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**Article**

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*Review*  
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## ESTIMATING RISK ON THE CAPITAL MARKET WITH VaR METHOD

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### **Abstract**

The two basic questions that every investor tries to answer before investment are questions about predicting return and risk. Risk and return are generally considered two positively correlated sizes, during the growth of risk it is expected increase of return to compensate the higher risk. The quantification of risk in the capital market represents the current topic since occurrence of securities. Together with estimated future returns it represents starting point of any investment. In this study it is described the history of the emergence of VaR methods, usefulness in assessing the risks of financial assets. Three main Value at Risk (VaR) methodologies are described and explained in detail: historical method, parametric method and Monte Carlo method. After the theoretical review of VaR methods it is estimated risk of liquid stocks and portfolio from the Croatian capital market with historical and parametric VaR method, after which the results were compared and explained.

**Keywords:** Value at Risk, Parametric, Monte Carlo, Capital market.

*Jel Classification:* G17

### **INTRODUCTION**

Considering that the market movements of securities are facing with many uncertainties, it is necessary to establish a risk management system. Risk is an unavoidable factor in business and in the financial world, many banks, funds and brokerage houses are dealing with different methods to measure their exposure to risk. Risk measurement is every day even more important and it has received significant application in the last forty years. Experts in risk are always looking for better and more accurate ways of measuring risk, because each new crisis or failure of a financial

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institution discovers errors and limitations of modern risk management methods. Managing risk means to identify, measure, assess the risk to minimize its main effects on the financial result and equity. There are also a set of management methods and techniques used to reduce the possibility of personal accomplishment and unwanted adverse events and effects and thus to increase the likelihood of achieving the planned results. There are various types of risk in the market. Since the risks in the market cannot be avoided, it is very important to find a way to measure it.

One of the most important and appropriate method for risk measuring is considered to be the VaR (Value at Risk) method. For VaR method of measuring risk is characteristic that it measure losses due to market movements, calculated risk value aggregates all risks into a single number that presents risk value. Lindsmeier and Pearson (2000) in their research have pointed out that VaR was first used by large financial institutions in the late 1980s to measure the risks of its market portfolios. Right after that use VaR is greatly popularized. J.P. Morgan first tried to establish a market standard through its Risk Metrics and 1994 and it has given a major boost for the application of the measurement of market risk using the VaR method. VaR is now used by many institutions - financial and non-financial, and various investors. There is no method that would represent a kind of cure for risk, when using the VaR method it is a method that compresses data in probability distribution of possible changes in the portfolio's value in a certain way, ie. just reporting a loss that is exceeded with a probability of  $x$  percent. According to Catherine Simons (1996) approach to the Value at Risk-in has been accepted by many people, and the author emphasizes the danger to people that over-rely on it as such risk management can give a false sense of security and create a sense of (maybe false) satisfaction.

## 1. THE METHOD VALUE AT RISK

The method Value at Risk or VaR method is a tool for the risk assessment of stocks, bonds, generally any securities, portfolios or even company. The question that the VaR method is trying to at least approximately answer is related to the maximum amount of funds that could be lost in certain market conditions. Name of the VaR method, before was known by various names such as Dar (Dollar at risk), EaR (earnings at risk), CAR (capital at risk) etc., In the end, name was accepted and assigned by JP Morgan—VaR (value at risk) method. The VaR method measures the height of any possible loss in relation to the confidence interval. There are three basic methods used to calculate the VaR method, namely: *historical method*, *variance and covariance* and *Monte Carlo method*. One of the most important determinants in determining the VaR method is in determining the probability distribution of the individual risk and the correlation between risk and risk impact on value of financial asset.

The three most important elements in the VaR method include: *the amount of potential loss*, *a specific time within the risk is estimated* and *the probability of loss or reliability*. The amount of risk may be expressed in absolute or relative number. When it's talking about the period of time within the calculated risk value can be calculated than it can be for 24 hours, week, month, year or other period of time that an analyst wants to evaluate. Time and risk are positively correlated sizes, so longer period is causing higher risk. The likelihood of potential loss or degree of reliability is usually measured at the levels of 95% and 99% reliability. Each business entity independently

determines the degree of reliability which he accepts, considering the worst-case scenario. If for example, an entity account risk value using the 99% confidence level, then within a year such an event would be achievable only three times, or one day within a hundred days. If the company decides to calculate VaR with 90% confidence then statistical risk value could be realized once in ten days. These characteristics provide the quite broad applicability of the VaR method. VaR method can be used eg. generally in the context of the calculation VaR for financial companies, in assessing market risk, foreign currency risk, the risk of economic growth or interest rate risk, etc., but also perfectly applicable in a broader context, when it comes to assessing the riskiness of individual security. For better impression of the importance of methods that quantify the risk, such as Value at Risk method we will briefly describe the capital market by the end of the First World War.

After the First World War, strong optimism reigned among people, people believed that the saving time has passed and with investments they can achieve larger gains than with savings. In 1920, many investors invest in the stock market although it was known that investing in stocks was risky, but in this period investor sentiment was favorable for new investments that the mass of people started investing in the stock market which grew so much, that it was considered infallible investment which was in 1925 largely reflected. The capital market has grown to the extent that it was considered as a place where people come to enrich safe. Everyone were buying shares, when they lacked the money they were buying on margin which is a form of risky trade than trading with their own funds. After an enormously large amount of optimism in October 29, 1929 year, there was a strong decline in the stock market on Wall Street, and that day was remembered as "Black Tuesday". A large drop in Wall Street was only a prelude for a decade of the Great Depression that followed the fall.

Few years after the big drop, SEC (Securities and Exchange Commission) market regulator was established, whose job was to monitor the market and its participants. As people were increasingly becoming aware of the stock market riskiness, the interest in studying riskiness was growing. Historically VaR method itself has its roots in the portfolio theory which was founded by Harry Markowitz. It can be said that foundation of VaR method were set by Markowitz (1952) and Roy (1952) independently, combining securities in a way to achieve the highest yields for a given level of risk. In describing the VaR method Sharpe joined in (1963), although Sharpe's way of describing was different, he was a step before writing on the model of capital assets known as the CAPM. In later years, Bloomberg, Reuters, Telerate as specialized finance companies have enabled the collection of historical data as well as prices of securities. Precisely such information will serve as the raw data in determining the riskiness with the Value at Risk method. When it's talking about price trends in 70's and 80's, it is certainly important to mention that these are the years when the market was somewhat more volatile and businesses were increasingly reaching for a leverage which increased the risk. The situation in the markets created also a growing need to control risk and the need for VaR method gradually grew also. In the eighties SEC increased precaution to risk and made provision for financial companies to do each month VaR with 95% confidence and to hold additional capital in the case to realize the potential loss. Following regulatory measures SEC businesses recognize the usefulness of the introduction of VaR and by starting to use internally for specific risk assessment of their operations. Kenneth Garbade developed VaR method in 1984 so it can be applied for assessing portfolio risk with fixed incomes see Garbade (1986). First

after Kenneth Garbade in 1993 Thomas Wilson published a detailed description of using the VaR method in market conditions (Wilson, 1999). Tim Guldemann was the next important figure in the development of the VaR method. His task in J.P. Morgan was to develop and promote the VaR method in the company, and later outside. After 1993, when the other operating companies have shown increasing interest in the implementation of the VaR method, Guldemann within its company JP Morgan developed "RiskMetrics" which became available to the public. On its web site it was published the complete methodology of using models and software by which it was possible to calculate the risk value. Risk measurement by using the VaR method received wide application in the different activities, regardless of the business activity is financial or not.

## 2. TYPES AND APPLICATION OF VAR METHODS

Basic methods based on which the VaR can be calculated are: *historical method*, *parametric method* and *Monte Carlo simulation*. Each of these methods is marked by certain advantages and disadvantages.

*The historical method* uses historical market prices or rates that are presented in the form of the distribution are determined on the degree of reliability that investor choose. Since the historical method is based on the available information empirically determined distribution, it belongs into the non-parametric methods. The historical method is considered one of the easiest methods to use. Since the historical method based on the data determines distribution, it belongs to the non-parametric methods. The historical method is considered one of the easiest methods to use. It is essential to set a time period which will be analyzed, after which the historical market size will be arranged according to the criterion of the size and degree of reliability calculated risk value. Its simplicity arises from readily available data used. Data on historical trading eg. securities are publicly available information stored on exchanges or on specialized terminals on which financial companies serve daily (Bloomberg, Reuters, etc.). The historical method is a popular method among financial and non financial entities, it is easy to modify, and for its calculation there can be used programs such as Excel, SPSS, etc. Its key assumption is that the future will unfold the events of the past, and it is also the weakest point as far as this critique. Generally the lack of VaR method is in future predictions which are based on past trends of securities. The past can not constitute a guarantee of the future, but in any case it is better to do a risk assessment by the VaR method, rather than a passive approach to risk. Time period significantly affects on the risk value that will be calculated. According to Laubsch who published a practical guide of risk management, for the main advantages of the historical method he stated accuracy for all types of financial instruments, then a historical method which provides a complete distribution of the portfolio value is not only a certain percentage, and it is much faster than Monte Carlo method. Regarding the disadvantages of historical method Labusch states large amounts of historical data which are necessary for calculating the risk value. The historical method is difficult to apply in the more distant future, and it involves the risk of rare events, because of which the result can show greater risk value than the one that actually is.

*The parameteric method* has several names which are used in its defining. The method of variance–covariance, linear or delta normal VaR are just some of the names

used. This is a method that uses historical information to calculate like: arithmetic mean, correlation, standard deviation, all depending on the method used for calculating risk value. The parametric method is also very popular method, especially among hedge fund managers. According to Laubsch main advantages of parametric models are quick and easy calculation. The parametric model does not use a long number of historical data as historical method, but it use the historical data to calculate the risk factors in evaluating the potential loss. The two primary variables that parametric method use in its calculation, are namely the mean value of the yield rate, and the standard deviation of the same data. As for the disadvantages, parametric method is less suitable for nonlinear portfolios or distorted distributions. The basic requirement of parametric methods is that the yields of securities are normally distributed, and that the distribution corresponds to a theoretical distribution such as Gauss's. The basic features of a normal distribution would be: that it is symmetrical due to the mean value so the arithmetic mean, mode and the median are the same size, it has a bell shape, approximately 99.74% of the distribution is in the range of  $\pm 3\sigma$  from the mean value, 95.46% distribution is located in the area of  $\pm 2\sigma$  and 68.26% of the distribution is in the range  $\pm 1\sigma$ . According to Sverko (2011) RiskMetrics is recognized in practice as the parametric model or a model of variance and covariance, he introduced correlation coefficients among financial instruments and it is calculated by the formula which follows.

$$\text{VAR} = \sqrt{\sum_{i=1}^N \omega_i^2 \sigma_i^2 + \sum_{i=1}^N \sum_{\substack{j=1 \\ i \neq j}}^N \omega_i \omega_j \sigma_i \sigma_j \rho_{i,j}} \quad (1)$$

$\omega$  shares  
 $\sigma$  standard deviation  
 $\rho$  correlation

As the Laubsch stated, the biggest disadvantage of parametric methods is the hypothesis underlying the parametric method, and that is the assumption of normal distribution. This assumption analyst should check to avoid any wrong interpretation in future calculations. Following limiting factor of mentioned method is the constancy of the calculated standard deviation and correlation coefficients, which through different times have different values, and if the analyst which estimates VaR does not modify the calculation because of VaR extreme values he may misinterpret the results using this method.

The last method for calculating VaR is the *Monte Carlo method*. This methodology is called the stochastic method, and its name Monte Carlo is justified because it requires computer simulation of various influences on the observed portfolio of securities. This method represents the most complex method, it is similar to the historical method, since it calculates future risk or potential loss with a statistical confidence level. The Monte Carlo method is considered the most precise method for calculating VaR which is achieved by statistical simulation of hundreds or thousands of possible scenarios based on which would come up with a solution. Monte Carlo method can be used to calculate values that are stochastic, and for the calculating values that are not stochastic. Vose (1997) defined Monte Carlo method as risk analysis, which includes a number of modeling techniques to mathematically describe

the impact of risk and uncertainty on the problem. Each uncertain parameter in the model is represented by the distribution of probabilities. The shape and size of these distribution defines the range of values that parameters can have with their relative probabilities. The shape and size of these distributions define the range of values that parameters can have with their relative probabilities. The scenario represents a calculated value of the portfolio with nonlinear evaluation for a particular day. Based on a large number of scenarios we choose one that has the highest loss with respect to a certain percentage of probability. For example if we calculate with the Monte Carlo method 5000 scenarios, and based on the determination of VaR 95% probability, risk value would be equal to 250 the biggest loss of all calculated scenarios. According to Laubsch advantage of this method would be in effective accurately calculating the risk value of the various financial instruments. Monte Carlo method in contrast to the historical method doesn't have a need for a large amount of historical data. The Monte Carlo method enables the use of various distributions, such as the T-distribution, normal and similar. Disadvantages of Monte Carlo are: very complex analysis, it takes time for calculation of each scenario. The risk of "thickened tail" distribution can be quantified only if there is used proper distribution.

### 3. THE RISK ASSESSMENT USING THE VAR METHOD

Based on the aforementioned theory regarding the VaR method we will show a hypothetical example of the risk calculation on the Croatian capital market with historical and parametric method for 5 stocks quoted on the Croatian capital market. The risk will first be calculated individually for each stock and than for portfolio which is consisted from listed stocks. The risk was estimated for the stocks of the following companies: Adris Group (ADRS-PA), Ericsson Nikola Tesla (ERNT-RA), AD Plastik (ADPL-RA), Valamar Adria Holding (ATPL-RA), and Podravka (PODR-RA). The selected stocks are liquid shares which was the most important criterion for their selection. After evaluating individual risk of stocks it is estimated portfolio risk. The portfolio was consisted of listed stocks. Each stock had an equal share in the portfolio, that was 20%. During the assessment of portfolio risk there were calculated several different levels of VaR confidence.

While estimating VaR with historical method we first need to calculate historical returns that will serve as the base for calculating Value at Risk. Historical stock returns on a daily basis are calculated by using the formula in continuation.

$$Pd_{j,t} = \frac{C_{jt} - C_{jt-1}}{C_{jt-1}} \quad (2)$$

$Pd_{j,t}$  The return on the stock  $j$  in day  $t$

$C_{j,t}$  The stock price  $j$  in day  $t$

Returns can be calculated using the natural logarithm as well.

$$Pd_{j,t} = \log\left(\frac{C_{jt}}{C_{jt-1}}\right) \quad (3)$$

After calculating the daily returns of individual stocks, portfolio return can be calculated according to formula that follows.

$$PP_t = \sum_{j=1}^N w_j Pd_{j,t} \quad (4)$$

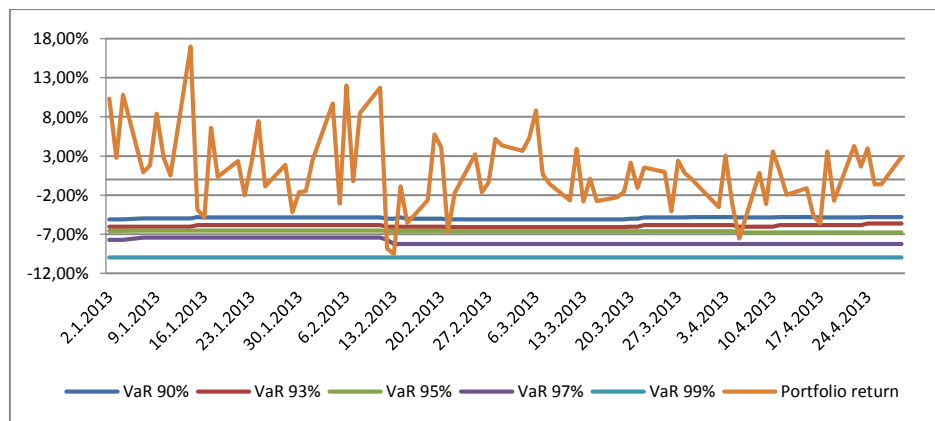
- $PP_t$  The return of the portfolio in the day  $t$
- $N$  The total number of shares in the portfolio
- $w_j$  The share of stock  $j$  in portfolio
- $Pd_{j,t}$  The return on the stock  $j$  in day  $t$

Portfolio return is calculated according on the above formula. This formula sum the returns of individual stocks that multiply the shares of stocks in the portfolio. The following table shows the individual riskiness of stocks that count on a certain level of reliability. The following table shows the individual riskiness of stocks on a certain level of reliability.

**Table 1.** Calculation of individual risk for selected shares with historical VaR method

	VaR 90%	VaR 93%	VaR 95%	VaR 97%	VaR 99%
ADRS-P-A	-1,49%	-1,77%	-1,93%	-2,35%	-3,90%
ERNT-R-A	-1,66%	-1,94%	-2,12%	-2,91%	-4,53%
ADPL-R-A	-1,25%	-1,51%	-1,68%	-2,08%	-2,68%
KORF-R-A	-1,79%	-2,08%	-2,35%	-2,75%	-4,17%
PODR-R-A	-2,32%	-2,54%	-2,87%	-3,30%	-4,11%

Table 1 shows the estimated VaR at confidence levels of 90%, 93%, 95%, 97% and 99%. Risk values are calculated in the time period 01.01.2012–01.01.2013, for 250 business days in the business year 2012. At the level of the 99% confidence lowest risk value realized AD Plastik -2.68% while at the same level of reliability highest risk value have achieved stocks of Ericsson Nikola Tesla -4.53%. The reliability level of 99% can be interpreted as the price will not fall 99 business days below the calculated risk value within a period of 100 business days. In continuation there are shown three graphs that show the application of VaR methods in the assessment of the portfolio risk. The first chart shows the estimated VaR (historical method) of the portfolio using the data in the period 01.01.2013–01.01.2013.



**Figure 1.** Portfolio risk using historical VaR



Return on portfolio has breached VaR at the levels 90%, 93%, 95%, and 97%. VaR at the level 99% was not breached.

Another form of calculating VaR is a parametric method which is known also as the method of variance-covariance. On the same sample of stocks there will be calculated the basic elements of parametric methods, such as expected returns and volatility. After calculating of the individual riskiness with parameter method we will calculate portfolio risk using the same method. Very important is also to determine the Z value according to formula that follows:

$$z = \frac{x - \bar{x}}{\sigma} \quad (5)$$

z z score  
 $\bar{x}$  mean  
 $\sigma$  standard deviation

**Table 2.** Calculation of individual risk for selected stocks with parametric VaR method

	<i>ADRS-P-A</i>	<i>ERNT-R-A</i>	<i>ADPL-R-A</i>	<i>KORF-R-A</i>	<i>PODR-R-A</i>
$\bar{x}$	0,06%	0,12%	0,03%	0,19%	0,03%
$\sigma$	1,32%	1,77%	1,15%	1,77%	1,76%
90% VaR	-1,63%	-2,15%	-1,44%	-2,08%	-2,22%
93% VaR	-1,88%	-2,49%	-1,67%	-2,42%	-2,56%
95% VaR	-2,11%	-2,79%	-1,86%	-2,72%	-2,86%
97% VaR	-2,42%	-3,21%	-2,13%	-3,14%	-3,27%
99% VaR	-3,00%	-3,99%	-2,64%	-3,93%	-4,06%

With the parametric method VaR was estimated at levels of 90%, 93%, 95%, 97% and 99% confidence as it is shown in table 2. It is used the same period of time as in the calculation of VaR with historical method. Risk values were calculated as the product of the z-score and volatility that result was reduced by the mean value. For calculation of the portfolio VaR it is necessary to calculate portfolio volatility which is presented by standard deviation. For calculating the portfolio risk it is necessary to calculate the covariance matrix, which is shown in continuation. Portfolio risk can be calculated by correlation matrix also, there are several ways of calculating the volatility of the portfolio.

**Table 3.** Covariance matrix of the selected stock portfolio

	<i>ADRS-P-A</i>	<i>ERNT-R-A</i>	<i>ADPL-R-A</i>	<i>KORF-R-A</i>	<i>PODR-R-A</i>
<i>ADRS-P-A</i>	0,00017	0,00006	0,00001	0,00000	0,00005
<i>ERNT-R-A</i>	0,00006	0,00031	0,00003	0,00002	0,00003
<i>ADPL-R-A</i>	0,00001	0,00003	0,00013	0,00006	0,00003
<i>KORF-R-A</i>	0,00000	0,00002	0,00006	0,00031	0,00002
<i>PODR-R-A</i>	0,00005	0,00003	0,00003	0,00002	0,00031

Volatility Portfolio can be calculated by multiplying the weighting of shares in the portfolio ( $w_i$ ) and elements of the covariance matrix ( $\sigma_{ij}^2$ ), in continuation is an example of calculation portfolio volatility that is made of 5 stocks with equal shares.

$$\sigma_{p_2} = [w_1 \ w_2 \ w_3 \ w_4] \begin{bmatrix} \sigma_{11}^2 & \sigma_{12}^2 & \sigma_{13}^2 & \sigma_{14}^2 & \sigma_{15}^2 \\ \sigma_{21}^2 & \sigma_{22}^2 & \sigma_{23}^2 & \sigma_{24}^2 & \sigma_{25}^2 \\ \sigma_{31}^2 & \sigma_{32}^2 & \sigma_{33}^2 & \sigma_{34}^2 & \sigma_{35}^2 \\ \sigma_{41}^2 & \sigma_{42}^2 & \sigma_{43}^2 & \sigma_{44}^2 & \sigma_{45}^2 \\ \sigma_{51}^2 & \sigma_{52}^2 & \sigma_{53}^2 & \sigma_{54}^2 & \sigma_{55}^2 \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ w_4 \\ w_5 \end{bmatrix} \quad (6)$$

This matrix can be written in the form of the formula.

$$\sigma_p^2 = \sum_{i=1}^n w_i^2 \sigma_i^2 + 2 \sum_{i=1}^{n-1} \sum_{j=i+1}^n w_i w_j \text{Cov}(R_i, R_j) \quad (7)$$

According to the formula (7)  $w$  represents stocks in portfolio,  $\sigma^2$  represents the variance, while the term  $w_i w_j \text{Cov}(R_i, R_j)$  represent product of the stock  $i$  and the stock  $j$  with elements of covariance matrix. Stock shares in portfolio are equal. According to formula (7) below in formula (8) is a calculation of the portfolio volatility.

$$\begin{aligned} \sigma^2 = & 0,2^2 \cdot 0,00017 + 0,2^2 \cdot 0,00031 + 0,2^2 \cdot 0,00013 + 0,2^2 \cdot 0,00031 + 0,2^2 \cdot 0,00031 + \\ & 2 \cdot 0,2^2 \cdot 0,00006 + 2 \cdot 0,2^2 \cdot 0,00001 + 2 \cdot 0,2^2 \cdot 0,0000 + 2 \cdot 0,2^2 \cdot 0,00005 + 2 \cdot 0,2^2 \cdot \\ & 0,00003 + 2 \cdot 0,2^2 \cdot 0,00002 + 2 \cdot 0,2^2 \cdot 0,00003 + 2 \cdot 0,2^2 \cdot 0,00006 + 2 \cdot 0,2^2 \cdot \\ & 0,00003 + 2 \cdot 0,2^2 \cdot 0,00002 \end{aligned} \quad (8)$$

$\sigma^2 = 0,000075$   
 $\sigma = 0,87\%$

Calculated portfolio volatility is 0.87%. Below is shown the VaR of the portfolio obtained by parametric method on several different levels of confidence.

**Table 4.** Portfolio risk by parametric VaR method

VaR 90%	VaR 93%	VaR 95%	VaR 97%	VaR 99%
-0,69%	-0,86%	-1,01%	-1,21%	-1,60%

Between estimates of portfolio risk by the historical and parametric method there can be observed minor differences. It is also necessary to mention that the biggest difference between these two methods are in use of distributions. Historical method uses an empirical distribution, while parametric method uses a theoretical distribution. Assessing the basic characteristics of the distribution it was found that the distribution is only slightly positively skewed (0.088) as far as the kurtosis coefficient it was 4.31. Normality of distribution was tested by Jarque-Bera test whose main task was to assess whether the estimated values deviate from the size of a normal distribution. The hypothesis  $H_0$ : "residuals are normally distributed" rejected as false if  $JB > \chi^2_\alpha$  or if the empirical level of significance  $p$  is less than the theoretical significance level  $\alpha$  (Bahovec and Erjavec 2009). Since this condition is not met because the empirical level of significance  $p$  is 0.000110 which is less than 0.05 and 0.01 hypothesis  $H_0$  is rejected at both levels of 5% and 1%.

Examples for the VaR calculation at various levels of reliability were used only as hypothetical examples of the Croatian capital market, in the more detail research of portfolio risk in Croatian capital market it is necessary to make certain modifications. One of the disadvantages of a historical method is the same weight for all observations, which presents a problem in assessing the risk value. The difference from the standard historical method, and weighted historical models would give more representative results of the risk assessment.

As a form of VaR modification history VaR can be combined with time series model which have Cabedo and Moya introduced to estimate VaR methods using ARMA model or combination of ARMA models (Cabedo and Moya 2003) (Eng. Autoregression and Moving Average) with neural networks according which Hsieh and

Chou have made a hybrid model that has surpassed conventional VaR model in Shanghai capital Market (Hsieh and Chou 2008). Modifications that have to be included definitely should respect the demands of emerging markets such as the Croatian capital market. More about the application of VaR methods in the Croatian capital market see in: Zikovic, "Applying Hybrid Approach to Calculating VaR in Greece."

## CONCLUSION

VaR is therefore the largest possible loss of funds invested in individual securities or an entire portfolio. This method of measuring risk is increasingly used because of simplicity and applicability, despite being not ideal, it has lots of advantages. VaR is focused on portfolio losses but can not fully predict future losses. VaR method is through its development passed various modifications with the aim of more precise prediction of risk values. Using the VaR—can also give false security in case if the loss is greater than the calculated. VaR has the best applicability in stable market conditions. In times of great crisis, price fluctuations are larger, so it is not advisable to rely only on calculated VaR, but investors should be ready to losses greater than the VaR. After the calculation of VaR, investor can do backtesting, ie. subsequently he can test to verify the accuracy of the VaR model. This test, for a given number of days, can compare loss in the portfolio with a VaR which is assessed on the previous day. Considering this situation there are two types of calculated risk: overvalued and undervalued risk. The risk will be underestimated if the loss in the recorded several days is larger than estimated risk value. In contrast, the risk will be overestimated if the number exceeds the value risk occurs in fewer days than indicating a chosen level of confidence.

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