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# Recent Periods of Financial Turbulence on the Russian Stock Market and Their Effect on Price Correlation and Value at Risk

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# Recent Periods of Financial Turbulence on the Russian Stock Market and Their Effect on Price Correlation and Value at Risk

**Abstract**
The aim of this article is to observe and analyze the recent periods of financial turbulence on the Russian stock market and determine their influence on the correlation coefficients between asset prices and the Value at Risk measure for a portfolio. Our task was to describe the previously observed phenomenon of correlation enlargement during times of financial crises deemed in our research as separate Black Swans. Based on up-to-date financial data analysis we determined correlation trends that can be useful in risk management and applied the Value at Risk method.

**Keywords**
correlation, crisis, stock prices, risk

## Introduction

The theme of rare, unprecedented events with huge consequences, called Black Swans, which is the underlying assumption of this work, is very urgent nowadays, because chances and probabilities determine our lives, and we must be ready to battle these uncertainties. Risk is embedded into day-to-day life, but some aspects of life are more risk-sensitive than others. For example, an asset portfolio and the risks associated with it are very important for investors and traders. In this research work, the authors wanted to examine the peculiarities of previously observed phenomena of increasing correlation of financial asset prices during turbulent times, using data from the Russian stock market, and to apply the Value at Risk risk-management method. Although several studies have been made into this phenomenon (Campbell et al., 2008), only one has been made concerning the Russian economy and stock markets (Yumina, 2013). The results of this research will be beneficial for people dealing with a portfolio of assets, in their decision-making processes and risk-management techniques.

## Analysis

This research work deals with periods of financial turbulence, which we connect to Black Swan events, which occur in our world. This notion of "Black Swans" was developed by the American economist Nassim Nicholas Taleb (2007) and it is concerned with rare unpredictable events. According to his point of view, there are three attributes of an event, in order for it to be classified as a Black Swan:

- It has to be extraordinary, something never seen before,
- It has to be very influential, and
- It has to be able to be retrospectively explained.

This is a completely new concept, which has not been very much spoken about before the publications if its studies by Mr Taleb (2005). This dangerous combination of features makes Black Swans very difficult to predict, but also makes the prediction of these events a vital necessity, due to the second point, which is the effects of these events. Apart from an economic viewpoint, there exists a psychological side to it, which states that people are always able to find plausible causes for these events, but only after the said event had already occurred.

Taking into account these three factors, the authors concluded, that some events that had taken place in 2013 – 2014 may be characterised as being these Black Swans. The ongoing political crisis in the Ukraine, may be classified as a Black Swan, because nobody envisaged the change of political power, the change in the territorial integrity of the country and the state of civil war in the country.

Major changes in the life of the Ukrainian people have occurred and are occurring now, and at the same time, various political experts are finding reasonable explanations to these developments. The authors also believe that the financial crisis in Cyprus may also be regarded as a Black Swan. Although there have been developments that lead to the crisis, nevertheless it caused a shutdown of the whole financial system of the republic, causing a state close to a default.

Another aspect of the work is connected to the financial market, namely to correlations between different financial assets. Numerous studies have been conducted, which describe the phenomenon of increasing correlation of financial assets during times of high turbulence and financial crises (Moldovan and Medrega, 2011). Studies have shown that when one calculates the pair correlation of financial asset prices during high turbulence in the market and before or after it, one will find that the figures will differ, with correlation during turbulence being greater, than that of other times (Longin and Solnik, 2001).

The history of the financial markets is full of episodes, which have been devastating to the people directly and indirectly involved, and due to the increasing pace of overall globalisation, the consequences of these events stretch far out than one individual country. Examples of such events are the Great Depression of the 1920-1930s, the United States stock market crash of 1987 and the sub-prime mortgage crisis of 2007-2008. The Russian stock market has existed for just over 20 years, but nevertheless, there was the infamous default of 1998, and prior to that a monetary reform and period of high inflation. In our point of view, it is worth making an analysis of fairly recent financial data, to verify whether the rule of increasing correlation really takes place.

To conduct the research we used data for the stock prices of several Russian companies: Sberbank, VTB Bank, Lukoil, Uralkaliy and GMKNorNikel (all quoted on the Moscow Exchange (MOEX)), which were taken from the *Finam.ru* website. The analysis of the initial information was performed by calculating correlation with respect to the time-lapse of the crises. It was decided to use data for the Russian stock market because there was no such profound influence on the major indexes, such as DJIA, FTSE or NIKKEI due to our common economic space.

Data were taken at a day-period basis beginning from 8 January 2013 up to the 31 October 2014 (FINAM.RU, 2014) to suit the timeframe of the Cypriot crisis, the Euromaidan demonstrations, and the sanctions of the progressive Western world against the Russian Federation. However, Euromaidan is an internal political conflict; there was a conspicuous trend on our stock markets to be discovered.

Table 1 is an extract from the initial data that were acquired by the authors.

Table 1. Stock prices of Sberbank and VTB, roubles.

| <DATE> | SBER | VTB |
|---|---|---|
| 08.01.2013 | 98,37 | 0,05492 |

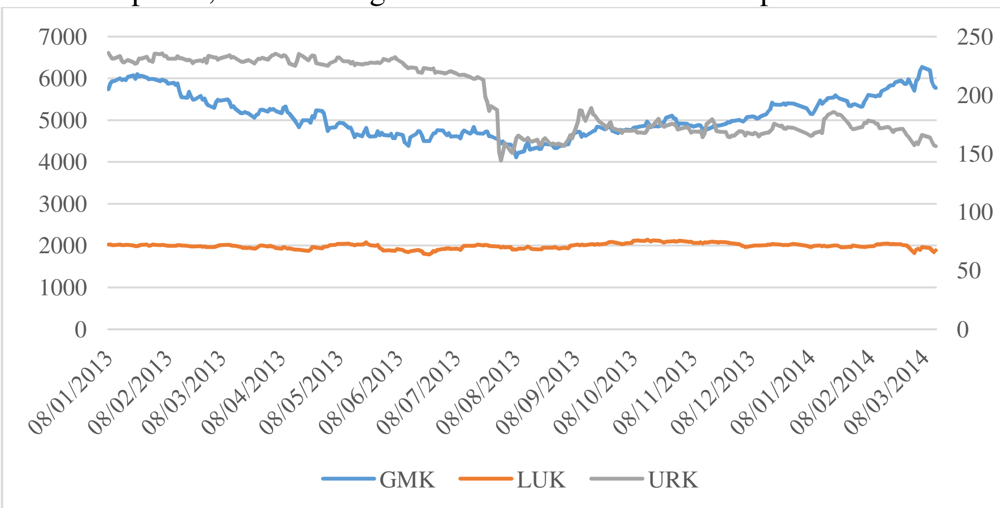
| | | |
|---|---|---|
| 09.01.2013 | 98,23 | 0,05479 |
| 10.01.2013 | 98,41 | 0,05524 |
| 11.01.2013 | 99,56 | 0,05754 |
| 14.01.2013 | 100,99 | 0,05775 |
| 15.01.2013 | 99,85 | 0,05740 |
| 16.01.2013 | 99,97 | 0,05771 |
| 17.01.2013 | 101,15 | 0,05775 |
| 18.01.2013 | 103,48 | 0,05823 |
| 21.01.2013 | 103,64 | 0,05833 |
| 22.01.2013 | 102,35 | 0,05936 |
| 23.01.2013 | 103,45 | 0,05947 |
| 24.01.2013 | 102,48 | 0,05899 |
| 25.01.2013 | 103,67 | 0,05914 |
| 28.01.2013 | 106,90 | 0,05929 |
| 29.01.2013 | 106,55 | 0,05800 |
| 30.01.2013 | 107,80 | 0,05609 |
| 31.01.2013 | 109,59 | 0,05582 |
| 01.02.2013 | 108,36 | 0,05615 |
| 04.02.2013 | 107,20 | 0,05508 |
| 05.02.2013 | 107,75 | 0,05530 |
| 06.02.2013 | 106,80 | 0,05402 |
| 07.02.2013 | 105,65 | 0,05422 |
| 08.02.2013 | 107,08 | 0,05363 |
| 11.02.2013 | 107,04 | 0,05310 |
| 12.02.2013 | 108,48 | 0,05280 |
| 13.02.2013 | 108,80 | 0,05564 |
| 14.02.2013 | 107,62 | 0,05647 |
| 15.02.2013 | 105,08 | 0,05599 |
| 18.02.2013 | 106,23 | 0,05599 |
| 19.02.2013 | 108,73 | 0,05649 |
| 20.02.2013 | 107,82 | 0,05689 |

Source: (FINAM.RU, 2014)

Let us state our hypothesis. *Correlation between assets tends to increase rather than decrease in times of high financial turbulence.* We shall try to apply calculus to determine pair correlation between several stock prices.

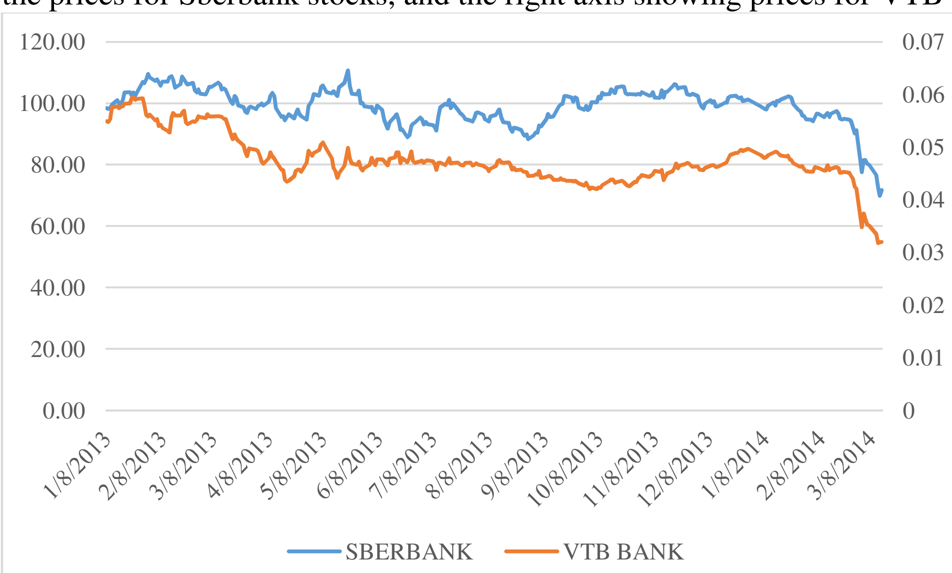
The general findings lead us to believe that if during normal times stock markets correlate moderately, relations between them intensify when sudden price drops occur. This is largely due to the occurrence of the phenomenon known as "shift contagion," defined as significant change in cross-market links after a shock to an individual country or group of countries. A similar phenomenon may be observed in the banking sector, which is called a “bank run”. This is exactly what we received in our processing part.

Graph №1 shows the price changes of stocks of Lukoil, Uralkaliy and NorNickel. The prices are expressed in roubles; the left axis is the scale for GMK and URK prices, while the right scale determines the LUK prices.




Graph №1. Price changes of stocks of Lukoil, Uralkaliy and NorNickel. Source: (FINAM.RU, 2014).

Graph №2 shows the price changes of stocks of Sberbank and VTB. Similarly, the prices are expressed in Russian roubles, with the left axis showing the prices for Sberbank stocks, and the right axis showing prices for VTB stocks.




Graph №2. Price changes of stocks of Sberbank and VTB. Source: (FINAM.RU, 2014).

The analysis of the initial data were conducted as follows:

Firstly, we obtained variance of share prices of each company, using the formula

$$Var(X) = \sigma^2 = E(X^2) - (E(X))^2 \ , \quad (1)$$

where $E(X)$ is the expected value of the random variable.

The result of this operation is monthly variance for the companies. Afterwards, using the same initial data and the variance for the companies we obtained the monthly figures for the correlation coefficient for both sets of asset prices, using the formula

$$\rho_{xy} = \frac{E((X-\mu_X)(Y-\mu_Y))}{\sigma_x \sigma_y} \ , \quad (2)$$

where $\rho_{xy}$ is the correlation coefficient, $\sigma_x$ and $\sigma_y$ are the standard deviations of returns of the $x$-th and $y$-th assets respectively, $E$ is the mean of a random variable, $X$ and $Y$ are occurrences of $x$ and $y$, and $\mu_x$ and $\mu_y$ are the means of $x$ and $y$ respectively.

The authors used Microsoft Excel software to determine the correlation coefficients between the stocks of the companies of the two sectors.

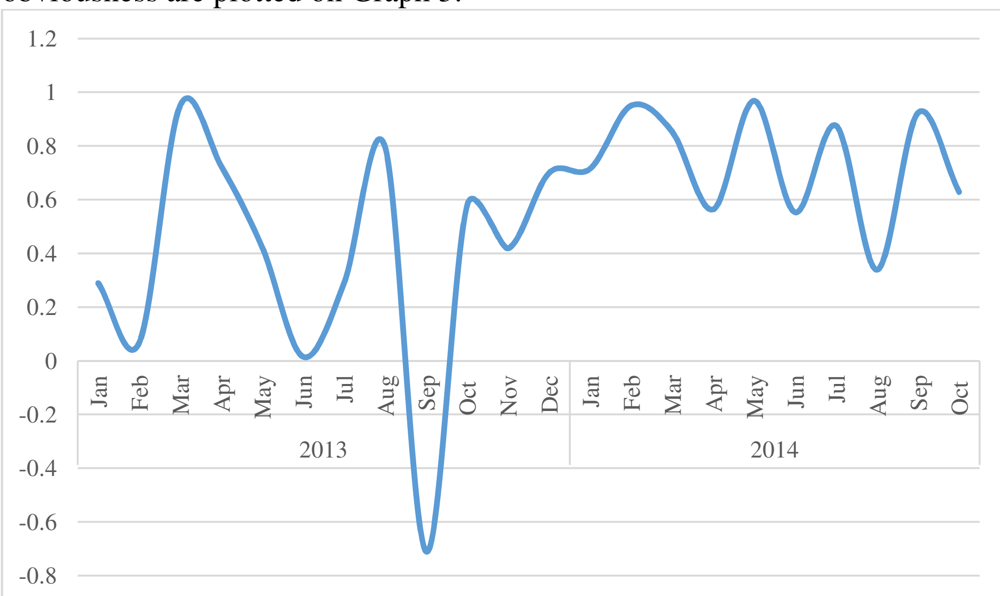
Table 2. Monthly levels of correlation between the stock prices of Sberbank and VTB.

| Year | Month | Correlation |
|---|---|---|
| 2013 | January | 0,289148 |
| | February | 0,067159 |
| | March | 0,950833 |
| | April | 0,725323 |
| | May | 0,422567 |
| | June | 0,014728 |
| | July | 0,29145 |
| | August | 0,794241 |
| | September | -0,71127 |
| | October | 0,579511 |
| | November | 0,418335 |
| | December | 0,699934 |
| 2014 | January | 0,715684 |
| | February | 0,950711 |
| | March | 0,85313 |
| | April | 0,563861 |
| | May | 0,968392 |
| | June | 0,553133 |
| | July | 0,875433 |
| | August | 0,338927 |

| | | |
|---|---|---|
| | September | 0,923998 |
| | October | 0,62847 |

Source: authors’ calculations

Table 2 contains the results of the calculations performed by the authors. Opposite every month, there is the level of correlation between the price levels for that particular month, as shown in Table 1. The data, for simplicity, clearness and obviousness are plotted on Graph 3.




Graph №3. Correlation coefficients. Source: authors’ own calculations.

The x-axis shows the timeline from January 2013 to October 2014, while the y-axis shows the levels of correlation coefficients. The points on the graph represent the levels of correlation during the indicated months. Let us determine the timeframe of the crises and the definition of “high correlation”:

- The financial crisis in the Republic of Cyprus occurred in February-March, 2013;
- The beginning of public unrest in the Ukraine occurred in December 2013;
- The Crimean crisis began in March 2014.
- Sanctions are taking place from Spring 2014 to present day.
- Levels of the correlation coefficient surpassing the level of *0.75* shall be deemed as high.

If we look more closely at the times of our events, that is February-March 2013, December 2014 and March-October 2014, we see a formidable increase in the level of correlation coefficient for the two sectors. In all three cases the level of correlation exceeded 0,75; which surpasses our threshold of high level. Thus, we may conclude that indeed, this phenomenon really occurs, even if we turn to recent financial data, and the hypothesis is correct.

**Practical application**

Then the authors decided to apply the findings into practice. To do this, we used the concept of Value at Risk (VaR), which involves, among other things, correlation, to see the maximum possible risk of a hypothetical portfolio. VaR is the amount of maximum possible loss at the most unfavourable scenario, at a predetermined confidence level, it is obtained by analysis of statistical historic data. Mathematically, it may be described as the left tail of the normal distribution curve, the size of which depends on the chosen confidence level. Generally, VaR is calculated as a cutoff value, for example, under a 95% confidence level, we may cut off the 5% of "worst" outcomes and determine our Value at Risk.

Implicitly, VaR is defined as

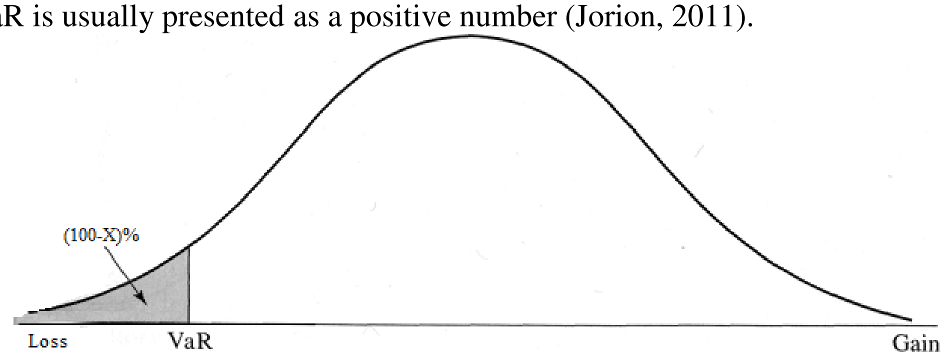
$$c = \int_{-VAR}^{\infty} f(x)dx \,, \tag{3}$$

where:

*c* is the confidence level,

*x* is the currency profit/loss.

VaR is usually presented as a positive number (Jorion, 2011).




Graph №4. Graphical representation of VaR.

In graph №4 we may see the bell-shaped curve of the distribution of profits or losses, where X is the cutoff value. If the confidence level is 95%, (100-95)% gives us 5%, which is the five percent of losses on the left tail, where the arrow is pointing.

This method looks at the market risk, which is encountered by parties, having a relationship with any kind of market. Market risk arises from the possibility of losses resulting from unfavourable market movements. The VaR is calculated using the following formula:

$$VAR_p = \alpha\sigma_p W = \alpha\sqrt{\vec{x}^T \sum \vec{x}} \,, \tag{4}$$

where $\alpha$ is the confidence level, $\sigma_p$ is the portfolio standard deviation and $W$ is the portfolio. Under the square root we have

$$\vec{x}^T \Sigma \vec{x} = \begin{bmatrix} x_1 & x_2 \end{bmatrix} \begin{bmatrix} \sigma_1^2 & \rho\sigma_1\sigma_2 \\ \rho\sigma_1\sigma_2 & \sigma_2^2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}, \qquad (5)$$

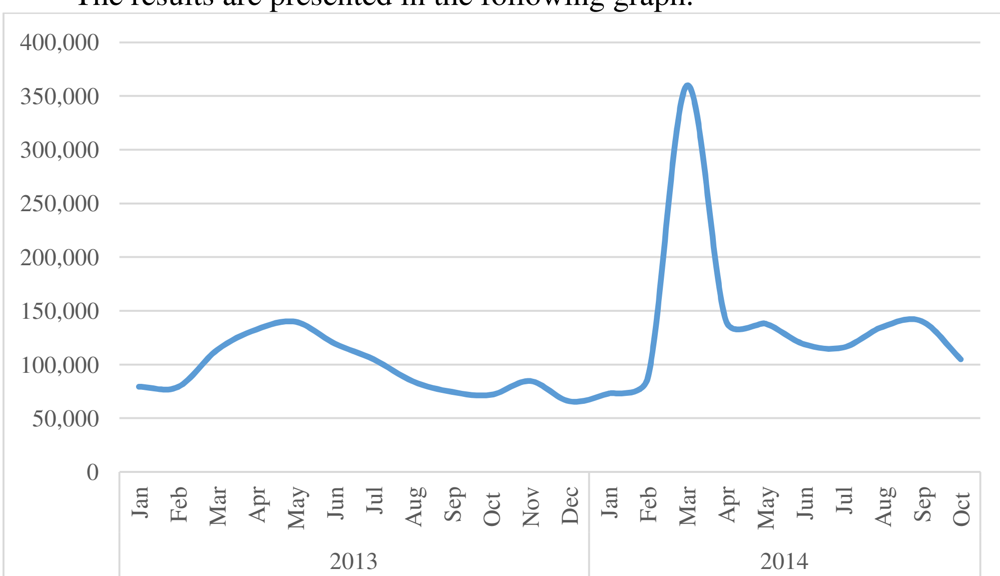
which is the covariance matrix $\Sigma$ multiplied by the vectors of investments $x_i$. To avoid matrix notation, we have another formula for a two-asset portfolio:

$$VaR_p = \alpha\sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\rho_{1,2}\sigma_1\sigma_2}W, \qquad (6)$$

where $w_1$, $w_2$ are the weights of the 1st and 2nd assets, $\sigma_1$, $\sigma_2$ are the standard deviations for the 1st and 2nd assets, $\rho_{1,2}$ is the correlation coefficient between the 1st and 2nd assets, $\alpha$ is the confidence level and $W$ is the portfolio.

We shall consider a hypothetical portfolio of 1 million RUR, where investments are made into the stocks of Sberbank and VTB. The values, used in the formulas, were obtained from the stock prices presented before. Similar to the previous approach, VaR for the portfolio is calculated on a monthly basis.

The results are presented in the following graph.




Graph №4. Correlation coefficients and VaR. Source: authors' own calculations.

The left axis provides information on levels of VaR, the blue line is the monthly VaR figures for the portfolio.

The peaks of the maximum possible losses are consistent with the high turbulence events. We may observe a slight increase in spring of 2013, which reflects the financial crisis in Cyprus, afterwards, during times of stability, we see the Value at Risk declining. In November 2013 the risk level increases once again, while in spring of 2014 the risk level rose from approximately RUR 75 000 to approximately RUR 350 000, afterwards, the VaR level did not descend lower than RUR 100 000.

This provides us with an example of the dangerousness of high correlation levels. It may be overcome by methods of portfolio diversification, preferably into stocks with negative correlation coefficients.

## Conclusions

As we can see from the research, basing on recent events, the rule of increasing correlation holds even under Russian stock market conditions. Indeed, we saw a great increase in the correlation coefficient, which actually coincided with the Black swans – periods of high turbulence in the market. It is worth noting for traders, who may adopt this knowledge in their risk-management practices. This knowledge will help us to differentiate minor fluctuations, corrections or random movements of the stock market from a global, systemic movement that involves numerous financial assets. Considering high trading volumes that accompanied trading sessions, we can claim that there is relation between current Ukraine commotions and asset correlation on the Russian MOEX exchange.

The practical applications of the findings, which are contained in the analysis of the Value at Risk of the portfolio, show us that recent crises created a risk of losing 35% of the portfolio and a constant risk of losing more that 10% of the portfolio. These phenomena may be applied in real risk-management practices, and they emphasize the importance of hedging techniques, for example, diversification of assets, which will reduce the exposure of a party to market risk.

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