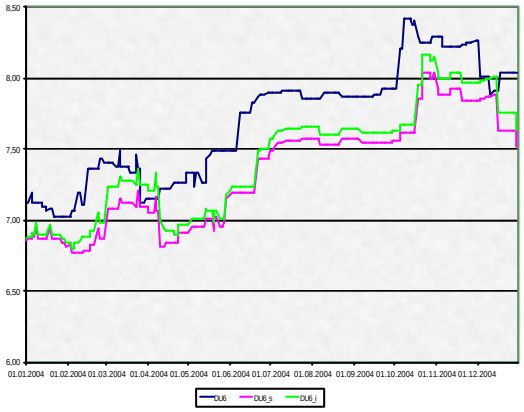
Deposits from Individuals up to 12 months

Figure A3. *Back-testing for the Interest Rate Risk EUR*

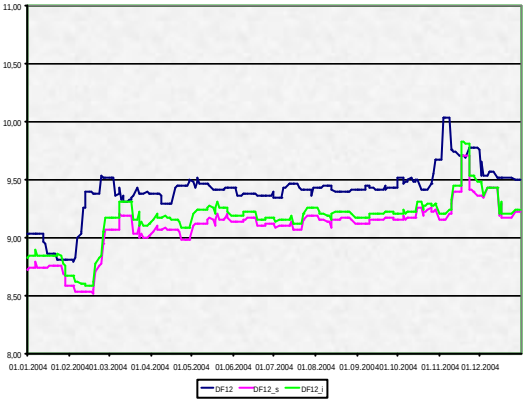
Credits for Individuals up to 1 month



Credits for Firms up to 3 months

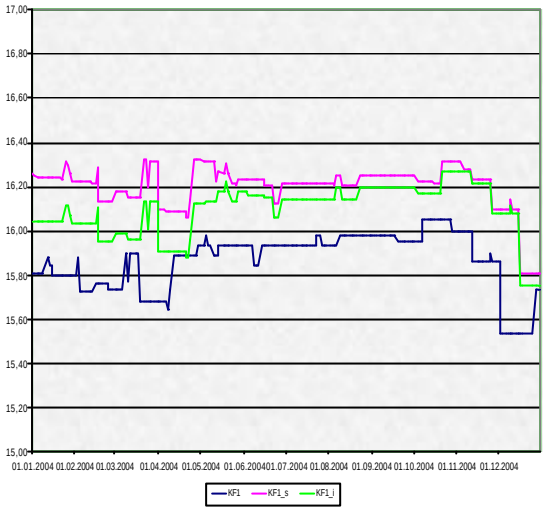


Deposits from Firms up to 6 months

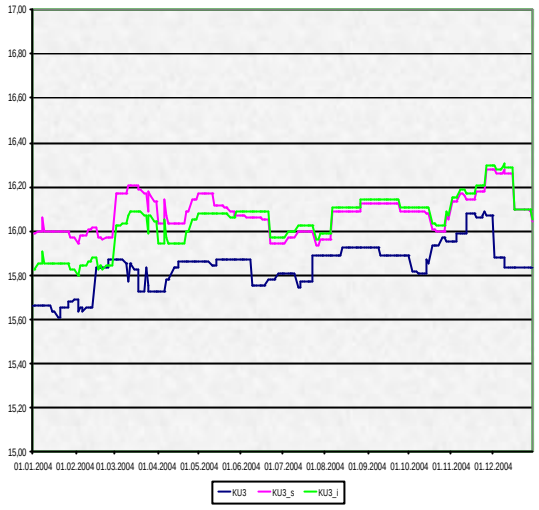


Deposits from Individuals up to 12 months

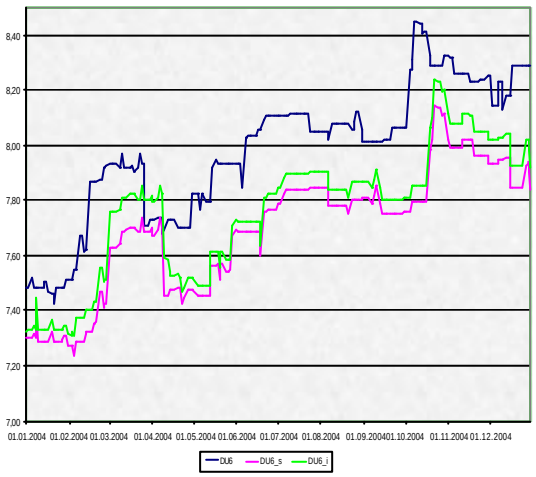
Figure A4. *Back-testing for the Interest Rate Risk, USD*



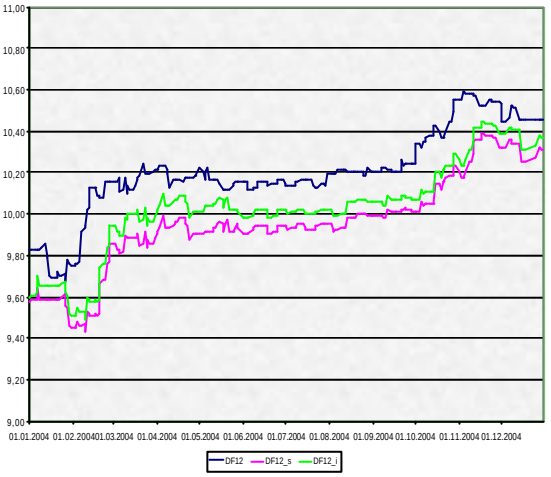
Credits for Individuals up to 1 month



Credits for Firms up to 3 months



Deposits from Firms up to 6 months



Deposits from Individuals up to 12 Months

Table A1. *Summary Statistics for Exchange Rates*

UAH

```
. sum  kf1 kf3 kf6 kf12 ku1 ku3 ku6 ku12 df1 df3 df6 df12 du1 du3 du6 du12

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
         kf1 |       517    23.44524    .8581318      22.64       26.8
         kf3 |       517    24.45468    1.068522      23.13       27.7
         kf6 |       517    24.95451    1.132623      23.55      28.67
        kf12 |       517     25.2548    1.476562      23.31      29.76
         ku1 |       517    22.74509    .9091362      21.92      26.09
-------------+--------------------------------------------------------
         ku3 |       517    23.74193    1.146089      22.47      27.52
         ku6 |       517    24.61569    1.183019      23.38      28.31
        ku12 |       517    25.36265    1.257515      23.98      29.33
         df1 |       517    8.976015    .9458305        7.6      11.38
         df3 |       517    13.34342     .618668      12.23      15.26
-------------+--------------------------------------------------------
         df6 |       517      15.044    .3286725      14.33      16.16
        df12 |       517    16.63584    .2302937      16.15      17.26
         du1 |       517    10.10903    .7940119       8.69      12.36
         du3 |       517    12.64466    .5012301      11.63      14.02
         du6 |       517    14.21269    .3743836       13.5      15.14
-------------+--------------------------------------------------------
        du12 |       517    15.84017    .3654222      15.31      16.89
```

USD

```
. sum  kf1 kf3 kf6 kf12 ku1 ku3 ku6 ku12 df1 df3 df6 df12 du1 du3 du6 du12

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
         kf1 |       516    16.03209    .3565943      15.53       17.4
         kf3 |       516    16.39254    .5402753       15.7      17.97
         kf6 |       516    16.61058    .6773313      16.02      18.47
        kf12 |       516     16.4932    .8610428      15.65      18.71
         ku1 |       517    15.52346    .2733999      15.11      16.26
-------------+--------------------------------------------------------
         ku3 |       517    15.83224    .2445459      15.51      16.83
         ku6 |       517    16.14099    .2854351      15.79      17.21
        ku12 |       517    16.31002    .3176553       15.9       17.5
         df1 |       517    4.490503    .5305337       3.86       5.91
         df3 |       517    6.816383    .7449319       5.75       8.62
-------------+--------------------------------------------------------
         df6 |       517    8.316808    .6466308       7.28       9.32
        df12 |       517    9.653752    .6082637       8.66      10.59
         du1 |       517    5.077718    .3712568       4.47       6.35
         du3 |       517    6.527176    .4531023        5.9       7.48
         du6 |       517    7.614894    .4089013       7.06       8.45
-------------+--------------------------------------------------------
        du12 |       517    8.814565     .528014        8.1       9.65
```

Kf (1, 3, 6, 12) – credits to Individuals (up to 1, 3, 6, 12 months)

Ku (1, 3, 6, 12) – credits to Firms (up to 1, 3, 6, 12 months)

Df (1, 3, 6, 12) – deposits from Individuals (up to 1, 3, 6, 12 months)

Du (1, 3, 6, 12) – deposits from Firms (up to 1, 3, 6, 12 months)

Table A2. *Assessment of Parametric and Non-parametric VaR Models*

Model of risk assessment	***Advantages***	***Disadvantages***
Historical simulation	• Applicable for all types of price risks; • Permits non-normal distribution; • Is good for non-linear instruments; • Integration of many risk types, low possibility of model risk; • Recommended by the Basel Committee.	• Transformation of the historical data into the future; • No information between correlation with risk factors; • The same price trajectory for every commodity.
Monte-Carlo simulation	• Statistically "clean" method; • The most flexible of all estimation techniques.	• Requires a lot of calculations or specific computer software; • Assumption about the normality of distribution.

Extreme Value Theory	• Most attention is paid to the tail observations; • Can help to estimate quantiles, using restricted data.	• Will work only in case of extreme events; • It's hard to explain results; • It's difficult to extrapolate it on the real data
Stress-testing	• Permits to consider different scenarios; • Makes possible to see influence of separate factors; • It helps to answer the question: "What can happen in residual 1%?"	• Subjective scenarios; • Do not include risk, which could be possible for changed portfolios; • It is applicable for small portfolios.
Variance-Covariance Analysis	• It takes into account explicitly all correlation.	• Assumption of normal distribution of risk factors; • Non suitable for non-linear price functions.

Table A3. *Results with Calculated Possible Loss According to the Interest Rate Risk*

VaR for the Credits to Individuals, UAH

Market Data	1M	3M	6M	12M
Market Interest Rate (Last)_31.12.04	23,31%	23,75%	24,44%	24,13%
Delta-Rate (Var-Cov. sim)	0,41%	0,37%	0,45%	0,42%
Delta-Rate (Hist. sim)	0,40%	0,42%	0,66%	0,59%

Credits	<1m	1-3m	3-6m	6-12m	>12m	Sum
Input Data						
Sum	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	**5 000,00**
Interest Rate	*19,78%*	*19,40%*	*19,87%*	*19,64%*	*24,77%*	
Duration	*24*	*40*	*150*	*300*	*600*	
FV	1 011,94	1 021,26	1 081,66	1 161,42	1 407,18	**5 683,46**
Weighted Average Market Interest Rate	23,31%	23,37%	24,19%	24,24%	24,13%	
Weighted Average Delta-Rate (Var-Cov)	*0,41%*	*0,40%*	*0,42%*	*0,43%*	*0,42%*	
Weighted Average Delta-Rate (Hist.sim)	*0,40%*	*0,40%*	*0,57%*	*0,62%*	*0,59%*	
PV	998,09	998,02	989,53	971,65	986,35	**4 943,65**
PV/S	**0,9981**	**0,9980**	**0,9895**	**0,9717**	**0,9864**	**0,9887**
VAR 1 (PV) by the Diapasons	**-0,22**	**-0,36**	**-1,37**	**-2,77**	**-5,50**	**-10,22**
VAR 2 (PV) by the Diapasons	**-0,21**	**-0,36**	**-1,87**	**-3,95**	**-7,71**	**-14,10**
VAR 1 (PV) by the Durations	**-0,53**	**-0,55**	**-1,86**	**-7,27**		**-10,22**
VAR 2 (PV) by the Durations	**-0,52**	**-0,73**	**-2,61**	**-10,24**		**-14,10**

Matrix of Correlation Market Interest Rates

-0,53	**-0,55**	**-1,86**	**-7,27**	
1,0000	*0,9613*	*0,9680*	*0,9391*	**-0,53**
0,9613	*1,0000*	*0,9834*	*0,9828*	**-0,55**
0,9680	*0,9834*	*1,0000*	*0,9919*	**-1,86**
0,9391	*0,9828*	*0,9919*	*1,0000*	**-7,27**

VAR 1 (Credit Portfolio)	**10,17**

Matrix of Correlation Market Interest Rates

-0,52	**-0,73**	**-2,61**	**-10,24**	
1,0000	*0,9613*	*0,9680*	*0,9391*	**-0,52**
0,9613	*1,0000*	*0,9834*	*0,9828*	**-0,73**
0,9680	*0,9834*	*1,0000*	*0,9919*	**-2,61**
0,9391	*0,9828*	*0,9919*	*1,0000*	**-10,24**

VAR 2 (Credit Portfolio)	**14,05**

VaR for the Credits to Firms, UAH

Market Data	1M	3M	6M	12M
Market Interest Rate (Last)_31.12.04	22,45%	23,00%	23,73%	24,23%
Delta-Rate (Var-Cov. sim)	0,36%	0,32%	0,23%	0,22%
Delta-Rate (Hist. sim)	0,30%	0,29%	0,20%	0,19%

Credits	<1m	1-3m	3-6m	6-12m	>12m	Sum
Input Data						
Sum	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	**5 000,00**
Interest Rate	*21,23%*	*21,33%*	*20,97%*	*20,78%*	*19,78%*	**19,18%**
Duration	*24*	*40*	*150*	*300*	*600*	
FV	1 012,74	1 023,38	1 086,18	1 170,79	1 325,15	**5 618,24**
Weighted Average Market Interest Rate	22,45%	22,52%	23,46%	24,05%	24,23%	
Weighted Average Delta-Rate (Var-Cov)	*0,36%*	*0,35%*	*0,26%*	*0,22%*	*0,22%*	
Weighted Average Delta-Rate (Hist.sim)	*0,30%*	*0,30%*	*0,24%*	*0,19%*	*0,19%*	
PV	999,34	1 000,85	996,06	980,73	927,62	**4 904,60**
PV/S	**0,9993**	**1,0008**	**0,9961**	**0,9807**	**0,9276**	**0,9809**
VAR 1 (PV) by the Diapasons	**-0,19**	**-0,32**	**-0,87**	**-1,45**	**-2,68**	**-5,50**
VAR 2 (PV) by the Diapasons	**-0,16**	**-0,27**	**-0,78**	**-1,25**	**-2,30**	**-4,76**
VAR 1 (PV) by the Durations	**-0,46**	**-0,36**	**-1,07**	**-3,60**		**-5,50**
VAR 2 (PV) by the Durations	**-0,40**	**-0,32**	**-0,94**	**-3,10**		**-4,76**

Matrix of Correlation Market Interest Rates

-0,46	**-0,36**	**-1,07**	**-3,60**	
1,0000	*0,9787*	*0,9699*	*0,9632*	**-0,46**
0,9787	*1,0000*	*0,9969*	*0,9922*	**-0,36**
0,9699	*0,9969*	*1,0000*	*0,9978*	**-1,07**
0,9632	*0,9922*	*0,9978*	*1,0000*	**-3,60**

VAR 1 (Credit Portfolio)	5,49

Matrix of Correlation Market Interest Rates

-0,40	**-0,32**	**-0,94**	**-3,10**	
1,0000	*0,9787*	*0,9699*	*0,9632*	**-0,40**
0,9787	*1,0000*	*0,9969*	*0,9922*	**-0,32**
0,9699	*0,9969*	*1,0000*	*0,9978*	**-0,94**
0,9632	*0,9922*	*0,9978*	*1,0000*	**-3,10**

VAR 2 (Credit Portfolio)	4,75

VaR for the Deposits from Individuals, UAH

Market Data	1M	3M	6M	12M
Market Interest Rate (Last)_31.12.04	10,95%	15,26%	16,16%	17,26%
Delta-Rate (Var-Cov. sim)	0,82%	0,41%	0,30%	0,30%
Delta-Rate (Hist. sim)	1,17%	0,37%	0,26%	0,18%

Deposits	<1m	1-3m	3-6m	6-12m	>12m	Sum
Input Data						
Sum	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	**5 000,00**
Interest Rate	*15,00%*	*14,76%*	*14,51%*	*14,87%*	*16,05%*	
Duration	*24*	*40*	*150*	*300*	*600*	
FV	1 009,23	1 016,18	1 059,63	1 122,22	1 263,84	**5 471,09**
Weighted Average Market Interest Rate	10,95%	11,52%	15,83%	16,86%	17,26%	
Weighted Average Delta-Rate (Var-Cov)	*0,82%*	*0,76%*	*0,34%*	*0,30%*	*0,30%*	
Weighted Average Delta-Rate (Hist.sim)	*1,17%*	*1,06%*	*0,30%*	*0,21%*	*0,18%*	
PV	1 002,36	1 004,10	997,53	987,29	972,79	**4 964,08**
PV/S	**1,0024**	**1,0041**	**0,9975**	**0,9873**	**0,9728**	**0,9928**
VAR 1 (PV) by the Diapasons	**-0,49**	**-0,75**	**-1,19**	**-2,09**	**-4,15**	**-8,67**
VAR 2 (PV) by the Diapasons	**-0,69**	**-1,05**	**-1,07**	**-1,47**	**-2,50**	**-6,78**
VAR 1 (PV) by the Durations	**-1,14**	**-0,54**	**-1,51**	**-5,49**		**-8,67**
VAR 2 (PV) by the Durations	**-1,60**	**-0,53**	**-1,20**	**-3,44**		**-6,78**

Matrix of Correlation Market Interest Rates

-1,14	**-0,54**	**-1,51**	**-5,49**	
1,0000	*0,9034*	*0,8970*	*0,8060*	**-1,14**
0,9034	*1,0000*	*0,9674*	*0,8011*	**-0,54**
0,8970	*0,9674*	*1,0000*	*0,8904*	**-1,51**
0,8060	*0,8011*	*0,8904*	*1,0000*	**-5,49**

VAR 1 (Deposit Portfolio)	8,32

Matrix of Correlation Market Interest Rates

-1,60	**-0,53**	**-1,20**	**-3,44**	
1,0000	*0,9034*	*0,8970*	*0,8060*	**-1,60**
0,9034	*1,0000*	*0,9674*	*0,8011*	**-0,53**
0,8970	*0,9674*	*1,0000*	*0,8904*	**-1,20**
0,8060	*0,8011*	*0,8904*	*1,0000*	**-3,44**

VAR 2 (Deposit Portfolio)	6,45

VaR for the Deposits from Firms, UAH

Market Data	1M	3M	6M	12M
Market Interest Rate (Last)_31.12.04	12,36%	14,02%	15,14%	16,89%
Delta-Rate (Var-Cov. sim)	0,83%	0,52%	0,39%	0,40%
Delta-Rate (Hist. sim)	0,84%	0,42%	0,30%	0,26%

Deposits	<1m	1-3m	3-6m	6-12m	>12m	Sum
Input Data						
Sum	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	**5 000,00**
Interest Rate	*13,00%*	*15,89%*	*15,97%*	*16,47%*	*15,07%*	
Duration	*24*	*40*	*150*	*300*	*600*	
FV	1 008,07	1 017,41	1 065,63	1 135,37	1 247,73	**5 474,21**
Weighted Average Market Interest Rate	12,36%	12,58%	14,73%	16,26%	16,89%	
Weighted Average Delta-Rate (Var-Cov)	*0,83%*	*0,79%*	*0,44%*	*0,40%*	*0,40%*	
Weighted Average Delta-Rate (Hist.sim)	*0,84%*	*0,78%*	*0,35%*	*0,28%*	*0,26%*	
PV	1 000,37	1 004,29	1 007,12	1 003,12	965,39	**4 980,30**
PV/S	**1,0004**	**1,0043**	**1,0071**	**1,0031**	**0,9654**	**0,9961**
VAR 1 (PV) by the Diapasons	**-0,48**	**-0,77**	**-1,58**	**-2,82**	**-5,43**	**-11,08**
VAR 2 (PV) by the Diapasons	**-0,49**	**-0,76**	**-1,25**	**-1,98**	**-3,59**	**-8,08**
VAR 1 (PV) by the Durations	**-1,15**	**-0,68**	**-2,01**	**-7,24**		**-11,08**
VAR 2 (PV) by the Durations	**-1,15**	**-0,56**	**-1,50**	**-4,86**		**-8,08**

Matrix of Correlation Market Interest Rates

-1,15	**-0,68**	**-2,01**	**-7,24**	
1,0000	*0,9715*	*0,8938*	*0,7984*	**-1,15**
0,9715	*1,0000*	*0,9618*	*0,8668*	**-0,68**
0,8938	*0,9618*	*1,0000*	*0,9522*	**-2,01**
0,7984	*0,8668*	*0,9522*	*1,0000*	**-7,24**

VAR 1 (Deposit Portfolio)	**10,78**

Matrix of Correlation Market Interest Rates

-1,15	**-0,56**	**-1,50**	**-4,86**	
1,0000	*0,9715*	*0,8938*	*0,7984*	**-1,15**
0,9715	*1,0000*	*0,9618*	*0,8668*	**-0,56**
0,8938	*0,9618*	*1,0000*	*0,9522*	**-1,50**
0,7984	*0,8668*	*0,9522*	*1,0000*	**-4,86**

VAR 2 (Deposit Portfolio)	**7,82**

VaR for the Credits to the Individuals, EUR

Market Data	1M	3M	6M	12M
Market Interest Rate (Last)_31.12.04	15,30%	15,40%	15,75%	14,96%
Delta-Rate (Var-Cov. sim)	0,49%	0,42%	0,34%	0,31%
Delta-Rate (Hist. sim)	0,38%	0,36%	0,30%	0,09%

Credits	< 1m	1-3m	3-6m	6-12m	>12m	Sum
Input Date						
Sum	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	**5 000,00**
Interest Rate	*0,00%*	*14,00%*	*0,00%*	*13,04%*	*0,00%*	
Duration	*24*	*40*	*150*	*300*	*600*	
FV	1 000,00	1 015,34	1 000,00	1 107,18	1 000,00	**5 122,52**
Weighted Average Market Interest Rate	15,30%	15,31%	15,62%	15,24%	14,96%	
Weighted Average Delta-Rate(Var-Cov)	*0,49%*	*0,48%*	*0,37%*	*0,32%*	*0,31%*	
Weighted Average Delta-Rate (Hist. sim)	*0,38%*	*0,38%*	*0,32%*	*0,17%*	*0,09%*	
PV	990,68	999,61	942,09	985,31	795,19	**4 712,89**
PV/S	**0,9907**	**0,9996**	**0,9421**	**0,9853**	**0,7952**	**0,9426**
VAR 1 (PV) by the Diapasons	**-0,28**	**-0,46**	**-1,23**	**-2,23**	**-3,48**	**-7,67**
VAR 2 (PV) by the Diapasons	**-0,22**	**-0,36**	**-1,07**	**-1,16**	**-1,03**	**-3,84**
VAR 1 (PV) by the Durations	**-0,67**	**-0,51**	**-1,58**	**-4,90**		**-7,67**
VAR 2 (PV) by the Durations	**-0,53**	**-0,44**	**-1,10**	**-1,77**		**-3,84**

Matrix of Correlation Market Interest Rates

-0,67	**-0,51**	**-1,58**	**-4,90**	
1,0000	*0,2132*	*0,0107*	*-0,1003*	**-0,67**
0,2132	*1,0000*	*0,9595*	*0,9335*	**-0,51**
0,0107	*0,9595*	*1,0000*	*0,9780*	**-1,58**
-0,1003	*0,9335*	*0,9780*	*1,0000*	**-4,90**

VAR 1 (Credit Portfolio)	**6,94**

Matrix of Correlation Market Interest Rates

-0,53	**-0,44**	**-1,10**	**-1,77**	
1,0000	*0,2132*	*0,0107*	*-0,1003*	**-0,53**
0,2132	*1,0000*	*0,9595*	*0,9335*	**-0,44**
0,0107	*0,9595*	*1,0000*	*0,9780*	**-1,10**
-0,1003	*0,9335*	*0,9780*	*1,0000*	**-1,77**

VAR 2 (Credit Portfolio)	**3,31**

VaR for the Credits to Firms, EUR

Market Data	1M	3M	6M	12M
Market Interest Rate (Last)_31.12.04	14,87%	15,00%	15,31%	15,63%
Delta-Rate (Var-Cov. sim)	0,39%	0,37%	0,35%	0,36%
Delta-Rate (Hist. sim)	0,27%	0,28%	0,30%	0,32%

Credits	< 1m	1-3m	3-6m	6-12m	>12m	Sum
Input Date						
Sum	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	**5 000,00**
Interest Rate	*17,00%*	*13,34%*	*12,55%*	*13,28%*	*12,96%*	
Duration	*24*	*40*	*150*	*300*	*600*	
FV	1 010,38	1 014,62	1 051,58	1 109,15	1 213,04	**5 398,76**
Weighted Average Market Interest Rate	14,87%	14,89%	15,20%	15,52%	15,63%	
Weighted Average Delta-Rate(Var-Cov)	*0,39%*	*0,39%*	*0,36%*	*0,35%*	*0,36%*	
Weighted Average Delta-Rate (Hist. sim)	*0,27%*	*0,27%*	*0,30%*	*0,32%*	*0,32%*	
PV	1 001,21	999,30	992,18	985,16	955,43	**4 933,28**
PV/S	**1,0012**	**0,9993**	**0,9922**	**0,9852**	**0,9554**	**0,9867**
VAR 1 (PV) by the Diapasons	**-0,22**	**-0,37**	**-1,26**	**-2,48**	**-4,85**	**-9,18**
VAR 2 (PV) by the Diapasons	**-0,15**	**-0,25**	**-1,05**	**-2,23**	**-4,41**	**-8,10**
VAR 1 (PV) by the Durations	**-0,54**	**-0,51**	**-1,69**	**-6,44**		**-9,18**
VAR 2 (PV) by the Durations	**-0,37**	**-0,42**	**-1,46**	**-5,84**		**-8,10**

Matrix of Correlation Market Interest Rates

-0,54	**-0,51**	**-1,69**	**-6,44**	
1,0000	*0,8321*	*0,7799*	*0,7595*	**-0,54**
0,8321	*1,0000*	*0,9817*	*0,9668*	**-0,51**
0,7799	*0,9817*	*1,0000*	*0,9941*	**-1,69**
0,7595	*0,9668*	*0,9941*	*1,0000*	**-6,44**

VAR 1 (Credit Portfolio)	9,04

Matrix of Correlation Market Interest Rates

-0,37	**-0,42**	**-1,46**	**-5,84**	
1,0000	*0,8321*	*0,7799*	*0,7595*	**-0,37**
0,8321	*1,0000*	*0,9817*	*0,9668*	**-0,42**
0,7799	*0,9817*	*1,0000*	*0,9941*	**-1,46**
0,7595	*0,9668*	*0,9941*	*1,0000*	**-5,84**

VAR 2 (Credit Portfolio)	8,00

VaR for the Deposits from Individuals, EUR

Market Data	1M	3M	6M	12M
Market Interest Rate (Last)_31.12.04	5,31%	7,59%	8,25%	9,51%
Delta-Rate (Var-Cov. sim)	0,59%	0,44%	0,33%	0,36%
Delta-Rate (Hist. sim)	1,05%	0,26%	0,23%	0,34%

Deposits	< 1m	1-3m	3-6m	6-12m	>12m	Sum
Input Date						
Sum	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	**5 000,00**
Interest Rate	*5,50%*	*6,27%*	*6,25%*	*5,52%*	*6,03%*	
Duration	*24*	*40*	*150*	*300*	*600*	
FV	1 003,53	1 006,87	1 025,68	1 045,37	1 099,12	**5 180,58**
Weighted Average Market Interest Rate	5,31%	5,61%	8,01%	9,06%	9,51%	
Weighted Average Delta-Rate(Var-Cov)	*0,59%*	*0,57%*	*0,37%*	*0,35%*	*0,36%*	
Weighted Average Delta-Rate (Hist. sim)	*1,05%*	*0,95%*	*0,24%*	*0,30%*	*0,34%*	
PV	1 000,12	1 000,86	993,72	973,46	946,65	**4 914,82**
PV/S	**1,0001**	**1,0009**	**0,9937**	**0,9735**	**0,9467**	**0,9830**
VAR 1 (PV) by the Diapasons	**-0,37**	**-0,60**	**-1,39**	**-2,55**	**-5,10**	**-10,00**
VAR 2 (PV) by the Diapasons	**-0,66**	**-0,98**	**-0,91**	**-2,19**	**-4,79**	**-9,53**
VAR 1 (PV) by the Durations	**-0,89**	**-0,59**	**-1,79**	**-6,73**		**-10,00**
VAR 2 (PV) by the Durations	**-1,51**	**-0,46**	**-1,36**	**-6,19**		**-9,53**

Matrix of Correlation Market Interest Rates

-0,89	**-0,59**	**-1,79**	**-6,73**	
1,0000	*0,8949*	*0,8495*	*0,8656*	**-0,89**
0,8949	*1,0000*	*0,9829*	*0,9801*	**-0,59**
0,8495	*0,9829*	*1,0000*	*0,9937*	**-1,79**
0,8656	*0,9801*	*0,9937*	*1,0000*	**-6,73**

VAR 1 (Deposit Portfolio)	**9,87**

Matrix of Correlation Market Interest Rates

-1,51	**-0,46**	**-1,36**	**-6,19**	
1,0000	*0,8949*	*0,8495*	*0,8656*	**-1,51**
0,8949	*1,0000*	*0,9829*	*0,9801*	**-0,46**
0,8495	*0,9829*	*1,0000*	*0,9937*	**-1,36**
0,8656	*0,9801*	*0,9937*	*1,0000*	**-6,19**

VAR 2 (Deposit Portfolio)	**9,34**

VaR for the Deposits from the Firms, EUR

Market Data	1M	3M	6M	12M
Market Interest Rate (Last)_31.12.04	6,13%	7,16%	8,04%	9,05%
Delta-Rate (Var-Cov. sim)	0,41%	0,42%	0,38%	0,31%
Delta-Rate (Hist. sim)	0,30%	2,00%	0,34%	0,29%

Deposits	< 1m	1-3m	3-6m	6-12m	>12m	Sum
Input Date						
Sum	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	**5 000,00**
Interest Rate	*5,00%*	*5,92%*	*8,38%*	*8,00%*	*0,00%*	
Duration	*24*	*40*	*150*	*300*	*600*	
FV	1 003,21	1 006,49	1 034,44	1 065,75	1 000,00	**5 109,89**
Weighted Average Market Interest Rate	6,13%	6,27%	7,72%	8,69%	9,05%	
Weighted Average Delta-Rate(Var-Cov)	*0,41%*	*0,41%*	*0,40%*	*0,34%*	*0,31%*	
Weighted Average Delta-Rate (Hist. sim)	*0,30%*	*0,53%*	*0,95%*	*0,31%*	*0,29%*	
PV	999,30	999,81	1 003,31	995,22	867,26	**4 864,90**
PV/S	**0,9993**	**0,9998**	**1,0033**	**0,9952**	**0,8673**	**0,9730**
VAR 1 (PV) by the Diapasons	**-0,25**	**-0,42**	**-1,51**	**-2,53**	**-4,06**	**-8,78**
VAR 2 (PV) by the Diapasons	**-0,19**	**-0,54**	**-3,63**	**-2,30**	**-3,73**	**-10,40**
VAR 1 (PV) by the Durations	**-0,62**	**-0,61**	**-1,87**	**-5,68**		**-8,78**
VAR 2 (PV) by the Durations	**-0,66**	**-1,41**	**-3,13**	**-5,21**		**-10,40**

Matrix of Correlation Market Interest Rates

-0,62	**-0,61**	**-1,87**	**-5,68**	
1,0000	*0,8244*	*0,8224*	*0,7873*	**-0,62**
0,8244	*1,0000*	*0,9954*	*0,9808*	**-0,61**
0,8224	*0,9954*	*1,0000*	*0,9766*	**-1,87**
0,7873	*0,9808*	*0,9766*	*1,0000*	**-5,68**

VAR 1 (Deposit Portfolio)	**8,62**

Matrix of Correlation Market Interest Rates

-0,66	**-1,41**	**-3,13**	**-5,21**	
1,0000	*0,8244*	*0,8224*	*0,7873*	**-0,66**
0,8244	*1,0000*	*0,9954*	*0,9808*	**-1,41**
0,8224	*0,9954*	*1,0000*	*0,9766*	**-3,13**
0,7873	*0,9808*	*0,9766*	*1,0000*	**-5,21**

VAR 2 (Deposit Portfolio)	**10,22**

VaR for the Credits to Individuals, USD

Market Data	1M	3M	6M	12M
Market Interest Rate (Last)_31.12.04	15,73%	15,90%	16,23%	15,90%
Delta-Rate (var-cov. sim.)	0,29%	0,24%	0,20%	0,21%
Delta-Rate (Hist.sim.)	0,22%	0,20%	0,20%	0,25%

Credits	<1m	1-3m	3-6m	6-12m	<12m	Sum
Input Data						
Sum	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	**5 000,00**
Interest Rate	*0,00%*	*11,22%*	*12,52%*	*13,16%*	*0,00%*	
Duration	*24*	*40*	*150*	*300*	*600*	
FV	1 000,00	1 012,30	1 051,45	1 108,16	1 000,00	**5 171,91**
Weighted Average Market Interest Rate	15,73%	15,75%	16,11%	16,02%	15,90%	
Weighted Average Delta-Rate (Var-Cov)	*0,29%*	*0,29%*	*0,21%*	*0,20%*	*0,21%*	
Weighted Average Delta-Rate (Hist.sim.)	*0,22%*	*0,22%*	*0,20%*	*0,23%*	*0,25%*	
PV	990,44	996,20	988,85	980,77	784,62	**4 740,88**
PV/S	**0,9904**	**0,9962**	**0,9889**	**0,9808**	**0,7846**	**0,9482**
VAR 1 (PV) by the Diapasons	**-0,17**	**-0,27**	**-0,75**	**-1,42**	**-2,30**	**-4,90**
VAR 2 (PV) by the Diapasons	**-0,12**	**-0,20**	**-0,70**	**-1,61**	**-2,78**	**-5,42**
VAR 1 (PV) by the Durations	**-0,40**	**-0,31**	**-0,98**	**-3,20**		**-4,90**
VAR 2 (PV) by the Durations	**-0,30**	**-0,28**	**-1,02**	**-3,82**		**-5,42**

Matrix of Correlation Market Interest Rates

-0,40	**-0,31**	**-0,98**	**-3,20**	
1,0000	*0,8907*	*0,8890*	*0,8473*	**-0,40**
0,8907	*1,0000*	*0,9915*	*0,9859*	**-0,31**
0,8890	*0,9915*	*1,0000*	*0,9919*	**-0,98**
0,8473	*0,9859*	*0,9919*	*1,0000*	**-3,20**

VAR 1 (Credit Portfolio)	**4,84**

Matrix of Correlation Market Interest Rates

-0,30	**-0,28**	**-1,02**	**-3,82**	
1,0000	*0,8907*	*0,8890*	*0,8473*	**-0,30**
0,8907	*1,0000*	*0,9915*	*0,9859*	**-0,28**
0,8890	*0,9915*	*1,0000*	*0,9919*	**-1,02**
0,8473	*0,9859*	*0,9919*	*1,0000*	**-3,82**

VAR 2 (Credit Portfolio)	**5,37**

VaR for the Credits to Firms, USD

Market Data	1M	3M	6M	12M
Market Interest Rate (Last)_31.12.04	15,65%	15,83%	16,11%	16,43%
Delta-Rate (var-cov. sim.)	0,25%	0,21%	0,18%	0,17%
Delta-Rate (Hist.sim.)	0,22%	0,22%	0,18%	0,19%

Credits	<1m	1-3m	3-6m	6-12m	<12m	Sum
Input Data						
Sum	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	**5 000,00**
Interest Rate	*12,20%*	*13,73%*	*13,59%*	*13,13%*	*12,52%*	
Duration	*24*	*40*	*150*	*300*	*600*	
FV	1 007,60	1 015,05	1 055,85	1 107,92	1 205,81	**5 392,22**
Weighted Average Market Interest Rate	15,65%	15,67%	16,01%	16,32%	16,43%	
Weighted Average Delta-Rate (Var-Cov)	*0,25%*	*0,25%*	*0,19%*	*0,17%*	*0,17%*	
Weighted Average Delta-Rate (Hist.sim.)	*0,22%*	*0,22%*	*0,19%*	*0,19%*	*0,19%*	
PV	998,01	998,98	993,35	978,50	939,03	**4 907,86**
PV/S	**0,9980**	**0,9990**	**0,9933**	**0,9785**	**0,9390**	**0,9816**
VAR 1 (PV) by the Diapasons	**-0,14**	**-0,23**	**-0,66**	**-1,19**	**-2,25**	**-4,47**
VAR 2 (PV) by the Diapasons	**-0,12**	**-0,20**	**-0,68**	**-1,30**	**-2,56**	**-4,86**
VAR 1 (PV) by the Durations	**-0,34**	**-0,27**	**-0,84**	**-3,01**		**-4,47**
VAR 2 (PV) by the Durations	**-0,30**	**-0,28**	**-0,89**	**-3,39**		**-4,86**

Matrix of Correlation Market Interest Rates

-0,34	**-0,27**	**-0,84**	**-3,01**	
1,0000	*0,8499*	*0,6951*	*0,7345*	**-0,34**
0,8499	*1,0000*	*0,9391*	*0,9487*	**-0,27**
0,6951	*0,9391*	*1,0000*	*0,9922*	**-0,84**
0,7345	*0,9487*	*0,9922*	*1,0000*	**-3,01**

VAR 1 (Credit Portfolio)	**4,37**

Matrix of Correlation Market Interest Rates

-0,30	**-0,28**	**-0,89**	**-3,39**	
1,0000	*0,8499*	*0,6951*	*0,7345*	**-0,30**
0,8499	*1,0000*	*0,9391*	*0,9487*	**-0,28**
0,6951	*0,9391*	*1,0000*	*0,9922*	**-0,89**
0,7345	*0,9487*	*0,9922*	*1,0000*	**-3,39**

VAR 2 (Credit Portfolio)	**4,77**

VaR for the Deposits from Individuals, USD

Market Data	1M	3M	6M	12M
Market Interest Rate (Last)_31.12.04	5,36%	8,62%	9,32%	10,46%
Delta-Rate (var-cov. sim.)	0,46%	0,35%	0,20%	0,20%
Delta-Rate (Hist.sim.)	0,99%	0,20%	0,10%	0,10%

Deposits	<1m	1-3m	3-6m	6-12m	<12m	Sum
Input Data						
Sum	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	**5 000,00**
Interest Rate	*6,70%*	*6,84%*	*6,86%*	*6,21%*	*8,52%*	
Duration	*24*	*40*	*150*	*300*	*600*	
FV	1 004,27	1 007,50	1 028,19	1 051,04	1 140,05	**5 231,06**
Weighted Average Market Interest Rate	5,36%	5,79%	9,06%	10,05%	10,46%	
Weighted Average Delta-Rate (Var-Cov)	*0,46%*	*0,45%*	*0,26%*	*0,20%*	*0,20%*	
Weighted Average Delta-Rate (Hist.sim.)	*0,99%*	*0,88%*	*0,14%*	*0,10%*	*0,10%*	
PV	1 000,83	1 001,30	992,18	971,48	968,06	**4 933,85**
PV/S	**1,0008**	**1,0013**	**0,9922**	**0,9715**	**0,9681**	**0,9868**
VAR 1 (PV) by the Diapasons	**-0,29**	**-0,46**	**-0,97**	**-1,46**	**-2,86**	**-6,03**
VAR 2 (PV) by the Diapasons	**-0,62**	**-0,91**	**-0,52**	**-0,75**	**-1,49**	**-4,29**
VAR 1 (PV) by the Durations	**-0,69**	**-0,42**	**-1,14**	**-3,79**		**-6,03**
VAR 2 (PV) by the Durations	**-1,41**	**-0,31**	**-0,60**	**-1,97**		**-4,29**

Matrix of Correlation Market Interest Rates

-0,69	**-0,42**	**-1,14**	**-3,79**	
1,0000	*0,8535*	*0,8080*	*0,8284*	**-0,69**
0,8535	*1,0000*	*0,9863*	*0,9824*	**-0,42**
0,8080	*0,9863*	*1,0000*	*0,9951*	**-1,14**
0,8284	*0,9824*	*0,9951*	*1,0000*	**-3,79**

VAR 1 (Deposit Portfolio)	**5,92**

Matrix of Correlation Market Interest Rates

-1,41	**-0,31**	**-0,60**	**-1,97**	
1,0000	*0,8535*	*0,8080*	*0,8284*	**-1,41**
0,8535	*1,0000*	*0,9863*	*0,9824*	**-0,31**
0,8080	*0,9863*	*1,0000*	*0,9951*	**-0,60**
0,8284	*0,9824*	*0,9951*	*1,0000*	**-1,97**

VAR 2 (Deposit Portfolio)	**4,12**

VaR for the Deposits from Firms, USD

Market Data	1M	3M	6M	12M
Market Interest Rate (Last)_31.12.04	6,35%	7,48%	8,29%	9,61%
Delta-Rate (var-cov. sim.)	0,43%	0,34%	0,30%	0,26%
Delta-Rate (Hist.sim.)	0,34%	0,22%	0,21%	0,11%

Deposits	<1m	1-3m	3-6m	6-12m	<12m	Sum
Input Data						
Sum	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	*1 000,00*	**5 000,00**
Interest Rate	*7,30%*	*6,41%*	*7,44%*	*9,56%*	*0,00%*	
Duration	*24*	*40*	*150*	*300*	*600*	
FV	1 004,64	1 007,02	1 030,58	1 078,58	1 000,00	**5 120,82**
Weighted Average Market Interest Rate	6,35%	6,50%	7,99%	9,14%	9,61%	
Weighted Average Delta-Rate (Var-Cov)	*0,43%*	*0,42%*	*0,31%*	*0,28%*	*0,26%*	
Weighted Average Delta-Rate (Hist.sim.)	*0,34%*	*0,33%*	*0,21%*	*0,14%*	*0,11%*	
PV	1 000,58	1 000,10	998,52	1 003,79	859,99	**4 862,98**
PV/S	**1,0006**	**1,0001**	**0,9985**	**1,0038**	**0,8600**	**0,9726**
VAR 1 (PV) by the Diapasons	**-0,27**	**-0,43**	**-1,20**	**-2,08**	**-3,36**	**-7,33**
VAR 2 (PV) by the Diapasons	**-0,21**	**-0,34**	**-0,81**	**-1,09**	**-1,39**	**-3,84**
VAR 1 (PV) by the Durations	**-0,64**	**-0,50**	**-1,50**	**-4,69**		**-7,33**
VAR 2 (PV) by the Durations	**-0,51**	**-0,34**	**-0,91**	**-2,09**		**-3,84**

Matrix of Correlation Market Interest Rates

-0,64	**-0,50**	**-1,50**	**-4,69**	
1,0000	*0,8744*	*0,8473*	*0,8311*	**-0,64**
0,8744	*1,0000*	*0,9904*	*0,9722*	**-0,50**
0,8473	*0,9904*	*1,0000*	*0,9792*	**-1,50**
0,8311	*0,9722*	*0,9792*	*1,0000*	**-4,69**

VAR 1 (Deposit Portfolio)	**7,20**

Matrix of Correlation Market Interest Rates

-0,51	**-0,34**	**-0,91**	**-2,09**	
1,0000	*0,8744*	*0,8473*	*0,8311*	**-0,51**
0,8744	*1,0000*	*0,9904*	*0,9722*	**-0,34**
0,8473	*0,9904*	*1,0000*	*0,9792*	**-0,91**
0,8311	*0,9722*	*0,9792*	*1,0000*	**-2,09**

VAR 2 (Deposit Portfolio)	**3,76**

Table A4. *Results with Calculated Possible Loss According to the Exchange Rate Risk*

Open Long Position	*USD*	*EUR*	*PLN*	*CAD*	*GBP*	*RUB*
	1000,00	1000,00	1000,00	1000,00	1000,00	1000,00
Sigma standard	0,0016	0,3104	0,0970	0,1859	0,4236	0,0024
Sigma historical	0,0050	0,2789	0,0712	0,1646	0,3685	0,0029

VAR_st	1,61	310,35	96,98	185,92	423,58	2,40
VAR_hist	5,00	278,92	71,16	164,57	368,54	2,91

Correlation	*USD*	*EUR*	*PLN*	*CAD*	*GBP*	*RUB*	*VAR_s*	*VAR_hist*
USD	1,00	-0,74	-0,88	-0,80	-0,70	-0,68	1,61	5,00
EUR	-0,74	1,00	0,79	0,88	0,93	0,91	310,35	278,92
PLN	-0,88	0,79	1,00	0,81	0,65	0,65	96,98	71,16
CAD	-0,80	0,88	0,81	1,00	0,75	0,75	185,92	164,57
GBP	-0,70	0,93	0,65	0,75	1,00	0,95	423,58	368,54
RUB	-0,68	0,91	0,65	0,75	0,95	1,00	2,40	2,91

VAR_st Total	957,42

VAR_hist Total	831,72