EKONOMSKE TEME **(2013) 51(4): 671-683**

http://www.eknfak.ni.ac.rs/src/Ekonomske-teme.php

MODERN PORTFOLIO THEORY ON THE CAPITAL MARKET IN SERBIA

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UDC
658.15
Original scientific paper

Abstract: Modern Portfolio Theory is one of the most important innovations in the field of investments and securities portfolio management. The paper analyzes possibilities of using methods of portfolio analysis on the stock market traded at the Belgrade Stock Exchange. The aim of the paper is to select stocks on the Belgrade Stock Exchange which have had the best performance in the analyzed period, and by the application of portfolio analysis find out the optimal portfolio that will have better performance than BELEXline stock index at a lower risk rate. It should be noted that this method is limited in many ways on the stock markets similar to the stock market in Serbia, but in spite of that a portfolio has been obtained which gave better performance than BELEXline stock index.

Received:
15.07.2013.
Accepted:
26.12.2013.

Keywords: portfolio analysis, optimal portfolio

Introduction

Investing in any kind of financial assets is motivated by the expectation of investors to get some return. However, the return is not always certain and every investor faces a certain risk related to their investment. Therefore, the task of the investors is to quantify the extent of the expected return and risk associated with the investment. Various statistical models and risk evaluation

models attempt to specify the level of risk faced by the investors. With the help of the expected return and risk which such return bears, different options can be compared in terms of financial assets portfolio formation managed by the risk-return relation.

Causality of risk and return in the investment process is expressed through the ability of the investor to assess the level of acceptable risk in the expected return. His/her goal is to construct a portfolio that will bring him/her the maximum return with an acceptable risk level. Incorrect assessment of risk can lead to the absence of expected returns or even losing the invested capital.

Rarely are found investors who invest their whole capital in one type of securities. Instead, they invest in diversified portfolios. One of the main decisions is how much money to invest in risk-free, and how much in risk-bearing assets. In contrast to the risk-free assets (e.g. short-term Treasury bills) where the yield can be determined with high certainty, the return on risky assets (equities) bears a much higher risk in terms of uncertainty of return.

Portfolio theory provides an investor with the opportunity to decide which combination of financial instruments provides the highest return for a given risk. In this context, capital allocation line (CAL) is significant which shows all possible combinations of risk and return as a result of the distribution of the entire portfolio of the risk-bearing and risk-free assets. Based on CAL, the investor has to choose the optimal combination of a number of possible choices. This decision is related to the degree of rejection or institutional constraints of the investors towards risk. Investors who are less inclined to risk will choose a smaller portion of risky assets, and a higher proportion of risk-free instruments. There is no doubt that investors will hold efficient portfolio, that is, a portfolio that brings the highest return under the given risk. Since the effective portfolio is a personal choice of the investor, the number of efficient portfolios depends on the number of investors.

In order to understand the importance of portfolio theory, the paper will discuss the general settings of modern portfolio theory and its contribution to practical use in the modern world of finance. Statistics makes an important element in the portfolio theory by which we try to quantify the level of risk and expected returns of the very investments. Research part of the paper refers to the construction of an internationally diversified portfolio on the capital market in Serbia.

Modern Portfolio Theory – Theoretical Basis

The portfolio is a collection of various types of financial instruments and characteristics, i.e. a set of investments in different types of financial assets,

mostly in various securities held by an individual or institutional investor (Mirjanić, 2009).

Before the foundation of portfolio theory, investors made portfolios by selecting stocks with the best performance, considering that this technique maximizes the expected return of portfolios. Although aware of the risk, investors evaluated portfolio performance on the basis of the rate of return. Risk measures have not been developed, and the concept of risk has not been explicitly considered. However, the goal of the investors is not only to maximize the expected return. If it were the only goal, investors would allocate total assets in securities that carry the highest returns regardless of the risk.

The emergence of the modern financial economics is associated with the name of Harry Markowitz who presented his article on 'Portfolio Selection' in the *Journal of Finance* in 1952 and in the book titled "Portfolio Selection: Efficient Diversification of Investment" in 1959. Modern portfolio theory helps investors to select the package of securities, which gives higher return along with the desired level of risk (Markowitz, 1991). Development of portfolio theory in the early 1960s suggested a way of measuring risk as the observed variability of return. At that time, neither measure combined both return and risk, but these factors were observed individually. Researchers would group portfolios based on the measure of risk (e.g, variances of return) into classes with similar risk, in order to compare the rates of return of portfolios of different risk classes.

When selecting a portfolio, a rational investor, according to Markowitz uses two basic parameters: the profit and risk. Profit is measured by the average rate of return and risk as the deviation from the mean rate of return. The greater deviation is, the riskier portfolio would be. When they decide to make a portfolio, investors are trying to reduce this deviation by diversification of investments-investments in financial assets whose return rates fluctuate in different directions.

The investor is interested in the risk of an individual investment. However, the investor is not only interested in the variance of the investment, but rather for the covariance with other financial instruments in the composition of the portfolio.

Markowitz's model is used by the portfolio investors to construct the efficient borders respecting the trade-off of the return and risk. For a rational investor who maximizes the expected benefits, the selected portfolio is optimal taking into account the expected return as a criterion of profitability of the portfolio and variance of return as a measure of risk. The model assumes that the investor is risk-averse, and when deciding on the selection of the portfolio, pays attention to the expected return and variance of return in a period of

investment. Portfolio with the highest expected return for a given level of risk or the one bearing the lowest risk is an efficient portfolio.

Contribution of Modern Portfolio Theory to Financial - Economic Theory and Investment Practice

Modern portfolio theory can be observed through three postulates. The first postulate which was set by Markovitz refers to the relationship and the balance of the assumed risk and the expected return, which depends on diversification. The second one is attributed to William Sharp includes a simplified model of portfolio analysis in relation to the Markowitz's model, i.e. CAPM – Capital Asset Pricing Model and beta coefficient. Finally, the third postulate is the hypothesis on efficient market (EMH) by Eugene Fame (Alihodžić, 2010).

Prior to the development of Markowitz´s model, the financial risk was considered corrective factor of the expected return. Markowitz's model of the mean value and variance was the first attempt to quantify risk, and the measurement of the interdependence of the structure of return by calculating the correlation was undoubtedly something new. The structure of interdependence is represented by the variance-covariance matrix, which measures the impact of the selection of portfolio of each asset in comparison with the others, which explains the importance of diversification. In other words, the most significant contribution of the Markowitz theory is the distinction of the variability of return of individual securities and risk-bearing portfolio.

Long before Markowitz it was clear that individuals seek to increase their wealth and minimize the risk of potential return. However, Markowitz rejected the idea of the existence of the portfolio which would bring the investor the maximum expected return and minimum risk, by showing that a portfolio which has the maximum expected return does not need to have a minimum amount of variance.

Modern portfolio theory has eliminated the drawbacks of diversification, which is manifested in a decrease of efficiency with increasing number of elements of the portfolio. Markowitz pointed out that if we wanted to reduce the variance, it was not enough just to invest in many different securities, it was necessary to avoid investing in securities that had a high covariance. The model suggests not only the importance of diversification of investments to reduce overall portfolio risk, but also an effective way of carrying out diversification. It is also shown that, instead of random selection and random outcomes in the process of forming the portfolio, there is an optimal choice and the outcome - the optimal portfolio. It is possible to establish a set of portfolios that provide the highest possible expected return for a given level of risk or the lowest risk

for any given level of expected return. Such a set of portfolios creats an efficient limit and each portfolio that is on that line is economically efficient trade-off between return and risk.

Reviews of Modern Portfolio Theory

The most serious problems the investors face with in practical application of Markowitz's portfolio optimization can be summarized in the following points.

(1) Estimation errors of the input optimization parameters

Empirical studies have shown that the procedure for portfolio optimization proposed by Markowitz leads to financial irrelevant or even wrong "optimal" portfolios, and poor allocation of resources. Michaud (1989) found that the main problem of Markowitz's optimization is its tendency to maximize the effects of input parameters estimation errors so that the portfolio with equal ponder values was often superior to the portfolio constituted by application of Markowitz's optimization procedure.

The most important limitation of the model arises because of the assumption that all input data in the process of optimization are 100% accurate, which is never the case in practice. The basic problem is the selection of input parameters, particularily in terms of risk assessment and expected returns containing prediction errors. The selection of an optimal portfolio for the input parameters requires information about the expected return of each security, variance and covariance with the returns of other securities. However, in practice, the expected returns, variance and covariance are unknown and have to be estimated from the available historical data or subjective judgments.

(2) Neglecting factors of liquidity and volatility of the portfolio

Markowitz's optimization ignores factors that are fundamental in the investment management such as as the liquidity factor, or the percentage of the market capitalization of company represented in the possessed portfolios. The impact of liquidity on the set of efficient portfolios indicates that compared with the classical efficient border, imposing liquidity constraints, results in a small increase of return and/or lower risk reduction.

In some cases, in portfolio optimization the problem of portfolio instability arises, when the shares of individual securities are extremely sensitive to variations in the expected return. The problem of instability occurs when small changes in the estimate of input parameters lead to large changes in the resulting ponders (Jorion, 1986). One of the main reasons for the described behavior is the existence of errors in the covariance matrix. Markowitz's optimization involves the inversion of covariance matrix and errors in

covariance matrix lead to instability of ponders. The input parameters that do not reflect financially significant forecasts or use estimates of the parameters based on insufficient historical data often lead to instability (Latković, Barac, 1999).

(3) The lack of normal distribution of return

Using Markowitz's analysis is based on the assumption of normal distribution of return, that is the assumption that the utility function is the function of the first two moments. In the case of normal distribution, there is the central tendency of the data (the farthest, extreme data have the lowest probability of occurrence) and there is a symmetrical dispersion of data around the mean value. Contrary to that, most financial returns do not have normal distribution, which is particularly evident in emerging capital markets. Classical portfolio selection does not take into account the higher-order moments (asymmetry and roundness). Asymmetry of the return curve is a kind of risk measure or probability of occurrence of high returns, whether positive or negative, while the roundness indicates a probability of unexpected positive or negative big movements in terms of return.

Instead of random values, which move independently of each other, the prices and returns show a strong tendency of dependance. Historical data on the movement of prices and returns show that the emerging markets have the statistical property of autocorrelation (movement of prices and returns in one period is best described by movement of prices and returns earlier). Great autocorrelation of financial time series indicates periods of high and low volatility known as clustering. Clustering implies that big changes in the price of financial assets are followed by periods of great changes, while small changes in the price of financial assets are followed by periods of small changes (Knight, Satchell, 2007), which suggests that the change in the price of financial assets in the following period are associated with a change in current prices.

(4) Limitations on markets in transition

The main limitations of emerging markets, including the Serbian market, are primarily reflected in low liquidity, shalow market, the problem of reliability of information and financial reports, functioning of the rule of law, transparency of markets, unanticipated oscilation of returns, currency and interest rate risks and, above all, political risks that significantly affect the downgrade of the country and withdrawal of foreign investors and their hesitation to invest (Jeremić, Terzić, 2010).

Application of Modern Portfolio Theory on the Capital Market in Serbia

Previously in the paper theoretical concepts have beed presented in the process of securities portfolio formation. In this section, we will try to apply these concepts to the Serbian capital market. The study covers a period of 90 days from the July 9, 2012 till October 5, 2012. The survey was followed by a lot of obstacles in the direct application of modern portfolio theory. If we take into account the situation in the Serbian capital market, in forming portfolios it is recommended to involve in it only securities that meet certain criteria. The criteria are as follows:

1. There must be liquid securities whose market capitalization is above the median1 (according to liquidity ratio, average annual turnover relative to market capitalization)
2. There must be securities which are traded on a continuous basis in order to avoid interruption caused by irregular trading
3. There must be securities which have been listed on the stock exchange for more than 3 years.

Of course, due to pre-defined criteria for the selection of securities, slightly modified modern portfolio theory would be presented in this paper.

In accordance with the criteria, the following securities have been selected:

Table 1 Issuers and Their Market Capitalization

Issuer	Symbol	Capitalization
Nikola Tesla Airport joint stock company Belgrade	AERO	14.367.237.650
NIS joint stock company. Novi Sad	NIIS	102.564.991.600
AIK banka joint stock company Niš	AIKB	12.051.641.360
Komercijalna banka joint stock company Belgrade	KMBN	8.273.844.500
Tigar joint stock company Pirot	TIGR	376.342.740
Metalac joint stock company Gornji Milanovac	MTLC	1.698.300.000
Soja protein joint stock company Bečej	SJPT	6.837.045.516
Galenika Fitofarmacija joint stock company Zemun	FITO	2.904.000.000
Alfa plam joint stock company Vranje	ALFA	935.593.824
Philip Morris Operations joint stock company Niš	DINNBP	2.647.014.400

Source: Belgrade stock Exchange

[1] Median – the number that divides the upper half of the sample from the lower half

During the formation of the portfolio, we considered 10 securities because numerous studies, primarily by Evans and Archer (1968), questioned the economic feasibility of constructing a portfolio of more than 10 securities. Also, Elton and Gruber (1977) have investigated the relation between risk and the number of shares in the portfolio and came to the following conclusions: 51% of the standard deviation is eliminated by increasing number of stocks from 1 to 10; adding 10 more shares eliminates only additional 5%; increasing to 30 shares eliminates only additional 2%.

In order to create a portfolio, it is necessary to have longer continuous time series of daily rates of return. Here the problem arises because some stocks are not traded every day. Although we took into consideration the most liquid securities in the market, the problem still occurs. For the purpose of this research the problem is solved by using the assumption that there was no change in the price and the last known closing price for the day was taken. It is important to mention that such filling of data may give a distorted picture of reality. It is because of this phenomenon that we introduced the criteria for selecting shares to reduce the level of error in the research.

On the basis of the daily price changes standard deviations are calculated along with average returns of shares included in the portfolio:

Table 2 Average Returns on Shares and Their Standard Deviations in the Observed Period

ISSUER	Average return	Standard Deviation
AERO	-0,18%	1,43%
NIIS	0,00%	0,82%
AIKB	0,13%	5,41%
KMBN	0,70%	3,57%
TIGR	-0,37%	1,42%
MTLC	0,05%	1,16%
SJPT	0,16%	2,47%
FITO	-0,01%	2,19%
ALFA	0,20%	2,07%
DINNBP	0,25%	3,45%

Source: Calculations by authors

Based on these data, a matrix of correlation coefficients has been made as follows:

Table 3 Matrix of Correlation Coefficients of Shares Included in the Optimal Portfolio in the Observed Period

	AERO	NIIS	AIKB	KMBN	TIGR	MTLC	SJPT	FITO	ALFA	DINNBP
AERO	100,00%	-13,61%	1,20%	3,15%	-2,90%	-3,32%	-29,98%	-17,54%	26,58%	-0,33%
NIIS		100,00%	-3,70%	-4,72%	3,20%	13,96%	8,73%	-4,44%	0,86%	12,35%
AIKB			100,00%	-3,69%	-5,07%	-20,51%	9,52%	-2,09%	3,23%	-3,24%
KMBN				100,00%	1,16%	1,24%	-17,54%	0,96%	17,59%	1,80%
TIGR					100,00%	-19,86%	11,94%	3,81%	-5,46%	30,77%
MTLC						100,00%	-0,61%	2,29%	-0,19%	-9,30%
SJPT							100,00%	-14,78%	-18,50%	-0,12%
FITO								100,00%	-20,50%	8,24%
ALFA									100,00%	-2,94%
DINNBP										100,00%

Source: Calculations by authors

Note: Analysis used software "Softonic"

From the matrix we can see that there is a sufficient number of shares which are negatively correlated which provides a good basis for portfolio diversification. During the observed period the highest positive correlation was between Philip Morris Operations joint stock company Nis and Tigar joint stock company Pirot, while the highest negative correlation was between Soja protein joint stock company Bečej and Nikola Tesla Airport joint stock company Belgrade.

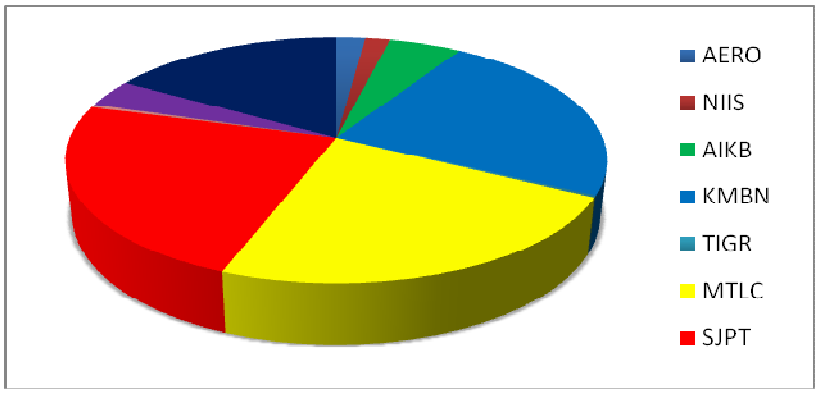
The aim of the research is to form a portfolio from the offered shares which has the best ratio of risk and return. Based on the data from Table 3, we got the optimal portfolio in which the portion of shares is allocated as follows:

Table 4 Securities and Their Stakes in Portfolio

Issuer	**AERO**	**NIIS**	**AIKB**	**KMBN**	**TIGR**	**MTLC**	**SJPT**	**FITO**	**ALFA**	**DINNBP**
Stake	2,07%	1,76%	5,15%	23,36%	0,28%	23,16%	23,55%	0,38%	3,69%	16,60%

Source: Calculations by authors

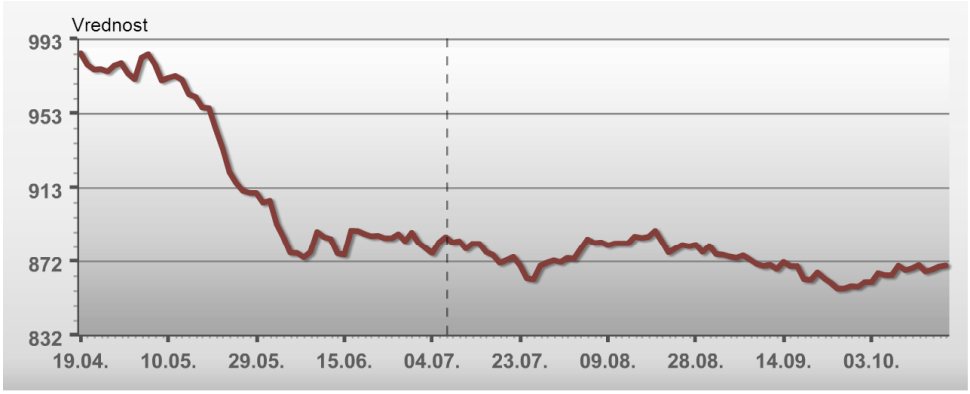
Figure 1 Portfolio Structure



Source: Calculations by authors

Of course the optimal portfolio return has to be compared with the benchmark index which is represented on the Belgrade Stock Exchange by BELEXLINE. Optimal portfolio rate of return has to be higher than the Belexline rate of return.

Figure 2 BELEXline Fluctuation



Source: Belgrade Stock Exchange

In the observed period, the BELEXline had return of 0.9 which is much lower than the optimal portfolio which had return rate of 22.5%. However, return is not the only measure which shows which investment was more successful. The goal of portfolio optimization is to optimize the relationship

between expected return and its risk. For that purpose, Sharpe index or ratio will be used in this paper.[2]

Sharpe ratio is taken, because it is not necessary to calculate the beta coefficient for it, which in our conditions would beextremely difficult and invalid.

The article by Nikola Radivojević (2009), states the following limitations in calculating the beta coefficient: a large number of extreme values which create the illusion of high variability of the rate of return, the choice of the referential index and the impact of non-synchronized trading. And, what is specific in terms of this paper, a short period of time of the research (90 days). Sharpe ratio formula is as follows:

$$S = \frac{Er - rf}{\sigma}$$

We see that for the calculation of this index, it is necesarry to determine the risk-free rate of return. On the Serbian capital market Treasury bills are available. The average rate of return from the last two issuings will be taken into consideration, which amounts to 0.031% on a daily basis. The period of 90 days has beed taken for the purpose of this paper, so that the rate of return amounts to 2.79% on Treasury bills.

Sharpe ratio for the optimal portfolio is 17.28, while for the BELEXline it amounts -4.39. The higher amount of Sharpe ratio shows that the optimal portfolio achieved a much higher return per unit of risk than the Belexline. By obtaining such result, modern portfolio theory was successfully applied in the Serbian capital market

Jeremic and Terzic (2010) presented the modern portfolio theory applied to the Belgrade Stock Exchange in the period January - December 2007. The portfolio also included 10 securities listed on the Belgrade Stock Exchange, with a difference in that the return of the portfolio was compared with the Belex15. It is interesting to note that the optimal portfolio in 2007 and our optimal portfolio in 2012 has 5 out of 10 listed securities in common, which confirms the attitude that the market is shallow.

Conclusion

The paper illustrates that the modern portfolio theory can be applied in the Serbian capital market, but its implementation is accompanied with numerous

[2] Sharpe ratio is the measure of the additional rate of return (Risk Premium) of some means (or portfolio) above the non-risk rate in relation to its risk.

limitations. It can be concluded that the application of this theory in the shallow and underdeveloped markets, such as the Serbian market, requires a selection of a narrow group of securities that comply with the criteria of liquidity and frequent trading in the stock market. Because of these difficulties, the paper presents a slightly modified modern portfolio theory in the sense that only previously determined shares have been used in the process of optimization.

Using Excell the optimal portfolio has been obtained which is more efficient than a comparable BELEXline, which was indeed the subject of this research. However, some empirical studies have shown that investors in the Serbian capital market have suffered significantly greater losses in the case of the declining market from those expected using the classical portfolio theory.

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MODERNA PORTFOLIO TEORIJA NA TRŽIŠTU KAPITALA U SRBIJI

Apstrakt: Savremena portfolio teorija predstavlja jednu od najznačajnijih inovacija na području investiranja i upravljanja portfoliom hartija od vrednosti. Rad se bavi ispitivanjem mogućnosti korišćenja metoda portfolio analize na tržištu akcija kojima se trguje na Beogradskoj berzi. Cilj rada je da se izaberu akcije sa Beogradske berze koje su u analiziranom periodu imale najbolje performanse, te da se primenom portfolio analize dođe do optimalnog portfolia koji će imati bolje performanse od berzanskog indeksa BELEXline uz manju stopu rizika. Treba napomenuti da na tržištu akcija kakvo je tržište akcija u Srbiji, postoje brojna ograničenja primene ovog metoda, ali je uprkos tome dobijen portfolio koji je dao bolje performanse od berzanskog indeksa BELEXline.

Ključne reči: portfolio analiza, optimalni portfolio