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ESTIMATION OF MARKET RISK IN UKRAINE USING VAR METHODOLOGY

The emergence of a market risk due to performing operations with currency can result in substantial financial losses. That is why such situations require carrying out of profound analysis and management of respective risks. The market risk of this kind is characterized with possible losses of financial resources due to incorrectly performed operations with currency. The paper considers the possibility of application of the VaR methodology to the bank currency portfolio: delta-normal, as well as the methods of historical modeling and Monte Carlo simulation. As a result of performing the computational experiments with the use of actual Ukrainian data it was established that the delta-normal technique turned out to be inadequate due to violation of assumption regarding normality of currencies exchange rates. The historical modeling technique provides acceptable results in conditions of stable market situations only. It showed unsatisfactory characteristics of adaptation to varying market factors and cannot be applied for analysis of unstable financial markets. Quite acceptable results of forecasting possible losses were received by making use of Monte Carlo simulation that hypothetically can take into account possible variations of the market exchange rates. It was established that the risk forecasting errors appear only due to non-predictable abrupt changes of exchange rates. However the model of this type is adapting quickly to the changes.

Key words: market risk, VaR methodology, currency portfolio analysis, Ukrainian currency market, computing experiments.

Introduction

As far as functioning of financial institutions is closely related to performing of substantial volumes of currency operations the problem naturally arises for performing profound analysis and management of possible financial risks. The currency related risk is a possibility of financial resources loss due to incorrectly performed operations with currency. From the risk management position the banking activities are basically directed towards risk acceptance and getting respective economic compensation instead. Some types of risks represent the price of banking business realization and it is impossible to avoid them completely. That is why the risk management processes is not aiming to complete elimination of the risks. A financial institution should provide a reliable substantiated relation between generalized parameters of possible risks and the capital, available financial resources and financial incomes [1, 2].

There exist various approaches to quantitative estimation of possible losses. As of today there are developed the methods for computing of the currency risks that are widely used in financial enterprises. A selection of appropriate computing method is determined by the volume

of available information, qualification of personnel that is busy with risk management problems, and the availability of necessary working instrumentation in the form of computer software. In spite of the fact that such instrumentation market for the financial analysis includes rather wide choice possibilities their cost and the practical usage problems very often result in development of their own software products by the financial institutions. Such systems for risk estimation may exhibit much more functional restrictions that availa than available at the market but their advantages are in the possibility of fast extension of a number of practically needed functions. Also in such cases the financial institution personnel has a possibility to enhance substantially their qualification and to improve existing computing methodologies.

The paper is devoted to application of the *VaR* methodology for computing possible financial losses in analysis of Ukrainian currency market with the use of original software.

The problem statement. The goal of the work is to execute the analysis of influence of exchange rates oscillations on profitability of currency transactions; to present algorithms of calculation of VaR meanings using delta–normal method and also using methods of historical and imitation modeling; to make comparison analysis of using indicated methods of VaR estimation and give recommendations concerning possibilities of their usage on Ukrainian financial market.

The influence of exchange rates oscillations on profitability

The model of currency matching. Despite the fact that all financial risks in this or that way are implemented on the results of bank activity but the functional connection between risks exists not for all its types. The dependence between size of profits (losses) received as a result of bank holding an open currency line item, and market changes of currency rates is described by a model of currency matching [3]*:*

$$\Delta P_v = VP(s_p - s), \tag{1}$$

where ΔP_v is a profit (loss) received from overestimating of currency money because of currency rate change; VP is a currency line item of a bank; s_p, s - predicted and leaking currency rates accordingly.

A currency item (CI) is the indicator of bank's currency risk that is defined by the parity between the amount of assets in certain foreign currency (A_v) and the amount of obligations in that same currency (L_v):

$$VP = A_v - L_V. \tag{2}$$

CI of a bank can be open or closed and be calculated separately for each foreign currency that is included in multicurrency bank briefcase. CI is considered to be open if the amount of assets in foreign currency does not correspond the amount of obligations in that same currency. If the amount of assets in foreign currency is balanced by the amount of obligations in that same foreign currency ($A_v = L_v$), such item is called closed or the item of correspondence. In such case currency risk is almost absent because the rate change of one currency concerning the other will equally influence both the cost of assets and the cost of obligations; this won't lead either to losses or to appearance of profits as a result of currency rate change.

The estimation of currency risk VaR using delta-normal method

In order to demonstrate shortcomings and advantages of a delta-normal method, let's consider how to estimate possible future changes of the cost of briefcase of currency money.

The algorithm of calculation of VaR. The cost of briefcase of currency money P_t in base currency is calculated with an expression:

$$P_t = \sum_{i=1}^{N} P_t^i = \sum_{i=1}^{N} k_t^i \cdot v_t^i , \tag{3}$$

where P_t - time line of costs of the whole briefcase of currency money in base currency in the moment of time *t* ($t = \overline{0,T}$, where $T + 1$ – quantity of meanings of time line P_t); $P_t^i = k_t^i \cdot v_t^i$ – the cost of briefcase component in *i* currency in base currency; k_t^i - exchange rate of briefcase *i* currency into base currency on date *t* ($i = \overline{1,N}$, where N – quantity of currency in briefcase); v_i^t - the volume of *i* currency in briefcase on date *t* (the size of open currency item in terms of currencies). Let's consider the sequence of calculations of risk cost VaR that reflects the possible volume of future changes of the cost of currency money briefcase P_t.

Stage 1. The calculation of daily change of currency rates. The meaning of daily change of rates of briefcase currencies is calculated with a formula of geometrical profitability:

$$x_t^i = \ln\left(\frac{k_t^i}{k_{t-1}^i}\right), \tag{4}$$

where k_t^i – the meaning of exchange rate of *i* currency to base currency on date *t*, $t = \overline{1,T}$; k_{t-1}^i – the meaning of exchange rate of *i* currency to base currency on date *t 1*. Logarithm of time of changes of currency rate characterizes the intensity of change of currency rate and is a random variable, the distributing of which is close to normal with average meaning close to zero.

Stage 2. The calculation of volatility of currencies. In order to calculate the volatility of each currency separately without taking into account its connection with other currencies in briefcase, it is necessary to calculate for each currency selective average and standard quadratic deviation σ^i time line of its profitability $\{x_t^i\}$ with formulas:

$$\overline{X^i} = \frac{\sum_{t=1}^{T} x_t^i}{T}, \tag{5}$$

Where $\overline{X^i}$ - expected (average) meaning of time line of changes $\{x_t^i\}$,

$$\sigma^i = \sqrt{\frac{\sum_{i=1}^{T} (x_t^i - \overline{X^i})^2}{T-1}} . \tag{6}$$

Stage 3. The estimation of possible losses behind the open currency item in *i* currency *VaR*$_i$. The variable of risk cost VaR^i of open item in *i* currency is calculated with a formula:

$$VaR^i = k_{1-\alpha} P_t^i \sigma^i. \quad (7)$$

As volatility of *i* currency according to expression (6) is defined on daily interval, the risk cost of VaR^i is also interpreted as maximum expected volume of reduction of total cost of a separately taken component of currency briefcase in *i* currency during one day with possibility 95% or 99% depending on the meaning of quantile $k_{1-\alpha}$ in formula (7).

Stage 4. The calculation of correlation matrix of briefcase currencies. In order to consider mutual correlation of exchange rate of briefcase currencies in the process of VaR calculation it is necessary to find correlation matrix of briefcase currencies. To do this first it is necessary to calculate co variations C_{ij} of possible combinations of lines of random variables $\{x_t^i\}$ and $\{x_t^j\}$ with an expression:

$$C_{ij} = \frac{1}{T}\sum_{t=1}^{T}(x_t^i - \overline{X^i}) \cdot (x_t^j - \overline{X^j}), \quad (8)$$

And also correlation coefficients K_{ij} of random variables $\{x_t^i\}$ and $\{x_t^j\}$:

$$K_{ij} = \frac{C_{ij}}{\sigma_i \sigma_j}. \quad (9)$$

Square matrix with dimension $n \times n$, in which on *i* row and *j* column intersection the element K_{ij} is located, is a correlation matrix of briefcase exchange rates. This matrix is symmetric: $K_{ij} = K_{ji}$ for all $i, j = \overline{1, N}$, and the elements of main diagonal are single.

Stage 5. The calculation of overall estimation of possible losses VaR of total cost of currency briefcase. Overall estimation of possible losses of total cost of currency briefcase VaR is calculated on the basis of risk costs of VaR^i of separate currencies of a briefcase and correlation matrix of exchange currency rates:

$$VaR = \sqrt{\overline{VaR} \cdot \| \mathbf{K} \| \overline{VaR^T}}, \quad (10)$$

where $\overline{VaR} = \| VaR^1 \quad VaR^2 \quad ... \quad VaR^N \|$ – vector – line of separate estimations VaR^i of briefcase parts in *i* currency; $\mathbf{K}$ - correlation matrix of exchange rates of briefcase currencies to base currency. This method assumes daily data updating and logarithm calculation of course growth rates, co variation and correlation matrixes, volatilities, all VaR^i estimations.

The estimation of currency bank risk VaR using the method of historical modeling

Method of historical modeling is a nonparametric method for VaR estimation. The sequence of usage of this method for band currency risks estimation is the following. First it is necessary to choose the period of time with depth T (for example, 250 working days). For these days selection is created from daily changes of currency rates for all N parts of currency briefcase:

$$\Delta k_t^i = k_t^i - k_{t-1}^i, \; i = \overline{1, N}, \quad (11)$$

де k_t^i – the meaning of exchange rate of *i* currency to base currency on date *t*,

$t = \overline{1,T}$; k_{t-1}^{i} – the meaning of exchange rate of *i* currency to base currency on date *t-1*. For each of T scenarios of rate changes it is modeled hypothetical rate *k** of each currency in future as its current rate k_0 plus rate growth which corresponds the chosen scenario:

$$k_t^i * = k_{i,o} + \Delta k_t^i . \tag{12}$$

Then it is conducted the complete revaluation of current currency briefcase according to rates modeled on the basis of historical scenarios, and for each scenario it is calculated how the cost of today (current) currency briefcase (separately according to long and short bank currency item) would change:

$$\Delta V_t = V_t^* - V_0 , \quad t = \overline{1,T} \tag{13}$$

where $V_0 = \sum_{i=1}^{N} k_{i,o} \cdot v_{i,o}$ – current cost of currency briefcase; $v_{i,0}$ – current volume of *i* currency in briefcase (the cost of open currency item in currency units); $V_t^* = \sum k_i^{t*} \cdot v_{i,o}$ – the cost of currency briefcase in base currency according to *t* historical scenario.

Received T changes of briefcase are ranged by falling for long currency item and on the contrary for the short. The ranged meanings are numbered from 1 to T. In accordance with desirable level of trust VaR is defined as maximum loss that is not exceeded in (1-α)*T* cases, or is equal to absolute variable of change with a number that corresponds integer part of a figure (1-α)*T*. This method is relatively easy to implement if daily updating data base of all currencies and briefcase parts exists. As a rule the more depth of a retrospective that is used for rates modeling, the higher is the accuracy of estimation VaR, but at the same time the bigger is the risk of using out-of-date data which as a rule are less informational than new market trends.

The method of imitation modeling Monte Carlo for estimation of bank currency risks VaR

Monte Carlo method for one part of currency briefcase. Monte Carlo method for estimation of currency risk consists in modeling *movement path of exchange rate according to chosen stochastic process*. Further let's adhere to the assumption that currency rate changes are described with geometric Brownian motion. In order to calculate the estimation VaR^i cost of *i* part of currency briefcase (open currency item, $i = \overline{1,N}$) it is necessary to build the division of modeled costs for this part. To find the line of modeled future costs of *i* currency item it is necessary to model *K* future prices according to movement path which is calculated during *n* steps. The figures *K* and *n* are chosen quite big depending on calculating capacities (for example, 500*1000). The process of estimation VaR can be represented the way:

1. To generate the consequence according to divided random variables $\varepsilon_1, \varepsilon_2, ..., \varepsilon_n$.
2. Using retrospective data of depth L of days to find the meaning of daily profitability (change of *i* rate of currencies) with a formula:

$$x_l^i = \ln\left(\frac{k_l^i}{k_{l-1}^i}\right), \qquad l = \overline{1, L}. \tag{14}$$

For the received sampling of profitability for *i* currency to calculate average μ and mean squared deviation σ.

3. Starting with current rate of *i* currency k_t^i to calculate future modeled prices k_{t+1}^i, $k_{t+2}^i, ..., k_{t+n}^i = k_T^i$ with formulas [2]:

$$\begin{aligned} k_{t+1}^i &= k_t^i + k_t^i(\mu\,\Delta t + \varepsilon_1 \sigma\sqrt{\Delta t}), \\ k_{t+2}^i &= k_{t+1}^i + k_{t+1}^i(\mu\,\Delta t + \varepsilon_2 \sigma\sqrt{\Delta t}), \\ &\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ k_{t+n}^i &= k_{t+n-1}^i + k_{t+n-1}^i(\mu\,\Delta t + \varepsilon_n\,\sigma\sqrt{\Delta t}). \end{aligned} \tag{15}$$

4. To calculate the cost of *i* currency item in base currency (the part of currency briefcase) for rate k_T^i:

$$P_T^i = k_T^i \cdot v_t^i, \tag{16}$$

where v_t^i – current volume of *i* currency item in units of currencies.

5. The steps 3 - 4 to repeat *K* times (depending on the quantity of variables). As a result we get a line of meanings:
$P_T^{i\,1}, P_T^{i\,2}, ..., P_T^{i\,K}$.

6. The received *K* costs of *i* currency item of briefcase are ranged similarly to the method of historical modeling.

The ranged meanings are numbered from 1 to *K*. Let's designate through $P_T^{i\,\alpha}$ the meaning of currency item from this line by a number that is equal to the whole part of a number $(1-\alpha)K$, that means that it corresponds the set level of trust. $(1-\alpha)$.

7. To calculate the average of modeled costs:

$$\overline{P_T^i} = \frac{\sum_{k=1}^{K} P_T^{i\,k}}{K}. \tag{17}$$

8. To calculate possible losses according to *i* currency item:

$$VaR^i = \overline{P_T^i} - P_T^{i\,\alpha}. \tag{18}$$

VaR calculation for currency briefcase using Monte Carlo method

As far as currency rates much correlate with each other, the modeling of future currency rates for each currency of a briefcase should take into account this correlation. In order to solve this task the time-table of Holetsktyi is used. The time-table of Holetsktyi is used to symmetric correlation matrix of currencies $\|K\|$, which can be represented in a form of multiplication of three-cornered matrix of lower order with nulls in upper right corner to the same matrix in such a way (let's consider the case of a briefcase with two currencies):

$$\|K\| = \begin{Vmatrix} 1 & K_{12} \\ K_{12} & 1 \end{Vmatrix} = \begin{Vmatrix} a_{11} & 0 \\ a_{12} & a_{22} \end{Vmatrix} \cdot \begin{Vmatrix} a_{11} & a_{12} \\ 0 & a_{22} \end{Vmatrix} = T \cdot T^T \Rightarrow$$ find the element of matrix T.

Now to get the sequence of random numbers ε_1 to model the rate of *i* currency and ε_2 - for modeling the rate of second currency the expression is calculated:

$$\begin{Vmatrix} \varepsilon_1 \\ \varepsilon_2 \end{Vmatrix} = \| T \| \cdot \begin{Vmatrix} \eta_1 \\ \eta_2 \end{Vmatrix}, \quad (19)$$

where η_1 and η_2 - the sequences of standardly divided normal random numbers. VaR for currency briefcase is calculated with a formula:

$$VaR = \sum_{i=1}^{N} |Var_i|, \quad (20)$$

where VaR_i – predicted estimation of losses according to each currency item which is calculated with Monte Carlo method taking into account correlation between currencies.

The peculiarities of model verification to estimate VaR currency briefcase using historical data

VaR estimation of currency briefcase of a bank takes into account losses which a bank receives as a result of market exchange rate oscillations. The further specified operations also influence the size of an open currency position and consequently currency risk: (1) - purchase and sale of available and non-cash foreign currency, including urgent operations which provoke demands and obligations in foreign currencies not depending on ways and forms of dismissals according to them; (2) - charge, receiving, payment of foreign currency in a form of profits and losses; (3) – receipt of funds in foreign currency to statute capital; (4) - repayment by a bank of hopeless debt in foreign currency; (5) - formation of reserves in foreign currency; (6) - purchase and sale of main costs and inventory items using foreign currency; (7) – other exchange operations with foreign currency [3, 5]. That means operations of physical change of structure of currency item. To estimate the changes of structure of bank currency item that does not depend on exchange rates oscillations, the index of Paashe is used.

Let's consider that the total cost of currency briefcase P_t in base currency on the moment of time *t* is defined by a formula:

$$P_t = \sum_{i=1}^{N} k_t^i \cdot \left| v_t^i \right|, \quad (21)$$

where $P_t^i = k_t^i \cdot v_t^i$ – currency item of a bank according to *i* currency in base currency. The index of Paashe J_{vi} characterizes the level of influence of structural changes of a currency item on the total volume of currency item taking into account exchange rates on the beginning of a period that is analyzed $[t-1, t]$ [3]:

$$J_{vi} = \frac{k_{t-1}^{i} \cdot v_{t}^{i}}{k_{t-1}^{i} \cdot v_{t-1}^{i}}, \qquad i = \overline{1, N}. \tag{22}$$

The process of verification of a model for currency risk estimation is the following. On the moment of time *t* it is possible to calculate the meaning of actual cost of a briefcase Δ_t and compare it with the meaning of VaR_t. The peculiarity of comparison consists of necessity to exclude from calculation the factor of change of physical volumes of briefcase currencies as far as the indicator *VaR* does not take into account the changes of volumes of each currency in briefcase. Taking this the adequacy check of VaR–model is made in the following sequence:

1. To define Δ_t^i as losses from *i* currency item for a period of time [*t*-1, *t*], as disparity between the cost of *i* currency item on the moment of time *t* without taking into account the changes of physical structure that occurred on the period [*t*-1, *t*] and its cost on the moment of time *t*-1 with a formula:

$$\Delta_t^i = \begin{cases} \left| \frac{P_t^i}{J_{vi}^t} - P_{t-1}^i \right|, \text{ якщо } \frac{P_t^i}{J_{vi}^t} - P_{t-1}^i < 0 \\ 0, \text{ якщо } \frac{P_t^i}{J_{vi}^t} - P_{t-1}^i > 0 \end{cases}, \tag{23}$$

where J_{vi}^t is calculated according to expression (22) on the moment of time *t*. Then on each moment of time *t* of a period of back-testing ($t = \overline{1, T}$) it is calculated the loss from exchange rates oscillations for the currency briefcase on the whole:

$$\Delta V_t = \sum_{i=1}^{N} \Delta_t^i. \tag{24}$$

2. The comparison of daily meanings VaR_t and corresponding to them actual changes of briefcase cost ΔV_t. The case when the condition is observed

$$\Delta V_t > VaR_t, \tag{25}$$

that means that the cost change is negative (loss) and at the same time in absolute meaning exceeds VaR, is called the exceeding of predicted expenses. Then the quantity of cases of exceeding *L* is calculated.

3. The model adequacy is checked by the parity:

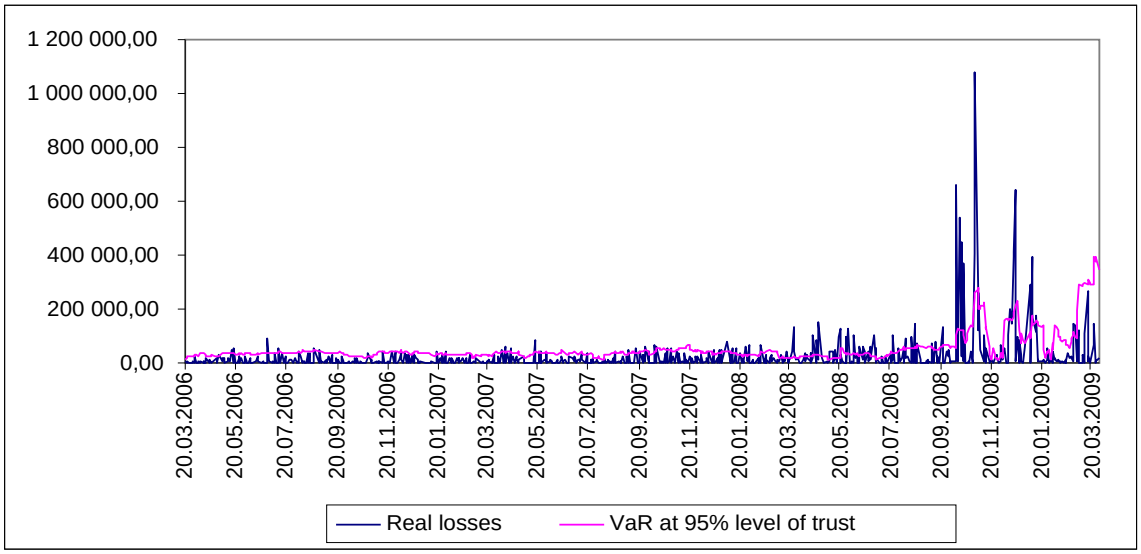
$$\frac{L}{T} < \alpha. \tag{26}$$

The analysis of results of estimation of losses VaR. To estimate VaR it has been used bank currency briefcase that consists of three items in three currencies (USA dollar, euro and Russian ruble). To estimate VaR and test models implementation on historical data it has been used the following data: (1) – daily meanings of market rates of dollar USA, euro and Russian

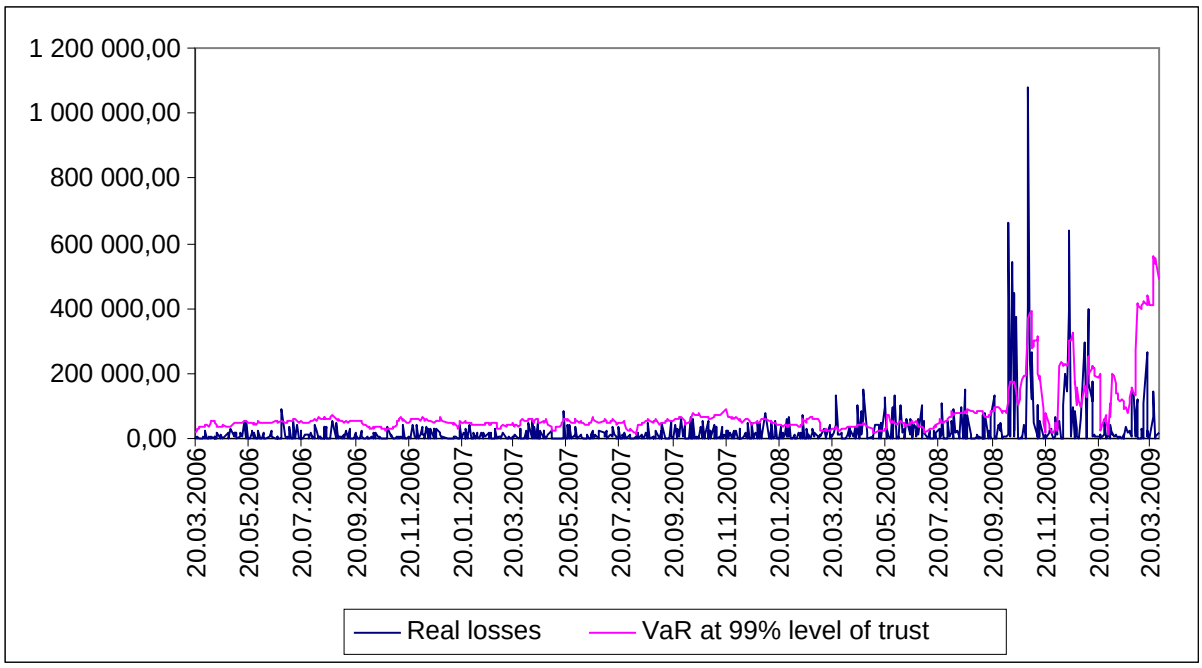
ruble from 01.01.2006 – 30.06.2010; (2) – daily data of bank rates from three currencies for a period from 01.06.2006 – 30.06.2010; (3) – daily meanings of open bank currency items in three above mentioned currencies for a period from 01.01.2006 – 30.06.2010. To calculate the meaning of VaR it has been used historical data of currencies rates and the meaning of currency item of a bank in hryvna equivalent.

The analysis of the results of estimation VaR using delta-normal method

On the input of a model the market meanings of exchange rates, bank meanings of exchange rates and bank currency items in briefcase currencies are presented. The definition of standard oscillation that is the measure of volatility of currency rate while using delta-normal method is made on the base of assumption about normal division of profitability of currency rate. On pictures 1 and 2 the results of prediction of bank losses from changes of currency briefcase cost as a result of rates oscillations for different levels of trust (95% and 99%) are represented. The depth of retrospective for estimation of standard oscillation is 250 days.



Picture 1. Real and predicted according to delta-normal method losses of a bank from currency rate oscillation for level of trust 95%



Picture 2. Real and predicted according to delta-normal method losses of a bank from currency rate oscillation for level of trust 99%

In order to check the adequacy of a model the recommendations of Basel committee of bank supervision for different levels of trust (95%, 99% and 97%) have been used. Each three months it is calculated the quantity of mistakes of forecast on former period in 250 days starting with 20/03/2006. The depth of retrospective for estimation VaR is also 250 days. The results of verification are brought together in table 1.

Table 1

The results of conduction of retrospective testing of calculation VaR using delta-normal method

Period	The results of back - testing					
	95%		97%		99%	
	Quantity of exceeding	% correct forecasts	Quantity of exceeding	% correct forecasts	Quantity of exceeding	% correct forecasts
from 21.03.06 to 21.03.07	13	94,80%	8	96,80%	3	98,80%
from 20.06.06 to 21.06.07	16	93,60%	7	97,20%	4	98,40%
from 22.09.06 to 21.09.07	16	93,60%	8	96,80%	6	97,60%
from 21.12.06 to 21.12.07	21	91,60%	9	96,40%	6	97,60%
from 23.03.07 to 21.03.08	30	88,00%	20	92,00%	15	94,00%
from 24.09.07 to22.09.08	57	77,20%	51	79,60%	40	84,00%
from 24.12.07 to 22.12.08	65	74,00%	62	75,20%	49	80,40%
from 20.03.08 to 30.03.09	62	75,20%	58	76,80%	42	83,20%

According to table 1 we can see that the model for estimation VaR of currency briefcase using delta-normal method is inadequate. In order to find the reasons of inadequacy of a model the retrospectives that are used to find estimations VaR are checked on normal division according to Pirson criterion. Profitability for USA dollar rate does not have normal division. Profitability for euro is divided close to normal division, and on some periods has normal division.

In table 2 it is represented the results of retrospective testing of a model while calculating VaR according to each currency. If meaning χ^2_{cn} is less according to euro than to USA dollar, then the division of profitability of euro rate is closer to normal (normal on some periods) than the division of USA dollar – means method gives less mistakes of forecast for euro than for USA dollar. The quantity of mistakes grows when the meaning χ^2_{cn} increases and removes from $\chi^2_{кр}$. Model of estimation VaR using delta-normal method for euro with normal division of retrospective of profitability of rate is adequate. In table 3 the results of retrospective testing of VaR calculation using method of historical modeling are represented.

Table 2

The results of retrospective testing of delta normal method of VaR estimation with 95% level of trust in case of VaR estimation according to each currency item of a briefcase separately

Period		Results of back - testing			
		USA dollar		Euro	
		Quantity of exceeds	% of correct forecasts	Quantity of exceeds	% of correct forecasts
from 21.03.06	to 21.03.07	18	92,80%	9	96,40%
from 20.06.06	to 21.06.07	14	94,40%	6	97,60%
from 22.09.06	to 21.09.07	17	93,20%	7	97,20%
from 21.12.06	to 21.12.07	15	94,00%	5	98,00%
from 23.03.07	to 21.03.08	37	85,20%	9	96,40%
from 22.06.07	to 23.06.08	53	78,80%	14	94,40%
from 24.09.07	to 22.09.08	61	75,60%	16	93,60%
from 24.12.07	to 22.12.08	63	74,80%	45	82,00%
from 20.03.08	to 30.03.09	58	76,80%	47	81,20%

Table 3

The results of retrospective testing of VaR calculation using method of historical modeling

Період	Results of back-testing					
	95%		97%		99%	
	Quantity of exceeds	% of correct forecasts	Quantity of exceeds	% of correct forecasts	Quantity of exceeds	% of correct forecasts
from 21.03.06 to 21.03.07	4	98,40%	2	99,20%	1	99,60%
from 20.06.06 to 21.06.07	5	98,00%	3	98,80%	1	99,60%
from 22.09.06 to 21.09.07	3	98,80%	2	99,20%	0	100,00%
from 21.12.06 to 21.12.07	5	98,00%	1	99,60%	0	100,00%
from 23.03.07 to 21.03.08	16	93,60%	3	98,80%	0	100,00%
from 22.06.07 to 23.06.08	35	86,00%	12	95,20%	2	99,20%
from 24.09.07 to 22.09.08	50	80,00%	17	93,20%	3	98,80%
from 24.12.07 to 22.12.08	74	70,40%	37	85,20%	9	96,40%

from 20.03.08 to 30.03.09	77	69,20%	46	81,60%	11	95,60%

From table 3 it is seen that the losses start exceeding estimation VaR with 95% level of trust on the period from March 2008 when unpredicted changes of USA dollar and euro rate started to be observed. With 99% level of trust (which is demanded by Basel committee) the quantity of forecast mistakes starts growing from the end of September 2008. In the period of forced reduction in second – third quarters of 2008 and on the period of 4-th quarter of 2008 – first quarter of 2009 the model for estimation of risk VaR using method of historical modeling ceases to be adequate.

While decreasing the depth of retrospective the accuracy of a model also decreases; the bigger the depth of a forecast, the higher is the accuracy of a forecast. But when the retrospective is small a model quicker adapts to market changes and in the period of instability the model gives fewer mistakes than with big retrospective. For example, during the period of oscillations on the market at the beginning of 2008 with small retrospective the model still remains adequate and with big retrospective – the quantity of mistakes during this period exceeds admissible level.

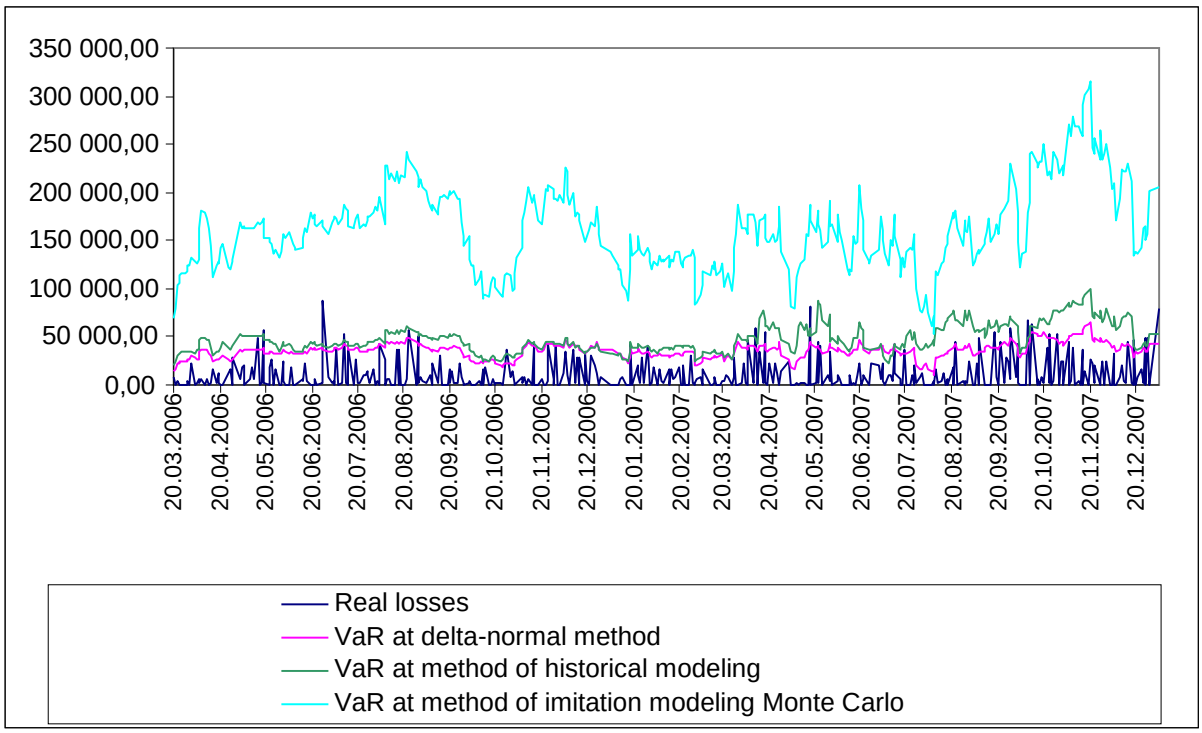
The comparison of methods of estimation VaR. To implement the methodology VaR on Ukrainian financial market the above described methods of estimation have been used. To compare the methods there have been used the results of implementation of methods with 95% level of trust and the depth of retrospective in 250 days.

On picture 3 the results of predicting of bank losses for all three methods at stable situation on financial market in a period from March 2006 to January 2008 are represented. On picture 4 the results of using methods in a period of sharp oscillations of currency rates and crisis phenomena on a period from the beginning of 2008 to March 2009 are represented. In table 4 the results of reverse testing for each of the models are presented and the quantity of mistakes from results of models work on several periods with duration of 250 days each are calculated.

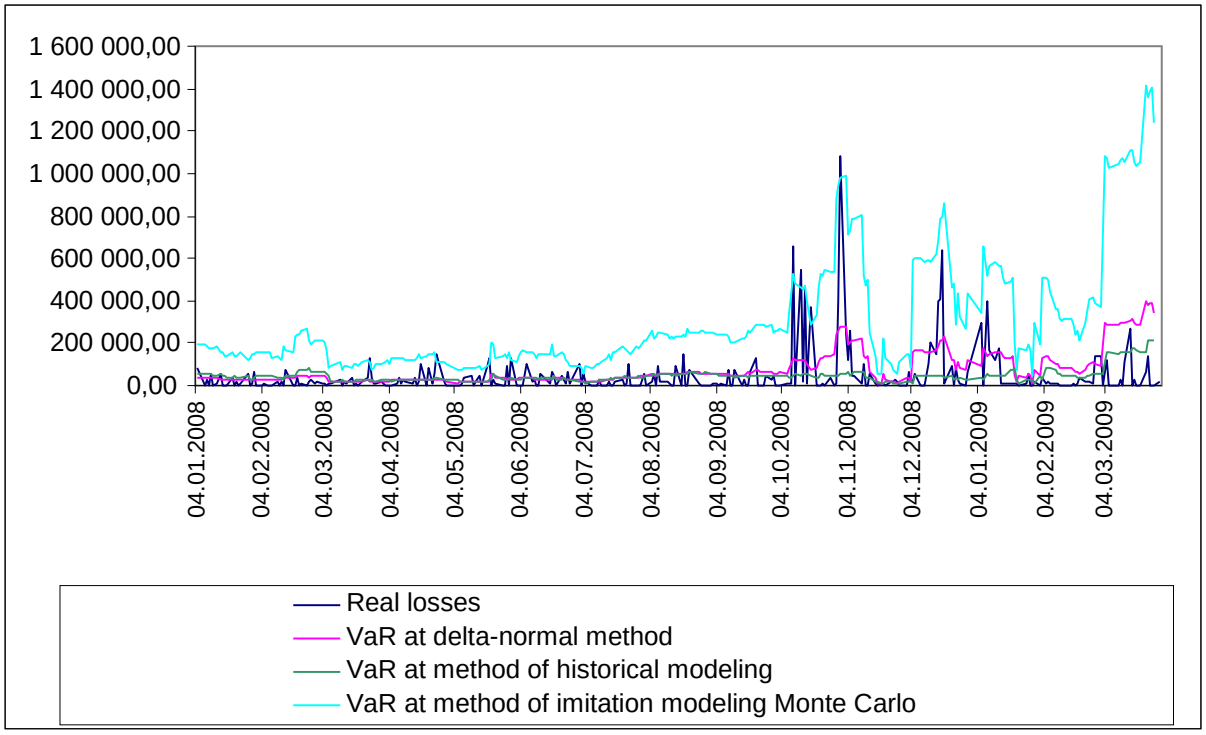
Table 4

Comparative analysis of back-testing of a model of risk estimation VaR using different methods

Period		**Results of back-testing with 95% level of trust**					
		Delta-normal method		**Method of historical modeling**		**Monte Carlo method**	
		Quantity of exceeding	**% correct forecasts**	**Quantity of exceeding**	**% correct forecasts**	**Quantity of exceeding**	**% correct forecasts**
from 21.03.06	to 21.03.07	13	94,80%	4	98,40%	0	100,00%
from 20.06.06	to 21.06.07	16	93,60%	5	98,00%	0	100,00%
from 22.09.06	to 21.09.07	16	93,60%	3	98,80%	0	100,00%
from 21.12.06	to 21.12.07	21	91,60%	5	98,00%	0	100,00%
from 23.03.07	to 21.03.08	30	88,00%	16	93,60%	0	100,00%
from 22.06.07	to 23.06.08	47	81,20%	35	86,00%	3	98,80%
from 24.09.07	to 22.09.08	57	77,20%	50	80,00%	4	98,40%
from 24.12.07	to 22.12.08	65	74,00%	74	70,40%	7	97,20%
from 20.03.08	to 30.03.09	62	75,20%	77	69,20%	7	97,20%



Picture 3. The results of work of different methods to estimate VaR for stable situation on the market



Picture 4. The results of using three methods of estimation VaR for big market oscillations

As graphics show, in a period of stable situation on currency market method of imitation modeling Monte Carlo and method of historical modeling show the best results, predicted meanings of losses cover the real in the majority of cases. The models are adequate, but the model of estimation VaR using method of historical modeling is more accurate. Delta-normal method is

inadequate to estimate risk on Ukrainian market, as the results of forecasting show. The results of back-testing prove that. The results of analysis of advantages and shortcomings of used methods to estimate VaR are summed in table 5.

Table 5

Comparative analysis of work of different methods for risk estimation VaR

Method / Criteria	Delta normal	Historical modeling	Method of imitation modeling of Monte Carlo
Estimation	Local	Total	Total
Taking into account historical division	As estimation of normal division	The similar to that in the past	Totally
Taking into account «admissible» volatility	Possible	No	Yes
Assumption about normal division of profitability	Yes	No	No
Estimation of extreme events	Bad	Bad	Possible
Model risk	Can be great	Admissible	High
Volume of retrospective	Average	Very big	Little
Calculation difficulty	Not high	High	Very high
Visualization	Average	High	High
Calculation capacities	Low	Average	High

Conclusions

Measure VaR has shortages and advantages, but it gives possibility to estimate the risk uniquely for each country and each bank. Using this methodology for developing countries is problematic because of insufficient development of financial markets, significant «tenezation» of economy and profits, influence on market indicators from the participants of the market and the country. To compare the results of implementation of this methodology on Ukrainian currency market three methods of estimation VaR of bank currency briefcase are represented: delta-normal, method of historical modeling and method of imitation modeling Monte Carlo.

The model of risks estimation on the base of delta-normal method has appeared to be inadequate because the assumption about the normal division of currency rates profitability hasn't been made. It is necessary to mark that the division of profitability of euro rate on some periods is close to normal and thus the model of estimation VaR of currency item to euro on these periods has appeared to be adequate.

The method of historical modeling has shown satisfactory result only on conditions of stable market situation. It badly adapts to different oscillations on the market and thus today it can't be used on Ukrainian financial market.

The best results of estimation of possible losses have been received using method of imitation modeling Monte Carlo which hypothetically takes into account all possible changes of exchange

rates on the market. The mistakes in forecasts of possible losses appear only on condition of unpredicted sharp shifts of rate but the model on the base of this method quickly adapts to market changes. To use this method on-line it is necessary to have big calculation capacities that mean vain charges for banks with little market risk. For these banks it is recommended to use standard approach on the base of fixed coefficients to estimate financial risks. For banks with huge market risks method Monte Carlo is the best. To estimate improbable sharp oscillations of currencies (costs, quoting) it is recommended to use stress-testing that gives representation about the volume of losses in crisis market phenomena.

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