MARKOWITZ' MODEL WITH FUNDAMENTAL AND TECHNICAL ANALYSIS – COMPLEMENTARY METHODS OR NOT

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Abstract

As it is well known there are few "starting points" in portfolio optimization process, i.e. in the stock selection process. Famous Markowitz' optimization model is unavoidable in this job. On the other side, someone may say that the indicators of the fundamental analysis must be the starting point. Beside that, the suggestions of the technical analysis must be taken into consideration. There are really numerous studies of the each approach separately, but it is almost impossible to find researches combining these approaches in logic and efficient unity.

The main task of the paper is to find out if these approaches are complementary and if they are, how to apply them as efficient unit process. The empirical part of the study uses share sample from the Croatian stock market. Beside Markowitz' MV model, fundamental and technical analysis, big role in the paper has an original multi-criterion approach.

Key words: *Markowitz M-V model, fundamental analysis, technical analysis, multi-criterion approach, Croatian stock market*

1. INTRODUCTION

The problem of choosing the optimal portfolio is of huge importance for all the investors on developed capital markets, especially on emerging capital markets as the Croatian capital market. Analysing securities is as important for small, individual investors or for big, institutional investors. When selecting the optimal portfolio, it is important to analyse securities thoroughly, which includes fundamental and technical analysis, and the use of Markowitz' M-V (mean-variance) model and multi-criteria approach. Only after a detailed analysis of all the information gathered by these methods, the investor can engage in trading stocks. This

papers' goal is to analyse and evaluate different methods for analysing the values and prices of stocks in portfolio selection process, to indicate the importance of each method, and to study the specifics of their application on the Croatian capital market. The goal is to select the right combination of methods which will provide us with an optimal portfolio and minimise investment risks.

2. THEORETICAL OVERVIEW

2.1. Fundamental analysis

The fundamental analysis is based on determining the value of stocks, and implies analysing all the available facts of the business entity, in order to bring out the conclusion about the quality of securities that is important in decision making process when buying a particular stock. The goal is to identify undervalued companies in order to make above average profits.

After detail economy and industry analysis, it is important to analyse company's financial statements and indicators. It is well known that both financial statements and financial indicators can be different for financial and non-financial companies. Therefore, only the indicators that can be calculated both for financial and non-financial companies are used in this paper. Financial indicators used in this paper are (Belak, 1995):

$$ROA = \frac{Net\_income}{Total\_asset} \tag{1}$$

$$ROE = \frac{Net\_income}{Total\_equity} \tag{2}$$

$$EPS = \frac{Net\_income - Dividends\_on\_preferred\_stock}{Average\_outstanding\_shares} \tag{3}$$

$$Dividend\_yield = \frac{Annual\_dividends\_per\_share}{Price\_per\_share} \tag{4}$$

$$P/E = \frac{Market\_value\_per\_share}{EPS} \tag{5}$$

$$P/EBIT = \frac{Market\_value\_per\_share}{Earnings\_before\_interests\_and\_taxes\_per\_share} \tag{6}$$

$$P/S = \frac{Share\_price}{Revenue\_per\_share} \tag{7}$$

$$P/B = \frac{Stock\_price}{Total\_assets - Intangible\_assets\_and\_liabilities} \tag{8}$$

2.2. Technical analysis

Starting point in technical analysis represents a graphical display of the motion in prices and volumes of stocks. Out of the analysis of stock prices in the past, special methods of technical analysis attempt to run conclusions about their movement in the future. The goal of technical analysis is to forecast stock prices with an aim to determine the favourable moments to buy or sell stocks. For technical approach to the market analysis it is important to know the concept of trends, i.e. the direction of market movements, and technical indicators, among which the most common used, are (Murphy, 2007):

- Moving average (MA)
- Bollinger bands
- Momentum
- Relative strength index (RSI)
- Moving average convergence divergence (MACD)

2.3. Markowitz' model

Using Markowitz' model it is possible to select a portfolio, out of all possible portfolios, whose relation between expected return and risk matches the investors' investment philosophy. Therefore, more conservative investor will require lower rate of risk, which means lower revenue. The portfolio that gives the lowest variance of return of all portfolios having the same expected return, or the one that has the highest expected return of all portfolios having the same variance, is called Markowitz' efficient portfolio (Aljinović, Marasović, and Tomić-Plazibat, 2005). Considering that every efficient portfolio has the highest revenue along with defined rate of risk c, mathematically we may define efficient portfolio as follows (Aljinović, Marasović and Šego, 2008):

$$\max E(R_\pi) \tag{9}$$

subject to:

$$\sigma_\pi \le c \tag{10}$$

$$\sum_{i=1}^{N} \pi_i = 1, \pi_i \ge 0, i \in \{1,2,...,N\}. \tag{11}$$

where: $$E(R_\pi) = \sum_{i=1}^{N} \pi_i E(R_i) = \pi' \cdot E(R) = E(R)' \cdot \pi \quad (12)$$

$$\sigma_\pi = \sqrt{\pi' \cdot S \cdot \pi} = \sqrt{\sum_{i=1}^{N} \sum_{j=1}^{N} \pi_i \pi_j \sigma_{ij}} \ . \quad (13)$$

2.4. Multi-criteria approach

Multi-criteria approach implies decision making using a number of criteria along with huge importance of decision marker in that process. PROMETHEE method (Preference Ranking Organisation Method for Enrichment Evaluation) is developed to help the decision maker in solving a multi-criteria problem, i.e. each pair of actions is compared according to each criterion (Marasović, 2006). Unlike the PROMETHEE method that compares alternatives and ranks them, multi-criteria programming in portfolio optimisation provides a portfolio and allows an absolute evaluation of each possible portfolio by comparing it with two fiction portfolios: the ideal ($\overline{P}$) and the anti-ideal ($\underline{P}$). The optimal portfolio is the one that solves (Tomić-Plazibat, Aljinović and Marasović, 2006):

$$Max\Phi(P) \quad (14)$$

subject to: $$\sum_{i=1}^{N} \pi_i = 1 \text{ i } 0 \le \pi_i \le \pi_{M_i}, \quad (15)$$

where $$\Phi(P) = \sum_{j=1}^{N} w_j \Phi_j(P) \quad (16)$$

$$P = \pi_P' S \quad (17)$$

$$\pi_P = (\pi_1, \pi_2, \ldots, \pi_N) \quad (18)$$

$$S_P = (s_1, s_2, \ldots, s_N) \quad (19)$$

π_i : proportion invested in share *i*, $i \in \{1,2,...,N\}$ in portfolio P,

π_{M_i} : maximum proportion to invest in share *i* in portfolio P,

N is the number of pre-selected shares which can be included in portfolio P.

3. AN APPLICATION TO THE CROATIAN CAPITAL MARKET

In this paper fifteen most traded shares (Irala and Patil, 2007; Tang, 2004) from the Zagreb stock exchange with good fundamentals have been singled out: ATPL-R-A, DDJH-R-A, DLKV-R-A, ERNT-R-A, HT-R-A,

IGH-R-A, INA-R-A, JDPL-R-A, LEDO-R-A, LKPC-R-A, PODR-R-A, PTKM-R-A, ULPL-R-A, VIRO-R-A, and ZABA-R-A, in the period from 1st November 2007 to 1st November 2009.

Using the Markowitz' model, efficient portfolios and efficient frontiers have been calculated. For each security from the sample we take the closing price at the end of each day. Firstly we calculate the daily returns for each security and then daily mean daily variance and daily standard deviation. By programming in MATLAB, we calculated ten efficient portfolios and efficient frontiers for Croatian capital market in observed periods. The range of solutions is given from the lowest to the highest possible daily return, with a proportion of shares in the portfolio which lies on the efficient frontier and their daily risk and return.

Table 1: Efficient portfolios for Croatian capital market from 01.11.2007 to 01.11.2009.

	1	2	3	4	5	6	7	8	9	10
ATPL-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
DDJH-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
DLKV-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
ERNT-R-A	0,0974	0,0594	0,0214	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
HT-R-A	0,4801	0,5161	0,5522	0,6014	0,6676	0,7338	0,7999	0,8661	0,9323	1,0000
IGH-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
INA-R-A	0,0263	0,0364	0,0466	0,0486	0,0401	0,0316	0,0231	0,0146	0,0061	0,0000
JDPL-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
LEDO-R-A	0,1632	0,1572	0,1511	0,1374	0,1139	0,0905	0,0670	0,0435	0,0201	0,0000
LKPC-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
PODR-R-A	0,2330	0,2309	0,2288	0,2127	0,1784	0,1442	0,1099	0,0757	0,0415	0,0000
PTKM-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
ULPL-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
VIRO-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
ZABA-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
Expected return	-0,105%	-0,101%	-0,096%	-0,091%	-0,086%	-0,081%	-0,077%	-0,072%	-0,067%	-0,062%
Standard deviation	1,374%	1,376%	1,382%	1,393%	1,418%	1,459%	1,514%	1,581%	1,659%	1,747%

Source: The authors' calculation

There is a significant discrepancy between the efficient frontiers for the years 2008 and 2009, i.e. their risk and return. Given results show that in general the efficient portfolios consist of the same 5 shares and that the civil engineering companies are not included in any portfolio. Considering the importance of variables other than risk and return, selection of the optimal portfolio becomes a multi-criterion problem.

Table 2: Efficient portfolios for Croatian capital market from 01.11.2007 to 01.01.2009.

	1	2	3	4	5	6	7	8	9	10
ATPL-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
DDJH-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
DLKV-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
ERNT-R-A	0,0396	0,0011	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
HT-R-A	0,3219	0,3623	0,4149	0,4618	0,5032	0,5446	0,5860	0,6274	0,8113	1,0000
IGH-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
INA-R-A	0,0416	0,0412	0,0134	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
JDPL-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
LEDO-R-A	0,1719	0,1628	0,1423	0,1171	0,0881	0,0590	0,0300	0,0010	0,0000	0,0000
LKPC-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
PODR-R-A	0,4250	0,4325	0,4293	0,4211	0,4087	0,3963	0,3840	0,3716	0,1887	0,0000
PTKM-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
ULPL-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
VIRO-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
ZABA-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
Expected Return	-0,272%	-0,265%	-0,259%	-0,252%	-0,245%	-0,239%	-0,232%	-0,226%	-0,219%	-0,212%
Standard Deviation	1,364%	1,366%	1,376%	1,398%	1,435%	1,485%	1,547%	1,621%	1,740%	1,935%

Source: The authors' calculation

Table 3: Efficient portfolios for Croatian capital market from 01.01.2009 to 01.11.2009

	1	2	3	4	5	6	7	8	9	10
ATPL-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0248	0,0593	0,0937	0,3694	1,0000
DDJH-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
DLKV-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
ERNT-R-A	0,1384	0,0944	0,0503	0,0062	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
HT-R-A	0,6065	0,6221	0,6377	0,6533	0,6406	0,4627	0,2798	0,0969	0,0000	0,0000
IGH-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
INA-R-A	0,0215	0,0580	0,0944	0,1309	0,1697	0,2490	0,3248	0,4006	0,3690	0,0000
JDPL-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
LEDO-R-A	0,1250	0,1363	0,1476	0,1588	0,1779	0,2076	0,2368	0,2660	0,1599	0,0000
LKPC-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
PODR-R-A	0,1087	0,0894	0,0700	0,0507	0,0023	0,0000	0,0000	0,0000	0,0000	0,0000
PTKM-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
ULPL-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
VIRO-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
ZABA-R-A	0,0000	0,0000	0,0000	0,0000	0,0095	0,0560	0,0994	0,1428	0,1017	0,0000
Expected Return	0,130%	0,137%	0,145%	0,153%	0,161%	0,169%	0,176%	0,184%	0,192%	0,200%
Standard Deviation	1,203%	1,208%	1,221%	1,243%	1,277%	1,361%	1,518%	1,727%	2,113%	3,305%

Source: The authors' calculation

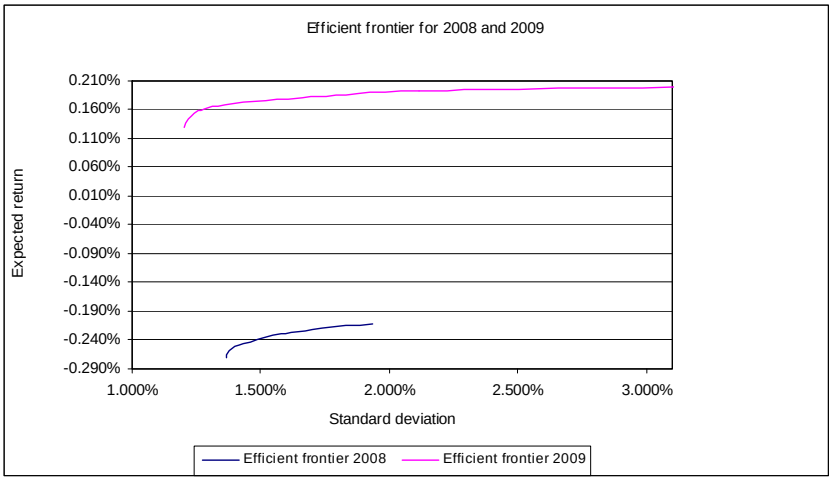

Figure 1. Efficient frontiers for 2008 and 2009

To apply proposed multi-criterion model, we had to calculate the followings: price to sales ratio, price to earnings ratio, price to book ratio, earnings per share, return on equity, return on asset, price to earnings before interests and taxes ratio, dividend yield, expected return, standard deviation, beta and turnover rate. The values of all criteria for the years 2008 and 2009 are shown in tables 4 and 5. The indicators from the financial statements are shown relative to the industry average.

Table 4: Stock's values for the constructed criteria for 2008

2008.	P/S	P/E	P/B	EPS	ROE	ROA	P/EBIT	Dividend yield	Expected return	Standard deviation	Beta	turnover (mil. kn)
ATPL-R-A	1,294	0,578	2,053	1,888	0,026	0,025	2,214	6,58%	-0,0056	0,0440	1,41	1871,213
DDJH-R-A	0,154	0,829	0,243	0,092	0,001	0,001	0,221	0,00%	-0,0053	0,0376	1,17	170,833
DLKV-R-A	0,504	0,762	0,910	0,256	0,012	0,005	0,659	4,38%	-0,0048	0,0397	1,22	804,431
ERNT-R-A	0,614	1,054	1,023	1,692	0,010	0,010	1,257	21,09%	-0,0034	0,0237	0,65	1061,291
HT-R-A	1,470	1,093	1,120	0,308	0,010	0,012	0,922	11,24%	-0,0021	0,0194	0,53	2947,216
IGH-R-A	0,708	0,542	0,639	2,397	0,012	0,004	0,434	3,57%	-0,0045	0,0413	1,30	1257,997
INA-R-A	0,648	-0,282	0,706	-2,211	-0,025	-0,013	-1,438	0,88%	-0,0028	0,0268	0,60	2022,885
JDPL-R-A	0,843	-1,533	0,918	-0,113	-0,004	-0,005	-5,779	0,00%	-0,0061	0,0380	1,17	284,675
LEDO-R-A	2,224	0,541	2,572	1,539	0,022	0,014	1,427	0,93%	-0,0042	0,0412	-0,21	302,292
LKPC-R-A	0,659	0,129	1,298	1,863	0,024	0,020	0,335	0,00%	-0,0053	0,0494	1,26	249,527
PODR-R-A	0,761	1,106	0,804	0,034	0,003	0,002	1,273	0,00%	-0,0025	0,0188	0,35	478,705
PTKM-R-A	0,903	1,182	0,685	-2,341	-0,007	-0,384	-13,268	0,00%	-0,0034	0,0311	0,80	209,714
ULPL-R-A	2,108	1,337	1,353	0,519	0,007	0,006	5,170	7,30%	-0,0065	0,0468	1,37	427,002
VIRO-R-A	1,092	6,972	1,136	0,006	0,001	0,000	3,893	6,29%	-0,0049	0,0359	0,98	346,857
ZABA-R-A	1,226	0,325	1,098	0,302	0,012	0,011	0,720	0,00%	-0,0041	0,0349	0,95	354,506

Source: Authors

Thresholds values are given by ranking method (Babić, Aljinović and Tadić, 2009) based on the opinion of the experts. The research was conducted based on multi-criteria programming in portfolio optimisation. In his case the linear preference criterion is used, which includes one threshold which define strict preference area.

Table 5: Stock's values for the constructed criteria for 2009

2009.	P/S	P/E	P/B	EPS	ROE	ROA	P/EBIT	Dividend yield	Expected Return	Standard deviation	beta	turnover (mil. kn)
ATPL-R-A	2,587	-9,105	2,271	-0,120	-0,002	-0,002	214,769	6,58%	0,0020	0,0331	1,14	953,279
DDJH-R-A	0,293	-0,062	0,294	-1,216	-0,011	-0,023	-0,046	0,00%	-0,0001	0,0350	1,10	29,827
DLKV-R-A	0,472	0,739	0,789	0,264	0,011	0,005	0,576	0,00%	0,0002	0,0326	1,18	434,101
ERNT-R-A	0,789	1,677	0,990	1,064	0,006	0,006	3,115	5,47%	0,0006	0,0210	0,64	179,928
HT-R-A	1,524	1,247	1,159	0,270	0,009	0,011	1,045	11,40%	0,0015	0,0142	0,34	1480,788
IGH-R-A	0,740	2,969	0,639	0,437	0,002	0,001	1,486	2,38%	0,0000	0,0390	1,24	463,449
INA-R-A	0,846	-0,791	0,721	-0,789	-0,009	-0,004	31,310	0,00%	0,0019	0,0239	0,71	176,417
JDPL-R-A	2,064	-2,952	0,845	-0,059	-0,002	-0,003	-6,934	0,00%	0,0017	0,0376	1,31	191,778
LEDO-R-A	2,282	0,478	2,132	1,744	0,020	0,011	1,301	1,54%	0,0018	0,0308	0,15	90,120
LKPC-R-A	0,905	0,819	1,265	0,293	0,004	0,003	1,726	0,00%	0,0013	0,0385	1,29	65,246
PODR-R-A	0,761	-0,183	0,954	-0,208	-0,024	-0,011	-0,999	0,00%	0,0005	0,0273	0,42	90,493
PTKM-R-A	1,355	-0,248	0,926	11,117	0,041	2,204	4,592	0,00%	0,0019	0,0368	1,22	147,824
ULPL-R-A	2,020	1,825	1,401	0,380	0,006	0,004	7,932	6,75%	0,0012	0,0350	1,11	131,968
VIRO-R-A	2,067	4,683	1,029	0,010	0,001	0,001	1,008	0,00%	0,0014	0,0345	1,16	104,898
ZABA-R-A	0,968	0,337	0,946	0,291	0,010	0,009	0,588	0,00%	0,0019	0,0278	0,80	73,335

Source: Authors

Threshold respects the relation:

$$p_j^- = p_j^+ = \frac{\left| f_j(\overline{P}) - f_j(\underline{P}) \right|}{2} \tag{20}$$

In table 6 weight of each criterion is shown.

Table 6: Weight of each criterion

Criteria	P/S	P/E	P/B	EPS	ROE	ROA	P/EBIT	Dividend yield	Expected return	Standard deviation	Beta	Turnover (mil. kn)
Weight	0,013	0,051	0,026	0,090	0,077	0,064	0,103	0,0385	0,1538	0,1154	0,14	0,1282

Source: According to experts' evaluation and ranking method

By programming in MATLAB we get solutions given in table 7 and 8. The optimal portfolios are calculated in considering maximum proportion constraint firstly by 20%, secondly by 30%, thirdly by 50% and finally without maximum proportion constraint. Analysing the given results we can conclude that the optimal solution depends on the maximum proportion constraint. However, lowering the maximum proportion constraint does not increase significantly the number of shares in an optimal portfolio, since the quality of the shares in a diversified portfolio is important. This also confirms the results given by the Markowitz model on the Croatian capital market.

Using several most commonly used technical analysis indicators (Colby 2002, Marphy 2007, Prohaska 1994), technical analysis is carried out on ERNT-R-A. Indicators used in the research are: moving average, boolinger bands, relative strength index, momentum and moving average convergence divergence.

Table 7: Optimal portfolios for 2008

Maximum proportion constraint	π_M=0,2	π_M=0,3	π_M=0,5	π_M=1
ATPL-R-A	0,0000	0,0000	0,0000	0,0000
DDJH-R-A	0,0000	0,0000	0,0000	0,0000
DLKV-R-A	0,0000	0,0000	0,0000	0,0000
ERNT-R-A	0,2000	0,3000	0,5000	0,0000
HT-R-A	0,2000	0,3000	0,5000	1,0000
IGH-R-A	0,0000	0,0000	0,0000	0,0000
INA-R-A	0,2000	0,1000	0,0000	0,0000
JDPL-R-A	0,0000	0,0000	0,0000	0,0000
LEDO-R-A	0,2000	0,0000	0,0000	0,0000
LKPC-R-A	0,0000	0,0000	0,0000	0,0000
PODR-R-A	0,2000	0,3000	0,0000	0,0000
PTKM-R-A	0,0000	0,0000	0,0000	0,0000
ULPL-R-A	0,0000	0,0000	0,0000	0,0000
VIRO-R-A	0,0000	0,0000	0,0000	0,0000
ZABA-R-A	0,0000	0,0000	0,0000	0,0000

Source: The authors' calculation

Table 8: Optimal portfolios for 2009

Maximum proportion constraint	π_M=0,2	π_M=0,3	π_M=0,5	π_M=1
ATPL-R-A	0,0000	0,0000	0,0000	0,0000
DDJH-R-A	0,0000	0,0000	0,0000	0,0000
DLKV-R-A	0,0000	0,0000	0,0000	0,0000
ERNT-R-A	0,0000	0,0000	0,0000	0,0000
HT-R-A	0,2000	0,3000	0,5000	1,0000
IGH-R-A	0,0000	0,0000	0,0000	0,0000
INA-R-A	0,2000	0,0528	0,0000	0,0000
JDPL-R-A	0,0000	0,0000	0,0000	0,0000
LEDO-R-A	0,2000	0,3000	0,0000	0,0000
LKPC-R-A	0,0000	0,0000	0,0000	0,0000
PODR-R-A	0,0000	0,0000	0,0000	0,0000
PTKM-R-A	0,2000	0,3000	0,5000	0,0000
ULPL-R-A	0,0000	0,0000	0,0000	0,0000
VIRO-R-A	0,0000	0,0000	0,0000	0,0000
ZABA-R-A	0,2000	0,0472	0,0000	0,0000

Source: The authors' calculation

Figure 2. Technical analysis of ERNT-R-A

4. CONCLUSIONS

This paper has theoretically and empirically explored important and inevitable methods for stock selection in an optimal portfolio. These methods include fundamental and technical analysis, Markowitz modern portfolio theory and multi-criterion approach. The aim was to investigate if they are complementary or not and to determine the way to combine them into the optimal process of portfolio selection. The research was conducted on a sample of 15 most traded stocks on the Croatian capital market, which have shown good fundaments, in the period from September 1st 2007 to September 1st 2009. The research revealed that these methods are complementary; they interlace, supplement and confirm each other. In the portfolio selection process it is necessary to include each of the methods mentioned, because only by combining them it is possible to perceive all the relevant factors for selecting stocks in an optimal portfolio, which leads to the best results. In the different stages of the decision making process one method could be more important than the other. For the purpose of selecting stocks in a portfolio it is important to start with fundamental analysis. After selecting the good stocks, it is possible to carry out an optimal portfolio using Markowitz model or multi-criteria approach, considering that they lead to the same results, but the right moment to buy or sell stocks is defined by the technical analysis. It can be said that technical analysis eliminates the lack of dynamism of the Markowitz' and multi-criterion optimisation model. Each investor who wants to generate above average profits should be familiar with all the methods mentioned.

REFERENCES

Aljinović, Z., Marasović, B. and Šego, B. (2008), *Financijsko modeliranje*, Zgombić&Partneri, Zagreb

Aljinović, Z., Marasović, B. and Tomić-Plazibat, N. (2005), "Multi-Criterion Approach Versus Markowitz in Selection of the Optimal Portfolio", *Proceedings of the 8th International Symposium on OPERATIONAL RESEARCH SOR'05*, Nova Gorica, Slovenia, pp. 261-266.

Babić, Z., Aljinović, Z. and Tadić, I. (2009), "Multicriteria Job Evaluation within the Centre of Lifelong Education", *Proceedings of the 10th International Symposium on Operational Research SOR'09*, Nova Gorica, Slovenia, pp. 407-415.

Belak, V. (1995), *Menadžersko računovodstvo*, RRIF, Zagreb

Colby, R.W. (2002), *The Encyclopedia of Technical Market Indicators*, 2nd edition, McGraw Hill, NY

Irala, L.R. and Patil, P. (2007), "Portfolio Size and Diversification", *SMCS Journal of Indian Management*, vol.4, no.1

Marasović, B. (2006), *Modeli optimizacije investicijskog portfelja*, magistarski rad, Ekonomski fakultet Zagreb

Murphy, J.J. (2007), *Tehnička analiza financijskih tržišta*, Poslovni dnevnik, Masmedia, Zagreb

Prohaska, Z. (1994), *Upravljanje vrijednosnim papirim*a, Poslovna knjiga, Infoinvest, Zagreb.

Tang, G.Y.N. (2004), "How efficient is naive portfolio diversification", an education note, *Omega-The International Journal of Management Science*, No.32, pp. 155-160.

Tomić-Plazibat, N., Aljinović, Z. and Marasović, B. (2006), *Matematički modeli u financijskom upravljanju*, Ekonomski fakultet Split, Split