Application of fundamental analysis methods to compare efficiency of complex portfolios consisting of values listed on stock exchange

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Abstract. The article presents theoretical basis and practical applications of selected quantity methods that can be used in building share fundamental portfolio, where elements of fundamental analyses and of classical portfolio theories are included. The new approach to creating a portfolio of securities, based on multidimensional comparative analysis is an alternative to models of Markowitz and Sharpe in portfolio analysis. This work shows theoretical basis of used methods and results of carried out empirical analyses.

Keywords: fundamental analysis, multidimensional comparative analysis, TMAI, BMS.

JEL Classification: C3, C8, G1, E4

AMS Classification: 91B28

1 Introduction

Due to changing market mechanisms and conditions, investing into financial markets is a compound process running is time and space. Uncertainty in obtaining investment goal, investment time, experience and psychological are the inseparable attributes in this process. However, the rational investor bases their decisions on intuition, experience and knowledge.

The aim of this work is to present models to support the investor in decision taking, which include new market tendencies. The process of investing into financial markets is a dynamic process depending on frequent changes, whose direction and impact is difficult to predict in the long periods of time.

2 Methodological elements of performed analyses.

Contemporary works on finances, econometrics and financial engineering present many methods which may help the investor in making decisions, among which we may distinguish methods of econometric predictions as well as methods of technical and fundamental analyses. In this article, selected methods taken from **fundamental analyses** and some notions of **classical portfolio theory** were used. The article consists of two basic parts. The first presents formulas and references as well as applied methods for data analyses; the other is of empiric character.

2.1 Multidimensional comparative analysis -TMAI construction.

When taking an investment decision on investment market, one should not base the decision only on such tools, which allow to analyses phenomena characterized by a single feature.

It is recommended to use methods that analyses complex phenomena, which are presented by a few (more than one) characteristics. **Multidimensional comparative analysis** (statistical comparative analysis) provide methods allowing to perform analysis of at least two variables, which describe the examined phenomenon. With such a device, we can compare different objects (companies or stock values), which are described by many features. On the basis of many data matrixes on objects, many taxonomic measurements can be built. The device may be also used to carry out an economic and financial check-up of a company. The estimation of *fundamental strength* of a given company by multidimensional comparative analysis is much more effective than the use of a single dimensional statistical method.

Fundamental portfolio of securities, built on the basis of multidimensional analysis is a long -term portfolio (is supposed to bring profit in long periods of time). Such a portfolio is highly efficient as it selects strong companies with regard to their economic and financial standing. Moreover, this portfolio is safe and stable in long periods of time.

The taxonomic measurement may be used to examine the attractiveness of investment, **fundamental power** of a company, which is its economic and financial condition. The analysis covers the period of three to five years

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back. The taxonomic measurement, which allows to work out fundamental estimation of a company, is called **taxonomic measurement of investment attractiveness (TMAI)**, in which by one number it is possible to present the standing of a stock-exchange company. While building TMAI measurement, the matrix presents diagnostic features of a company financial standing. The point is to choose out of many data, the most important ones, which can be done in different ways depending on the analyst and access to data. A properly selected set of data leads to an accurate evaluation of the company financial condition (Jajuga [1], Jaworski [2]).

The stages of building a fundamental portfolio of securities are as follows:

1. Analysis of company: macroeconomic, sector, estimation of company financial standing, and estimation of share interior value.
2. Synthetic measurement construction TMAI to evaluate fundamental power of company.
3. Building the function of aim, responsible for fundamental measurement synthetic maximizing.
4. Presenting limiting conditions.
5. Optimal solutions.

Building a taxonomic measure consists of three stages (Łuniewska, Tarczyński [3]), (Tarczyński [5])]. Having data matrix, we normalize (standardize) the values, following the formula

$$z_{ij} = \left(x_{ij} - \bar{x}_j\right) / s_j \tag{1}$$

where:

$\bar{x}_j$ – mean of feature *j*,

s_j – standard deviation for feature *j*.

Next, the module method is used, and in the normalized matrix of *m* variables, the highest value is taken, module z_{0j}. The Euclidean distance from the module is calculated, using the formula

$$d_i = \sqrt{\sum_{i=1}^{m} \left(z_{ij} - z_{oj}\right)^2 / m} \tag{2}$$

The shorter the distance of the given object from the module, the lower is the value d_i. The obtained variable is not normalized, which next is transformed into a stimulant using the formula

$$z_i = 1 - \left(d_i / d_0\right) \tag{3}$$

where:

z_i – taxonomic development measure for object *i*,

d_i – distance of *i* object from module,

d_0 – standard to assure that variable z_i will take values ranging from 0 to 1, for example $d_0 = \bar{d} + 2s_d$, where $\bar{d}$ – mean d_i and s_d – standard deviation d_i.

In order to include weights in taxonomic measure, the formula (2) is to be modified in the following way

$$d_i = \sqrt{\sum_{i=1}^{m} w_i \left(z_{ij} - z_{oj}\right)^2} \tag{4}$$

where w_j are the values calculated according to formula $w_j = V_j \Big/ \sum_{i=1}^{m} V_i$, and $V_j = s_j \big/ \bar{x}_j$ is the variability coefficient of *j* diagnostic variable for primary data (before normalization).

2.2 Non-norm synthetic measurement BMS

The analysis include the BMS measurement and following transformation formula of primary data transformation (Ostasiewicz [4])

$$y_{ij} = \left(x_{ij} - x_{\min,i}\right) / \left(x_{\max,i} - x_{\min,i}\right) \tag{5}$$

due to which variables become non-nominated quantities and receive the values ranging [0,1], retaining their different variance. The included synthetic measurement is the arithmetic mean of

$$BMS_i = \frac{1}{n} \sum_{j=1}^{m} \alpha_j y_{ij}, \tag{6}$$

where α_i equals -1, when the variable is destimulant and 1 when it is the stimulant; the higher the variable value, the higher the position in hierarchy is.

3 Inclusion of fundamental analyses selected elements and portfolio theory into the process of decision making.

Data taken from Stock Exchange in Warsaw and from London Stock Exchange were used for empiric analysis. The data related to companies dealing with the leading stock indices in the field of raw materials and output.

The selection of the data and indices showing fundamental strength of companies is subjective and depends on preferences of researcher and availability of data. Publication of data on fundamental strength of stock companies is different at various stock exchanges all over the world. Therefore, not always can you use the same model at different stock exchanges; the component elements of taxonomic measurements frequently have to be adjusted to published data.

Research period, namely years from 2009 to 2012 is described as period of financial crisis in the world, when investing into stock was very risky, and probably still is. Frequently, it was not connected with obtaining profit but rather with minimizing losses. Therefore, it is of primary importance to choose safe values, though there is no guaranteed profit.

3.1 Analysis on the basis of data taken from Stock Exchange in Warsaw

Empirical analysis includes data taken from Stock Exchange in Warsaw, namely data that characterize financial condition of companies creating WIG 20 index and those belonging to sectors of raw materials and fuels. Data was obtained from five companies in the period from 01.01 2009 to 31.12 2011. Values characterizing fundamental strength were selected, and in Table 1 (basis of data from: www.gpw.pl, www.bankier.pl, www.money.pl) averaged economic-financial indices covering the years were presented:

- Net profit margin index (net profit/net income from sales)
- ROA return of assets index (net profit/assets altogether)
- ROE return of equity index (net profit/own capital)
- Earning per share index (net profit/number of issued shares)
- Index P/BV (market price of share/company accountancy value for one share)

Company	***Net profit margin***	**ROA (%)**	**ROE (%)**	**Earning per share (zł)**	**P/BV**
BOGDANKA	17.5933	7.6867	11.0533	6.2967	1.7433
KGHM	32.4767	24.6933	34.0933	30.1933	1.77
LOTOS	3.99	4.32	10.2333	5.7333	0.5667
PGNIG	8.33	5.1867	7.6167	0.3033	0.9833
PKNORLEN	2.32667	3.7767	9.1533	4.71	0.77

Table 1 Results of empirical analyses, economical and financial company data.

The following values were calculated: historical rate of return R, standard deviation of return rate s, asymmetry coefficient A, and parameter β . TMAI were calculated for indices from Table 1 according to formula (1) – (4) and BMS values – according to formula (5) – (6)

Next, the indices were standardized using formula (1). Table 2 presents standardized values of variables as well as TMAI values. Module method was used (formula (2) and (3)). Every variable was given the highest value to build the module object. The distance of every variable from the module was calculated and the Euclidean distance was applied. The formula was modified by including weights based on variability coefficients (formula (4)).

Company	**R**	**s(R)**	**A**	β	**BMS**	**TMAI**
BOGDANKA	0.0010	0.0184	0.503941	0.6848	0.449926	0.488012
KGHM	0.0021	0.0298	-0.925854196	1.7266	0.707703	1
LOTOS	0.0012	0.0261	0.138393	1.0477	0.455379	0.353938
PGNIG	0.0003	0.0179	0.389455	0.6195	0.7165	0.348772
PKNORLEN	0.0006	0.0252	0.6377799	1.1321	0.402863	0.3392

Table 2 Results of empirical analyses for given companies. TMAI and BMS values.

Next, fundamental portfolio was built and with the use of Solver, the following optimization problem was solved. Calculation results are presented in Table 3. It turned out that basing on the above mentioned data, it is profitable to invest into companies like: BOGDANKA, KGHM, PNNIG . Adding the condition of including parameter value β did not change optimal result (task 2 and 3 as well as 5 and 6). Therefore, if one invests, according to model taken from task 1, dated 04.01.2010 the amount of PLN 1.000.000, the rate of return on

23.04.2012 is 46.19%. However, the investment horizon plays here an essential role as if one invested the same amount one year later, on 03.01.2011, the loss would be 5.4 %.

Model 1	Model 2	Model 3
$f=\sum_{i=1}^{5} TMAI_i x_i \to \max$ $\sum_{i=1}^{5} R_i x_i \ge \overline{R}$ $\sum_{i=1}^{5} s_i x_i \le \overline{s}$ $\sum_{i=1}^{5} x_i = 1$ $x_i \ge 0 \quad i=1,\dots,5$	$f=\sum_{i=1}^{5} TMAI_i x_i \to \max$ $\sum_{i=1}^{5} R_i x_i \ge \overline{R}$ $\sum_{i=1}^{5} s_i x_i \le \overline{s}$ $\sum_{i=1}^{5} A_i x_i \ge \overline{A}$ $\sum_{i=1}^{5} x_i = 1$ $x_i \ge 0 \quad i=1,\dots,5$	$f=\sum_{i=1}^{5} TMAI_i x_i \to \max$ $\sum_{i=1}^{5} R_i x_i \ge \overline{R}$ $\sum_{i=1}^{5} s_i x_i \le \overline{s}$ $\sum_{i=1}^{5} A_i x_i \ge \overline{A}$ $\sum_{i=1}^{5} \beta_i x_i \le \overline{\beta}$ $\sum_{i=1}^{5} x_i = 1$ $x_i \ge 0 \quad i=1,\dots,5$

Model 4	Model 5	Model 6
$f=\sum_{i=1}^{5} BMS_i x_i \to \max$ $\sum_{i=1}^{5} R_i x_i \ge \overline{R}$ $\sum_{i=1}^{5} s_i x_i \le \overline{s}$ $\sum_{i=1}^{5} x_i = 1$ $x_i \ge 0 \quad i=1,\dots,5$	$f=\sum_{i=1}^{5} BMS_i x_i \to \max$ $\sum_{i=1}^{5} R_i x_i \ge \overline{R}$ $\sum_{i=1}^{5} s_i x_i \le \overline{s}$ $\sum_{i=1}^{5} A_i x_i \ge \overline{A}$ $\sum_{i=1}^{5} x_i = 1$ $x_i \ge 0 \quad i=1,\dots,5$	$f=\sum_{i=1}^{5} BMS_i x_i \to \max$ $\sum_{i=1}^{5} R_i x_i \ge \overline{R}$ $\sum_{i=1}^{5} s_i x_i \le \overline{s}$ $\sum_{i=1}^{5} A_i x_i \ge \overline{A}$ $\sum_{i=1}^{5} \beta_i x_i \le \overline{\beta}$ $\sum_{i=1}^{5} x_i = 1$ $x_i \ge 0 \quad i=1,\dots,5$

where:

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

BMS_i – synthetic measure of investment attractiveness for *i*-company,

x_i – contribution of *i*-share in portfolio,

$\overline{R}$ – average rate of return for companies,

$\overline{s}$ – mean standard deviation,

$\overline{A}$ – mean asymmetry coefficient,

$\overline{\beta}$ – Mean coefficient β.

Such analyses, based on the a/m formula may be carried out for stock values from different stock sectors, and also take advantage of other data describing fundamental strength of companies. In this way, it is possible to compare portfolios, to which belong companies from given sectors (possible comparisons of companies), or choosing values from different sectors, having favourable qualities relating to selected indices of fundamental analysis.

Solution	Model 1	Model 2 Model 3	Model 4	Model 5 Model 6
X1=	0.555388292	0.751574064	0	0.468692832
X2=	0.444611708	0.248425821	0.46735873	0.223803519
X3=	0	0	0	0
X4=	0	1.14676E-07	0.532641269	0.307503649
X5=	0	0	0	0
Rate of return (%) **4.01.2010- 23.04.2012**	46.1892348	54.4636349	14.423967	37.7173163
Rate of return (%) **3.01.2011- 23.04.2012**	-5.3715624	0.37761	-3.16010934	2.7590323

Table 3 Fundamental portfolio.

3.2 Analysis based on data taken from London Stock Exchange

Research was based on data included in FTSE 350 High Field index and those belonging to Mining and Oil & Gas Producers sector. Values (table 4) informing about financial condition of companies on the basis of data presented on site www.londonstockexchange.com ,were selected. Averaged data for period from 2009 to 2011.

Company	Net Asset Value per Share	Profit After Tax	Return on Capital Employed	Earnings per Share - Basic	Equity Holders of Parent Company
BP	414.6666667	13177.33333	0.127467	68	12853
RDS A	3022	21459	0.156167	343.3333333	21187.66667
RDS B	3593.666667	21459	0.156167	343.3333333	21187.66667
AVOCET MINING	159.3333333	-1.19666667	0.018433	16.33333333	35.00666667
NEW WORLD RESOURCES	208.3333333	95.78666667	0.123667	1446.44	100.1266667

Table 4 Economical and financial company data, averaged for period from 2009 to 2011.

Synthetic measure values TMAI and BMS were calculated according to formula (1) – (4).

Company	Performance P	Volatility V	TMAI	BMS
BP	9.26%	2.521	0.622379	0.402399
RDS A	3.92%	1.468	0.934997	0.428834
RDS B	3.75%	1.533	1	0.434159
AVOCET MINING	5.60%	2.964	0.290343	0.268459
NEW WORLD RESOURCES	3.33%	3.64	0.259028	0.255849

Table 5 P, V, TMAI and BMS values for companies.

Next, fundamental portfolios 1 and 2 were built.

Model 1	Model 2
$f=\sum_{i=1}^{5} TMAI_i x_i \rightarrow \max$	$f=\sum_{i=1}^{5} BMS_i x_i \rightarrow \max$
$\sum_{i=1}^{5} P_i x_i \geq \overline{P}$	$\sum_{i=1}^{5} P_i x_i \geq \overline{P}$
$\sum_{i=1}^{5} V_i x_i \leq \overline{V}$	$\sum_{i=1}^{5} V_i x_i \leq \overline{V}$
$\sum_{i=1}^{5} x_i = 1$	$\sum_{i=1}^{5} x_i = 1$
$x_i \geq 0 \quad i=1,\ldots,5$	$x_i \geq 0 \quad i=1,\ldots,5$

where:

$TMAI_i$ – taxonomic measure of investment attractiveness for *i*-company,
BMS_i – synthetic measure of investment attractiveness for *i*-company.
x_i – contribution of *i*-share in portfolio,
$\overline{P}$ – mean value of P,
$\overline{V}$ – mean value of V.

With the use of Solver, the optimum task was solved.

SOLUTION	**MODEL 1, MODEL 2**
X1=	0.258076
X2=	0
X3=	0.741924
X4=	0
X5=	0
Rate of return (%)	
4.01.2010- 23.04.2012	-1.472553484

Table 6 Fundamental portfolio.

Optimal solution is characterized by negative rate of return, which is connected with big fluctuations of stock value prices during crisis times.

4 Conclusion

Investor, making a decision, is guided by the idea of obtaining highest possible profit at the lowest possible risk. In order to make the optimal decision, a rational investor is supported by different methods enabling analyses. However, the investor takes risks relating to making the right choices of analytical tools used for describing the task and selecting data for building a model. Therefore, the conclusion to be drawn is to include many methods and data for performing analyses, which allow to evaluate the examined object, taking into consideration as many features as possible.

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