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Value at Risk (VaR) Measurement on a Diversified Portfolio: Decomposition of Idiosyncratic Risk in a Pharmaceutical Industry

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Abstract
Risk measurement is one of the most prominent tools of financial institutions and managers. Many investors try to know potential maximum loss of their financial assets as well as possible. There are many internal and publicly known risk measurement methods in the financial world. In this study, maximum daily loss of diversified portfolio is calculated by using variance-covariance approach of the Value at Risk (VaR) Models. Correlation and covariance matrices are used to estimate daily loss. VaR values are estimated both with and without portfolio effect. Moreover, total risk of portfolio and individual shares are estimated by separating as idiosyncratic and systematic portions. 252 days of data belonging a year of 2015 are analyzed.
Keywords: Risk Measurement, VaR, Variance-Covariance approach, Systematic Risk, Idiosyncratic Risk

1. Introduction

Risk is related to the uncertainty concept. From the portfolio management perspective, risk can be defined as deviation from future expected cash flow. To prevent from this threat, it is very important to measure and eliminate business risk permanently as much as possible. Several market bubbles and financial crises have raised the awareness of the importance of reliable risk measurement methodologies. Appropriate risk calculation is a necessary first step of risk management. Although there are several risk measurement methodologies, many of them are company specific and known as internal. Value at Risk (VaR)is available to the public and is one of the most widely used techniques measuring market risk of portfolio and financial assets.

After determining the risk, elimination of risk is the second step of risk management. Diversification is the main tool of financial manager to decrease a portfolio's risk, which can be divided as idiosyncratic (asset-specific) and systematic. While an idiosyncratic portion of risk can be eliminated by diversification, systematic risk is undiversifiable.

In this study, I tried to measure daily risk of diversified portfolio and to decompose its' portions as systematic and idiosyncratic. Variance-covariance approach of the VaR models is used to calculate maximum daily loss of portfolio. The remainder of the paper proceeds as follows. In section 2, VaR model, systematic risk and idiosyncratic risk concepts are briefly introduced. In section 3, variance-covariance approach is used in empirical studies to determine daily loss value and other techniques are used to separate total risk as systematic and idiosyncratic unsystematic portions. Finally, section 4 concludes the paper.

2. Value at Risk (VaR) Measurement and Idiosyncratic Risk

The degree of uncertainity uncertainty about a company's future cash flows is known risk. Many sources of risk pose a threat to companies in a financial world. VaR technique calculates how much a financial asset (or portfolio) can lose with given probability over a time horizon. (Manganelli and Engle, 2001; 6). VaR models collect several parts of a price risk into one single loss value over a specified time horizon. The models are widely accepted by many financial managers and analysts because they aggregate many different risk components of entire portfolios in one number illustrating by dollar terms (Hendricks, 1996; 39). Variance – Covariance Approach, Historical Simulation and Monte Carlo Simulation are the three main approaches of VaR models. In this study, variance – covariance approach is preferred to calculate daily VaR. It includes parts of the modern portfolio theory of Markowitz using correlation coefficients between assets (Corkalo, 2011: 82).

In measuring risk, it is desirable to determine what portion is associated with the market and what portion is associated with the company itself (Hodveth and Tedder, 1978: 135). Under the Capital Asset Pricing Model (CAPM) model, there are two types of risks: systematic and idiosyncratic. While the former is related to the marketwide movement and affects all firms and investments, the latter is company-specific and affects only the company itself. In that sense, as there is no way to eliminate systematic risk with portfolio diversification, it is possible to remove idiosyncratic risk with proper diversification. (Simonoff, 2011: 1). In the next section, daily loss of a portfolio is calculated by using variance-covariance technique of VaR Model. Moreover, the total risk of the portfolio is separated as systematic and and idiosyncratic portions.

3. Empirical Analysis

3.1. Data

In this study, a hypothetical portfolio is created first; it contains three companies, which have been traded on Istanbul Stock Exchange (BIST). They are operating within the pharmaceutical industry. While DEVA and

ECILCC are producing medicine, SELEC is storing and wholesaling pharmaceutical products.

Table 1. Trade names of Companies

	Shares	Company Name	Operations
1	DEVA	Deva Holding. A.Ş.	Production
2	ECILCC	Eczacıbaşı İlaç, Sınai ve Finansal Yatırımlar A.Ş.	Production
3	SELEC	Selçuk Ecza Deposu Ticaret ve Sanayi A.Ş.	Storing, wholesale

Market return and beta of companies are estimated by using daily returns (adjusted price for US dollar). They are taken from the Isyatirim database[1]. 252 days of data belonging a year of 2015 are analyzed. Excel functions and data solver are used for all calculations.

To calculate for stocks daily return; the formula is applied as follows:

$$R_i = \frac{R_{it} - R_{it-1}}{R_{it-1}} \qquad (1)$$

where "Ri" is a daily return of share i, "Rit" is a closing price of share i in t date and "Rit-1" is a closing price of share i in t - 1 date

To calculate the Index (BIST 100) daily return; the formula is applied as follows:

$$R_{Bist100} = \frac{Bist100_t - Bist100_{t-1}}{Bist100_{t-1}} \qquad (2)$$

Where "$R_{Bist100}$" is a average return for market, "$Bist100_t$" is a market return in t date, "$Bist100_{t-1}$" is a market return in t-1 date.

A risk related with the existence of the probability of an expected return. Volatility of the expected return creates this probability and standard deviation is the most commonly used method for risk meaurement (Allen et al., 2009: 2). To calculate variance of stocks daily return and index return, I used the following historical volatility formula:

$$\sigma^2 = \frac{1}{n-1}\sum_{i=1}^{n}(Ri - Raverage)^2 \qquad (3)$$

Where "σ^2" is a variance of daily share return, "R_i" is a daily return of share i, "$R_{average}$" is average daily return, "n" is a sample size (252 days)

3.2. Empirical Results

As seen from Table 2, total market value of the portfolio equals the sum of the shares' values. Provided below is the number and closing price of shares in a portfolio (31.12.2005):

Table 2. A number and closing price of shares

Shares	Number of Shares (1)	Closing Price (USD) (2)	Market Value of Shares (USD) (3) (3) = (1) x (2)
DEVA	35.000	0,89	31.150
ECILCC	31.000	1	31.000
SELEC	34.000	0,92	31.280
Market Value of Portfolio (position) = 93.430			

Variance – covariance approach assumes that asset returns are distributed normally. This acceptance gives a chance to use standard deviation as a volatility measurement tool. In this model, standard deviations and correlations are calculated using historical data. It is known that, normal distribution is symmetrical so skewness is 0 and kurtosis is 3 (Corkalo, 2011: 82). Statistical features belong to shares and market index (BIST 100) is given below.

Table 3. Statistics about return

Shares	Standart Deviation	Variance	Skewness	Kurtosis
BIST 100	0,013962	0,000195	0,153806	1,392946
DEVA	0,034609	0,0011978	-0,255478	2,770261
ECILCC	0,029125	0,0008483	-0,2411436	2,113571
SELEC	0,024595	0,000605	0,130333	2,656761

As seen from Table 3, shares are more volatile than market index. Skewness and kurtosis values fall within acceptable boundaries. The returns are normally distributed. In that sense, the VaR model's main assumption is provided by the analysis of the data. In the next steps, correlation and covariance matrix are formed by using an excel data solver. Corelation coefficient shows a relationship between two financial assets. If, while one share price is increasing and the other is decreasing, they are negatively corelated. It is known that, risk can be reduced to make a portfolio consisting of imperfectly (negatively) correlated assets. Corelation

[1] http://www.isyatirim.com.tr/LT_isadata2.aspx. (17.01.2016)

coefficients have a value between – 1 and 1. While 1 is showing us perfectly correlation, -1 is showing us imperfectly corelation.

Table 4. Corelation matrix of share return

	DEVA	ECILCC	SELEC
DEVA	1	0,508022	0,415331
ECILCC	0,508022	1	0,381315
SELEC	0,415331	0,381315	1

As seen from Table 4, all shares have positive and high level correlation. However correlation between DEVA and ECILCC (production companies) is higher than DEVA – SELEC andECILCC – SELEC (distribution company). Covariance coefficient show us how much two financial assets change together. If the covariance is positive, than these shares have a similar tendency.

Table 5. Covariation matrix of share return

	BIST 100	DEVA	ECILCC	SELEC
BIST 100	0,000194	0,001193	0,000247	0,000171
DEVA	0,001193	0,001193	0,00051	0,000352
ECILCC	0,000247	0,00051	0,000845	0,000272
SELEC	0,000171	0,000352	0,000272	0,000603

For n assets, VaR is calculated as followed:

$$\vec{V} = \vec{P} * \vec{\sigma} \qquad (4)$$

$\vec{P}$ = Position Vector = $\begin{bmatrix} P_1 & P_2 & P_3 & \cdots & P_N \end{bmatrix}$ and $\vec{\sigma}$ =Volatility Vector = $\begin{bmatrix} \sigma_1 \\ \sigma_2 \\ \sigma_3 \\ \cdots \\ \sigma_n \end{bmatrix}$

$$\vec{V} = \text{Simple Risk Vector} = \begin{bmatrix} P_1 & P_2 & P_3 & \cdots & P_5 \end{bmatrix} * \begin{bmatrix} \sigma_1 \\ \sigma_2 \\ \sigma_3 \\ \cdots \\ \sigma_n \end{bmatrix} = \begin{bmatrix} V_1 & V_2 & V_3 & .. & V_n \end{bmatrix} \qquad (5)$$

$\vec{P}$ = [31.150 31.000 31.280] and $\vec{\sigma}$ =Volatility Vector= $\begin{bmatrix} 0{,}034609 \\ 0{,}029125711 \\ 0{,}024595 \end{bmatrix}$

$\vec{V}$ = [1.078 902 796] = 2.750 USD

Without portfolio effect, 2.750 USD is a daily total VaR value of 93.430 total USD portfolio value. It means that, maximum daily loss may be 2.750 USD for the portfolio. Next step is to calculate daily VaR value with portfolio effect.

$$\text{VaR} = \vec{V} * \vec{\rho} * \vec{V} \qquad (6)$$

$$VaR_p = \left\{ \begin{bmatrix} V_1 & V_2 & V_3 & \ldots & V_n \end{bmatrix} * \begin{bmatrix} 1 & \rho_{12} & \rho_{13} & \ldots & \rho_{1n} \\ \rho_{21} & 1 & \rho_{23} & \ldots & \rho_{2n} \\ \rho_{31} & \rho_{32} & 1 & \ldots & \rho_{3n} \\ & & \ldots & & \\ \ldots & \ldots & \ldots & \ldots & \ldots \\ \rho_{n1} & \rho_{n2} & \rho_{n3} & \ldots & 1 \end{bmatrix} * \begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ \ldots \\ V_n \end{bmatrix} \right\}^{1/2} \quad (7)$$

$$VaR_p = \left\{ \begin{bmatrix} 1078 & 902 & 796 \end{bmatrix} * \begin{bmatrix} 1 & 0,5 & 0,42 \\ 0,5 & 1 & 0,38 \\ 0,42 & 0,38 & 1 \end{bmatrix} * \begin{bmatrix} 1078 \\ 902 \\ 796 \end{bmatrix} \right\}^{1/2}$$

VaR p = 2204 USD

2204 USD is a daily total VaR value of 93.430 total USD portfolio value with taking account of portfolio effects. How can investors decrease risk of their portfolio? There are two methods of decreasing total risk of any portfolio: adding new shares to the portfolio which have negative or low correlation with the current shares (which is known as diversification) or increasing the weight of the shares in a portfolio which have lower volatility.

CAPM asserts that nondiversifiable risk (or systematic risk) is only one valid factor determining expected returns. This risk is measured by the covariance between the return on this asset and a market portfolio including all available assets in the market. Beta (β) is the name of the factor measuring systematic risk (Ajlouni et al., 2013: 432).

βİM= Cov (Rİ, RM) / σ 2 (RM) (8)

Where, "$R_İ$" is the return of asset I, "R_M" is the return of the market, "σ^2" is the variance of the returns of the market, "Cov $_{(Rİ, RM)}$" is the covariance between asset i and market returns.

Table 6. BIST 100 Beta Equivalent Value of Shares

Share	(β) Value of Shares (1)	Market Value (USD) (2)	BIST 100 (β) Equivalent Value (3) (3) = (1) x (2)
DEVA	1,32813966	31.150	41.430
ECILCC	1,271961	31.000	39.370
SELEC	0,881388	31.280	27.526
		Portfolio (β) Value =	108.326

A beta of one indicates that the security price will move with the market. A beta less than one means that the security will be less volatile than the market. A beta greater than 1 indicates that the security price will be more volatile than the market. As seen from Table 5, production companies (DEVA and ECILCC) in portfolio are more volatile than the market. Moreover, their expected returns and systematic risks are higher than the other company (SELEC) in the portfolio.To calculate shares beta equivalent, current market value is multiplied by beta coefficients. After calculating (β) Equivalent Value, index volatility (market portfolio) can be used instead of shares each volatility.

VaR (daily) = (β) Value of Portfolio * Standard Deviation of BIST 100 Index (9)

VaR (daily) = 108. 326 (USD) * 0,013962
= 1513 USD

One thousand, five hundred and thirteen (1513) USD reflects systematic (market) risk of portfolio. As seen above, total risk of portfolio is calculated as 2776 USD. In that sense, the difference between total risk and

systematic is 1263 USD and named as idiosyncratic risk of portfolio.
Idiosyncratic risk = Total risk - Systematic risk

$$\varepsilon i = \sigma i - (\beta i * \sigma M) \quad (10)$$

Table 7. Idiosyncratic Risk Value of Shares

ShareS	Standart Deviation of Shares (1)	(β) Value of Shares (2)	Standart Deviation of Market return (3)	Idiosyncratic Risk (4) (4) = (1) – (2*3)
DEVA	0,034609	1,33	0,013962	0,01604
ECILCC	0,0291257	1,27	0,013962	0,011394
SELEC	0,024595	0,88	0,013962	0,012308

Table 7. Weight of Systematic Risk in a Total Risk

ShareS	Total Risk (1) (1) = (2)+(3)	Systematic Risk (2)	Idiosyncratic Risk (3)	Weight of Systematic Risk in a Total Risk (4) (4) = (2) / (1)
DEVA	0,034609	0,018569	0,01604	0,536537
ECILCC	0,0291257	0,017731711	0,011394	0,608799
SELEC	0,024595	0,012287	0,012308	0,499573

Table 8. Daily VaR Value of Shares

Shares	Position (USD)	Systematic VaR	Idiosyncratic VaR (3)	Total VaR (4) (4) = (2) / (1)
DEVA	31.150	578,42435	499,646	1078,07035
ECILCC	31.000	549,683041	353,214	902,897041
SELEC	31.280	384,33736	384,99424	769,3316
Total Systematic VaR =		1512,444751	1237,85424	2750,298991

As seen from Table 7, idiosyncratic risk of DEVA is 46%, idiosyncratic risk of ECILCC is 40% and idiosyncratic risk of SELEC is 50% approximately. Totally, approximately 45% of total risk of portfolio comes from idiosyncratic risk. In that sense, it is possible to decrease a value of total risk by succesful diversification.

4. Conclusion

In this study, I calculated VaR value of portfolio by using variance – covariance approach of VaR models and decomposed total risk as systematic and idiosyncratic portions, Firsty, a hypothetical portfolio is created. It contains three company's shares equally. They are chosen from the same (pharmaceutical) industry but in a different operation fields. In that sense, it can be possible to compare risk behavior of competitors or near field companies. They have traded on Istanbul Stock Exchange. Two hundred and fifty two (252) daily returns are used to estimate beta, variance, standard deviation, skewness, and kurtosis values. All calculations are made by using excel functions. I had two main conclusions. First, two of three company's beta values are higher than 1 which means that they are more volatile than the market. They are both production companies. They are similar to each other in many ways. In that sense, their price movement is like the other. Moreover, correlation between these two companies is higher than the third one. In that sense, it is not reasonable to create a portfolio consisting of similar companies. The third one is also operating in the pharmaceutical industry but it is a distribution company. The correlation between them is smaller than the others. Although it is not enough to decrease risk preferred level by adding it portfolio, it reduced risk by certain amount. Therefore, to reduce a risk a portfolio must contain imperfectly correlated shares. Different industries or operational fields companies may help this strategy. These results are consistent with the literature. Second, an important weight of total risk of each shares comes from idiosyncratic risk, which can be eliminated by proper diversification. These results show us an importance of risk measurement and management.

References

Ajlouni, Moh'd M, Dima W.H. Alrabadi Tariq K. Alnader (2013). Forecasting the Ability of Dynamic versus static CAPM: Evidence from Amman Stock Exchange, *Jordan Journal of Business Administration,* Volume 9, No. 2.,https://journals.ju.edu.jo/JJBA/article/view/4458/3222

Allen, David E., Abhay Kumar Singh and Robert Powell (2009). Asset Pricing, the Fama-French Factor Model and the Implications of Quantile Regression Analysis, *School of Accounting, Finance and Economics & FEMARC Working Paper Series,* Edith Cowan University, Working Paper *0911*, October.

Corkalo, Sime (2011). Comparison of Value at Risk Approaches on a Stock Portfolio, *Croatian Operational*

Research Review (CRORR), Vol.2.

Hotvedt, James E. and Philip L. Tedder (1978). Systematic And Unsystematic Risk Of Rates Of Return Associated With Selected Forest Products Companies. *Southern Journal Of Agricultural Economics*, July.

Hendriks, Darryll (1996). Evaluation of Value at Risk Models Using Historical Data, FRBNY
https://www.ecu.edu.au/__data/assets/pdf_file/0013/40432/wp0911da.pdf

Manganelli, Simone and Robert F. Engle (2001). Value at Risk Models In Finance, *European Central Bank, Working Paper Series,* No.75, August.

Simonoff, Jeffrey S (2011). CAPM: Do you want fries with that.
http://people.stern.nyu.edu/jsimonof/classes/2301/pdf/mcdonald.pdf