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DIFFERENT VARIANTS OF FUNDAMENTAL PORTFOLIO

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Abstract

The paper proposes the fundamental portfolio of securities. This portfolio is an alternative for the classic Markowitz model, which combines fundamental analysis with portfolio analysis. The method's main idea is based on the use of the *TMAI*[1] synthetic measure and, in limiting conditions, the use of risk and the portfolio's rate of return in the objective function. Different variants of fundamental portfolio have been considered under an empirical study. The effectiveness of the proposed solutions has been related to the classic portfolio constructed with the help of the Markowitz model and the *WIG20* market index's rate of return. All portfolios were constructed with data on rates of return for 2005. Their effectiveness in 2006–2013 was then evaluated. The studied period comprises the end of the bull market, the 2007–2009 crisis, the 2010 bull market and the 2011 crisis. This allows for the evaluation of the solutions' flexibility in various extreme situations. For the construction of the fundamental portfolio's objective function and the *TMAI*, the study made use of financial and economic data on selected indicators retrieved from *Notoria Serwis* for 2005.

Keywords: fundamental portfolio, portfolio analysis, stock exchange.

JEL classification: C10, G12.

1. Portfolio analysis

Portfolio analysis deals with the techniques of investing in more than one kind of asset. The basic motive of purchasing more than one type of security is the will to minimize diversifiable risk to zero and optimize revenues and risk of investment. It can be proved that an appropriately constructed securities portfolio enables reaching the above-mentioned goals. Portfolio analysis methods are regarded as methods allowing for making long-term investments. This generally stems from the portfolio's low elasticity and liquidity. Undoubtedly, this results in methods of portfolio analysis being closer to methods of fundamental analysis, than to those of technical analysis.

In practice, securities with high rates of return are characterized by high risk. The investor seeks such opportunities of investing funds which will minimize risk while increasing the rate of return. A securities portfolio gives the possibility of making such an assumption feasible.

A securities portfolio is understood as any set of assets held by the investor. This means that the number of components of a given portfolio equals the exact number of different kinds of securities the portfolio contains. It has to be emphasized that the portfolio theory is one of the most important sections in modern finance.

1.1. The classic Markowitz model

The basis of portfolio management and methods of selecting efficient assets together with ways of their financing had been created by Markowitz[2]. Then, Markowitz's ideas were developed by Sharpe (who introduced in 1963 i.a. the single factor model, which simplified the classic Markowitz theory, and proposed a model of capital market equilibrium[3]), Lintner[4] and Mossin[5].

The Markowitz model is based on quantitative methods. Its fundamental assumptions are as follows:

1. The investment's rate of return adequately expresses the income achieved from the said investment, and investors are aware of the probability distribution of achieving given rates of return.
2. Investors' estimates concerning risk are proportional to the distribution of expected rates of return.
3. Investors decide to base their decisions solely on two parameters of the probability distribution function, i.e. on the expected return and probability of its achievement.

4. Investors are prone to take minimal risk at a given rate of return, whilst at a given grade of risk, they choose the project with highest profitability.

Taking into account these assumptions, diversification of investing in securities decreases the range of return values. Profit from securities' investment is two-fold by nature. The first is the dividend paid out by the company, the second represents profit resulting from the growth of the securities' market value. The profit from securities investments is determined by its rate of return.

One way of minimizing risk in a securities portfolio is diversification, as proposed by Markowitz, which consists in increasing the number of securities within a portfolio. As a result of portfolio diversification (increasing the number of elements comprised by a portfolio) one may decrease down to zero the participation of particular assets' variances in the portfolio's overall risk. On the other hand, the lowest possible risk of the entire portfolio may not be lower than the covariation whose share in the overall risk cannot be decreased. The model first proposed by Markowitz may be written in the form below:

$$\begin{aligned} &S_p \rightarrow \min \\ &R_p = R_0, \\ &\sum_{i=1}^{n} x_i = 1, \\ &x_i \geq 0, \end{aligned} \tag{1}$$

where:

S_p – portfolio's expected risk,

R_p – portfolio's expected rate of return,

R_0 – desired rate of return,

n – number of assets in a portfolio,

x_i – asset *i*'s share in the portfolio (necessary to determine R_p and S_p).

Applying Markowitz's model it is not possible to exactly define the optimal investment portfolio. However, it is possible to use it to determine a set of portfolios profitable in terms of rate of return and risk, namely portfolios yielding maximum profits at a given level of risk or displaying minimum risk for a given level of profits. In practice, the analyses reject portfolios with a negative rate of return. This is possible to carry out through the application of dual programming technique (non-linear objective function with linear limitations). A graphic interpretation of a set of possible portfolios has been presented in Figure 1.

Attention ought to be drawn to the fact that the potential portfolios' area corresponds to the risk-income map for single securities. The area limited by curves in Figure 1 contains potential portfolios, i.e. all the possible risk vs. the expected return comparisons. The boundary of profitability marked on the graph limits the area of potentially profitable portfolios. From the point of view of risk level, investors will prefer portfolios located on the boundary of profitability, which means the selection of maximum profit at a given risk. The problem that arises at this point is that there is an infinite number of efficient portfolios.

For instance, portfolios marked **b** and **d** produce the same income $E(R1)$ at different levels of risk $S(R1)$ and $S(R2)$. This is proved by the fact that investors will choose portfolios on the verge of profitability, because only in this way investment risk may be limited. Point **a** is the portfolio bearing the lowest level of risk, whereas point **c** is the one with the highest rate of return. Thus, this concludes that the choice of the optimal portfolio is an individual matter for each investor.

All portfolios lying on the boundary of profitability (curve **ac**) are **efficient portfolios**. These portfolios display the best parameters and are non-dominated. This means that for a portfolio's given rate of return which is on the verge of profitability it is not possible to find a portfolio carrying even lower risk. An example of such a portfolio is the one marked **b** in Figure 1.

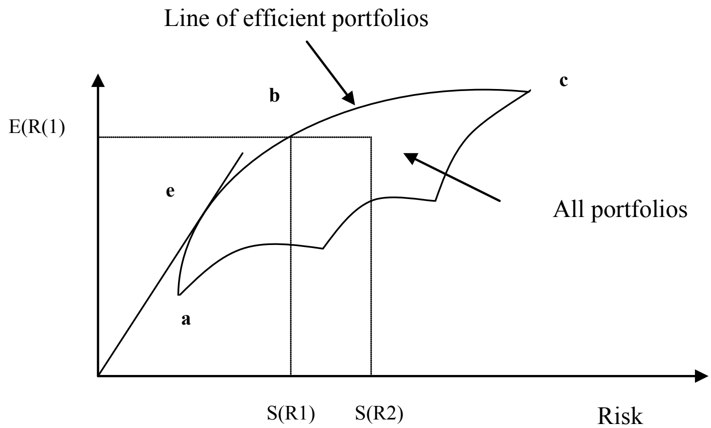


Fig. 1. Set of securities portfolios with regard to income and risk

Source: own study.

Portfolios preferred by investors who are risk-averse are called **conservative portfolios**. Their feature is that the shift to another conservative portfolio with a higher level of minimally acceptable return is related to a smaller growth of risk than the growth of profit. Thus, on the line marked as the boundary of profitability, it is assumed that conservative portfolios are located on the most steep section of the curve. Such portfolios are, for instance, those in Figure 1 contained between portfolios marked as **a** and **b**.

Another portfolio is the **minimal risk portfolio**. It is the one carrying the lowest global risk (marked as **a** in Figure 1). We may say that by applying portfolio analysis in relation to the assets alone, it is not possible to further lower this portfolio's risk. What is left is risk resulting from the rules of the stock market. The minimal risk portfolio is always located on the end of the profitability curve.

In contradiction to the previously mentioned portfolio, the one located on the other end of the profitability curve is called a **critical portfolio** (in Figure 1 marked as **c**). It is characterized by the fact that the growth of its return involves a faster growth in the level of risk. If a derivative from the curve of profitable portfolios is calculated, its value for the critical portfolio equals 1.

The **aggressive growth portfolio** is preferred by investors that are more prone to take risks. Portfolios from this group are characterized by the fact that a shift to another aggressive portfolio bearing a higher level of minimal acceptable profit involves a larger growth of risk than a growth of profit. They are presented in Figure 1 between **b** and **c**.

The **optimal portfolio** may be found on the boundary of profitability as a point through which a straight line led from the beginning of the coordinate system is tangent to the line on which efficient portfolios are found. Figure 1 presents the optimal portfolio marked as **e**. A characteristic feature of this portfolio is that it carries the highest profit in relation to risk. Moreover, this portfolio has the lowest relative risk related to profit (obviously, when loss occurs, this does not hold true). An advantage of the optimal portfolio seems to be the fact that it bears relatively the highest profit (thus, the probability of loss is the lowest). In this type of portfolio it is not possible to include any risk-free securities.

The last type of portfolio is the **market portfolio**. It differs from the optimal one in that the increment of profit in excess of the risk-free rate of return is compared against risk. In order to find this portfolio, one needs to lead a tangent from the point on the income axis corresponding to the risk-free rate of return to the line of efficient portfolios. The point of tangency corresponds to the market portfolio.

The main reservation towards the Markowitz model concerns the lack of possibility of its application in practice. To create the optimal portfolio even for a small number of securities in it, a great amount of data needs to be collected. What is more, these calculations do not present an easy task. Not questioning the advantages of the securities portfolio, Markowitz's model is not very often used in practice. Subsequent studies on the matters of creating the optimal securities portfolio led to the emergence of many models having larger practical significance than the classic Markowitz model.

2. Fundamental criterion of constructing a securities portfolio

Evaluating the classic concepts of securities portfolio from the pragmatic point of view, it may be said that these are techniques of analysis and conducting long-term investments. This stems from the portfolio's low elasticity. Constructing a portfolio seems pointless when the process of its construction may last even a few weeks, and change occurs after, for example, a month. Even if we do see, evaluating the current market situation, that there is a need to reconstruct the portfolio, then the process is impossible to practically carry out in a short period of time. This is due to the limited liquidity of the stock exchange (on the Warsaw Stock Exchange, on average there is 1% of each company's shares floating in one quotation). Therefore, it seems obvious that the securities portfolio ought to be constructed with long-term investment in mind. From analysis of the stock exchange it follows that the criteria of rate of return and risk, determined on the basis of the variance of the rate of return, are not the best measures owing to their instability. This is particularly visible on developing markets (and the Polish market, as such), with low liquidity, where classic portfolios do not enable reaching premium income.

This is an incentive to search for new solutions that would allow for the construction of a securities portfolio which in a natural way uses long-term foundations for making investment decisions. It appears purposeful to combine methods of fundamental analysis with the notion of constructing securities portfolio. This not possible directly because fundamental analysis is too broad and formalizing it for the needs of constructing a securities portfolio requires significant simplification. Fundamental analysis, as a typical technique of analysis for long-term investment, seems to be an appropriate basis for forming a securities portfolio. A problem which has to be solved is bringing multi-element results of fundamental analysis to a form enabling its application in the construction of a portfolio. Such a problem is guaranteed to be solved with the proposed taxonomic measure of investment's attractiveness *TMAI*.

The proposed new concept of constructing a securities portfolio is creating a securities portfolio that will be a long-term one, taking into account important advantages of fundamental analysis, i.e. taking into consideration companies' factual strength at the expense of entities that are weak from the financial and economic point of view, defined as speculative companies. A portfolio constructed on these foundations will be stable and safe. For long-term investors the advantages of such an approach are obvious. The principal criterion under optimization is the asset participation-weighted sum of values of synthetic measures defining the portfolio's companies' fundamental strength. The value of a criterion understood in this way is maximized. Such a construction of the objective function ensures the portfolio's stability and security in a long period of time. The first proposals for constructing such a portfolio can be found in the works of Tarczyński[6].

Stages of securities portfolio construction have been presented in Figure 2. The proposed approach makes it possible to objectively asses the financial and economic condition of stock companies and to construct a securities portfolio accounting for the companies' fundamental strength and the investment's long-term character. On the basis of such a portfolio, further work is possible, for instance aiming at developing universal and stable criteria for synthetic measure and limiting conditions, which will be insensitive to the capital market's stage of development in a given country.

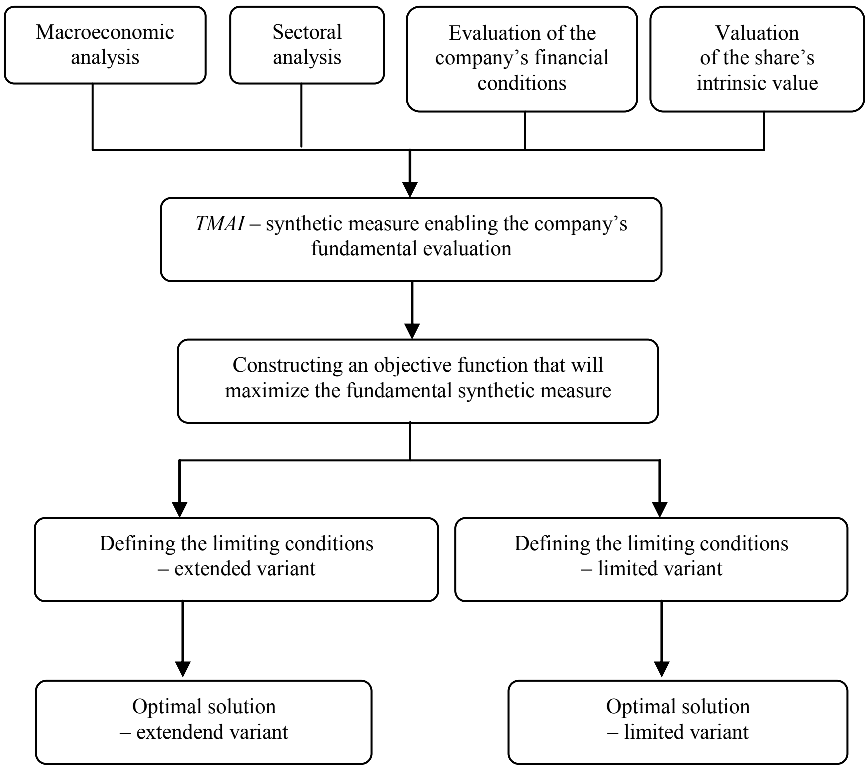


Fig. 2. Stages of constructing a fundamental portfolio

Source: own study.

In the proposed method of constructing a fundamental portfolio *TMAI* values are the criterion under optimization. This is the principal change in relation to the classic concepts based upon rate of return and risk. A portfolio founded on the *TMAI* criterion is optimal from the fundamental point of view, i.e. it chooses the best arrangement in terms of companies economic and financial condition.

The proposed objective function and limiting conditions in the extended variant may be presented as follows:

$$f = \sum_{i=1}^{n} TMAI_i \cdot x_i \to \max \tag{2}$$

$$\sum_{i=1}^{n} R_i \cdot x_i \geq R \tag{3}$$

$$\sum_{i=1}^{n} S_i \cdot x_i \leq S \tag{4}$$

$$\sum_{i=1}^{n} x_i = 1 \tag{5}$$

$$x_1, x_2, \ ..., \ x_n \geq 0 \tag{6}$$

where:

$TMAI_i$ – taxonomic measure of attractiveness of investment in company *i*,

x_i – asset *i*'s share in the portfolio,

R_i – weekly rate of return for company *i*,

R – portfolio's mean weekly rate of return desired by the investor,

S_i – weekly investment risk for company *i* determined as rate's of return standard deviation,

S – portfolio's mean weekly risk accepted by the investor,

n – number of companies.

The proposed model requires imposing additional limitations and explaining the occurrence of particular limiting conditions. The first stage is the limitation of potential securities that could become the portfolio's elements to those for which the rate of return in the analyzed period is greater than zero. Of course, in an extreme case this limitation may be omitted and all securities available on the market may be accepted. Formal criteria can also be used, such as discriminative analysis, which enables the isolation of a group of companies meeting specific requirements.

The second is the definition of the period under analysis. The principle of weekly time sections accepted in the model do not have to be the general rule. The period may be longer or shorter, which is first of all dependent on the investment's character. Generally, in a portfolio's long-term character resulting from its merit, the shortest period ought to be a week, while the longest – a month.

Thirdly, at the very beginning there is the necessity of defining the level of the investor's accepted risk and investment's expected rate of return. In this scope, the model is very flexible. Values *R* and *S* desired by the investor may be accepted in accordance with portfolio effect of rate of return and portfolio effect of risk, i.e. *R* as the minimal rate of return from companies used when constructing the portfolio, *S* as the maximum standard deviation of rate of return from companies used when constructing the portfolio. As limit values, it is possible to assume the levels of these measures estimated in a different way (e.g. arithmetic mean of rates of return and risks for companies considered when constructing the portfolio or the rate of return and risk measured using stock index).

As far as limiting conditions (3), (4), (5) are concerned, the share of particular assets in the portfolio sum up to one, and (6), they are clear and do not require any explanation. The rate of return and risk of the portfolio determined by formulas (2)÷(6) may be calculated using the same formulas as for Markowitz model:

$$S_p^2 = \sum_{i=1}^{N} \sum_{j=1}^{N} x_i \cdot x_j \cdot \mathrm{cov}(x_i, x_j) \to \min \tag{7}$$

$$R_p = \sum_{i=1}^{N} x_i \cdot R_i \tag{8}$$

This offers the possibility to compare the securities portfolio with classic portfolios. The drawback of this method of measuring the rate of return and risk, both in classic models and in the fundamental approach, is the fact that these values are not a forecast but merely an exemplification of the future. An ideal solution would be one which makes use of forecasts. Values estimated on the basis of historical data, as experience show, are not credible enough and must be approached with great prudence.

The proposed model does not take into consideration the possibility of short sale (condition 6). Removing this limitation from the model would be equivalent to admitting the application of short selling in practice (the assets' share in the portfolio can be negative, yet still their sum will be equal to one).

In general, the model's formula does not impose any definite limitations here and, depending on the investor's preferences, other limiting conditions may be introduced to the model.

However, one must bear in mind that the most important piece of information is contained by conditions (3) and (4), and that further development of the model does not necessarily lead (this is often the case) to its better quality. Still, if the quality does improve, it is not significant enough to justify the model's complication with new limiting conditions.

As for the *TMAI* values appearing in the objective function, in order to precisely define the companies' condition, it is possible to calculate the values of selected economic and financial indicators as a certain mean from the last three or five years, which would actually reflect the essence of the company's condition. In case of difficulties with obtaining credible predictions of these magnitudes, such an approach is highly advisable. Finally, an attempt may be made to analyze the series of *TMAI* values calculated for the company in several time periods and also include in the model some means of these values. In the case of a stable economy and capital market in a given country, it is proposed to predict *TMAI* values and, then, construct a fundamental portfolio on their basis.

The modified fundamental securities portfolio includes risk in the objective function. The portfolio's risk is minimized in this variant, reduced by the fundamental strength of the portfolio's shares for a given level of the rate of return:

$$S_p^2 = \sum_{i=1}^{N}\sum_{j=1}^{N} x_i \cdot x_j \cdot \operatorname{cov}(x_i, x_j) \cdot (1 - TMAI_i) \cdot (1 - TMAI_j) \to \min \tag{9}$$

$$R_p = R_0,$$

$$\sum_{i=1}^{n} x_i = 1,$$

$$x_i \geq 0,$$

where symbols are the same as in previous formulas.

3. Fundamental portfolio construction procedure based on the *TMAI*

The first step is to classify companies by their synthetic development measures *TMAI*. The classification criterion is the measures of economic and financial condition in the fields of: liquidity, profitability, indebtness and management efficiency. The base should comprise top 20 companies. Calculations were done based on 2005 end-of-year annual data. The calculations included all companies for which the economic and financial data were accessible and those listed on the exchange at least until the end of the year 2011.

The synthetic development measure "Taxonomic Measure of Attractiveness of Investments" (*TMAI*) can be estimated with the following formulae[7]:

$$TMAI_i = 1 - \frac{d_i}{d_0}, \quad (i = 1, 2, ..., n), \tag{10}$$

where:

$TMAI_i$ – synthetic development measure for the i-th object,

d_i – distance between the i-th object and the model object defined with the formula:

$$d_i = \sqrt{\sum_{j=1}^{m} (z_{ij} - z_{0j})^2}, \quad (i = 1, 2, ..., n),$$

z_{ij} – value of diagnostic variables (i-th object , j-th variables),

z_{0j} – maximum value of diagnostic variables,

d_0 – norm which assures that $TMAI_i$ values belong to the interval from 0 to 1:

$$d_0 = \overline{d} + a \cdot S_d.$$

According to the relation (10) and given $0 \leq TMAI_i \leq 1$ and $d_i > 0$, we may find the marginal value for the a constant:

$$a \geq \frac{d_{i\max} - \overline{d}}{S_d},$$

where $d_{i\max}$ is the maximum d_i value.

Table 1 presents 20 companies with the highest values of the *TMAI* measure. The fundamental portfolio for companies included in Table 1 has been constructed with the use of formulae (2)–(6) and the *Solver* tool available in *Excel* spreadsheet. Analogically, portfolios have been set by the application of the Markowitz model – formula (1), and with the use of the modified securities portfolio – formula (9). The results have been presented in Table 2. Table 2 also holds the components of all studied portfolios (fundamental portfolio, Markowitz model, modified fundamental portfolio). For the sake of comparison of analyzed portfolios' efficiency, the rates of return accepted here were those of portfolios constructed for companies listed in Table 1 on the basis of the Markowitz model, the fundamental portfolio, the modified fundamental portfolio as well as the *WIG20* stock index for the ends of years 2006–2011 (the results of the efficiency analysis are given in Table 3). Each portfolio had been purchased on December 30th, 2005. In each variant (except the fundamental portfolio), the portfolio bearing the minimum level of the coefficient of random variation V_s was chosen as the method's representative, where:

$$V_s = \frac{S_p}{R_p} \tag{11}$$

Table 1. Companies selected to database with the *TMAI* method
and their distances for 2005 year

No.	Company	*TMAI*
1	ZYWIEC	0.4192
2	WAWEL	0.3785
3	KGHM	0.3697
4	ATM	0.3591
5	STALPROD	0.3560
6	SANOK	0.3222
7	APATOR	0.3182
8	ZPUE	0.3146
9	ORBIS	0.3028
10	PEPEES	0.2727
11	LPP	0.2651
12	ALMA	0.2631
13	KOPEX	0.2625
14	TVN	0.2622
15	SWIECIE	0.2556
16	RELPOL	0.2545
17	PERMEDIA	0.2536
18	ADVADIS	0.2511
19	COMARCH	0.2508
20	INDYKPOL	0.2479

Source: own calculations.

Table 2. Structure of analyzed portfolios
and expected rate of return and risk

Fundamental portfolio (*FP*)											
ZYWIEC	ATM	ADVADIS							V_p	R_p	S_p
0.5444	0.2586	0.1971							0.1317	0.0438	0.0058
Markowitz model (*MM*)											
WAWEL	KGHM	ATM	APATOR	PEPEES	LPP	TVN			V_p	R_p	S_p
0.1222	0.1054	0.1507	0.2348	0.0941	0.1489	0.1439			1.3470	0.0150	0.0202
Modified fundamental portfolio (*MFP*)											
WAWEL	KGHM	ATM	APATOR	PEPEES	LPP	ALMA	KOPEX	TVN	V_p	R_p	S_p
0.1643	0.1484	0.1676	0.2173	0.0763	0.1280	0.0073	0.0005	0.0903	0.9054	0.0150	0.0136

Source: own calculations.

Table 3. Actual rate of returns on compared portfolios and index *WIG20*

Years	*FP*	*MM*	*MFP*	*WIG20*
2006	0.6082	0.5187	0.5710	0.2375
2007	0.1352	0.6327	0.6419	0.3017
2008	–0.2698	–0.2474	–0.2637	–0.3259
2009	–0.0895	0.2333	0.2803	–0.1003
2010	0.0437	0.6976	0.8147	0.0336
2011	–0.2271	0.4714	0.5686	–0.1923
2012	–0.1979	1.6095	1.7604	–0.0271
2013 (05)	–0.1483	1.8964	1.9704	–0.0994
2013 (09)	–0.1183	2.5044	2.5852	–0.0930
Average	**–0.0145**	**0.8025**	**0.8698**	**–0.0207**

Source: own calculations.

All calculations have been carried out with a weekly rate of return in mind. Figures 3 and 4 feature lines of efficient portfolios received with the application of the Markowitz model and the modified fundamental portfolio, respectively. Figure 5 presents a map of risk/rate of return for the analyzed portfolios. The data presented in Figure 5 shows that in the classic approach, none of the constructed portfolios should be bought as they carry expected parameters (rate of return and risk) that are worse than the *WIG20* stock index rate of return (lower gain at higher risk). This means that the use of classic methods based on the expected rate of return in the proposed solutions is not appropriate as it does not take into account the fundamental strength of the approach, that is considering the fundamental strength not measured by the historical rate of return, but by a synthetic measure of the attractiveness of investments (*TMAI*).

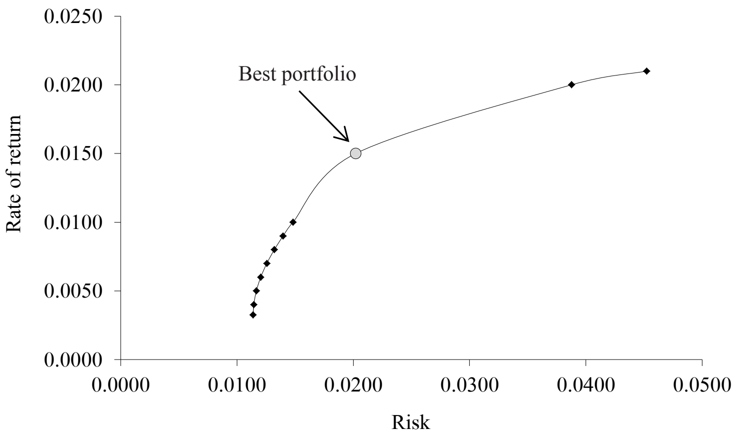


Fig. 3. Line of efficient portfolios – Markowitz model (*MM*)

Source: own calculations.

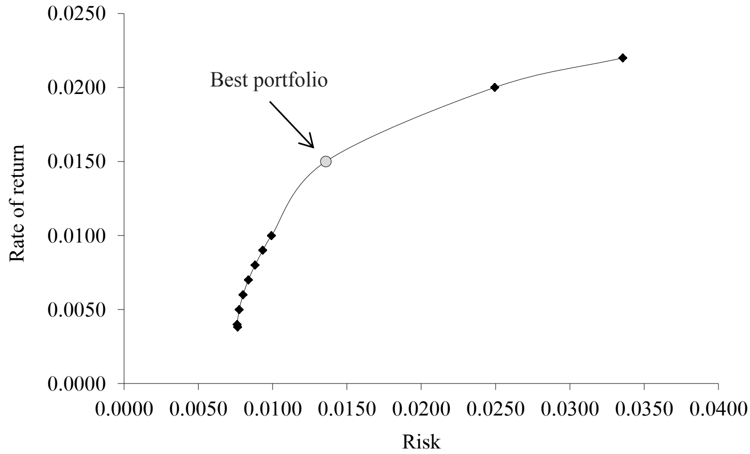
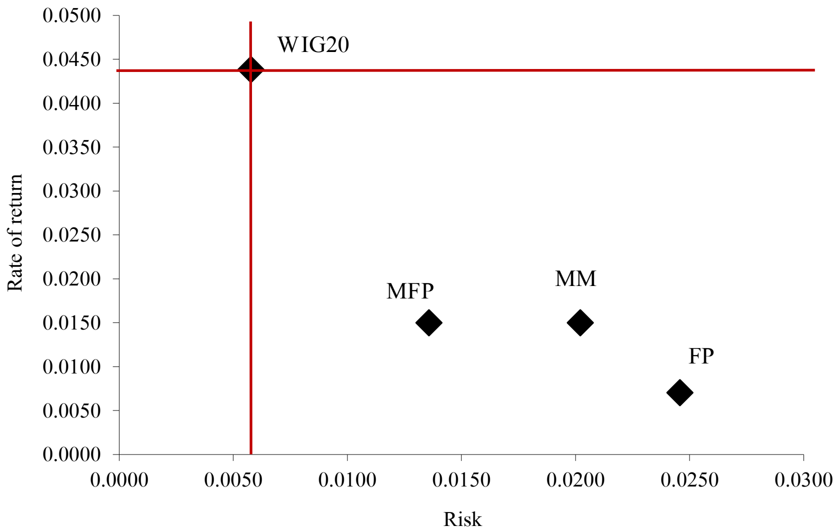


Fig. 4. Line of efficient portfolios – modified fundamental portfolio (*MFP*)

Source: own calculations.



MM – modified Markowitz model (for companies selected on the basis of *TMAI*).
FP – fundamental portfolio.
MFP – modified fundamental portfolio.

Fig. 5. Map of risk-rate of return for expected values (data 2005)

Source: own calculations.

The data presented in Table 3 leads to the conclusion that the practice proposition modified fundamental portfolio (*MFP*) is suited to market conditions. The modified fundamental securities portfolio (*MFP*) and the Markowitz model (*MM*) are much better than the *WIG20* stock index. During the analyzed period, the *MFP* portfolio gave the rate of return exceeding 259%, at the stock index rate of return of –9.30%. The classic fundamental portfolio of securities (*FP*) did not prove a success, reaching a loss of –11.83%. What also did very well was the classic Markowitz model, built taking into account the fundamental criteria (selection of companies to the database for which the portfolio was built) 250.44%. The average annual rate of return for *MFP* was 86.98%, at the –2.07% benchmark. What proved best in the analyzed period (2006–2013), which includes the bull market period of 2004–2006 and the 2007–2009 crisis, was the *MFP* portfolio which responded best to changing market conditions and steadily increased its value with time, which is the effect of the impact of fundamental factors included in the process of building the portfolio.

Conclusions

The paper proposed a concept of a modified fundamental securities portfolio. It is an alternative to the classic Markowitz model. The empirical study examined two variants of the fundamental portfolio (*FP* and *MFP*) and the Markowitz model built for the database created on the basis of *TMAI* at the *WIG 20* index rate of return as a benchmark. The study covered the years 2005–2013 (up until September). The studies confirmed the validity of combining the portfolio analysis with elements of the fundamental analysis. The results encourage further research in this direction. What seems to be theoretically correct (combination of the portfolio analysis with the fundamental analysis) has been confirmed in practice. The advantage of the proposed portfolio (*MFP*) is its simplicity, ease of construction, transparency and high efficiency.

Notes

1 Procedure for calculating TMAI is presented e.g. in Tarczyński (1994).

2 Markowitz (1952); Markowitz (1959).

3 Sharpe (1963).

4 Lintner (1965a); Lintner (1965b).

5 Mossin (1966).

6 Tarczyński (1995a); Tarczyński (1995b); Tarczyński (1996); Tarczyński (1997).

7 Tarczyński (2002).

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