Fundamental and Behavioral Methods in Investment Decision Making

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Abstract

This work presents theoretical basis and practical applications of selected quantity methods that are used for risk management on capital market. Several elements of fundamental analysis and theory of behavioral finances have been taken into consideration. Moreover, use of mentioned theories in process of making investment decisions was discussed and obtained results of carried out empirical analyses have been presented.

Key words

Fundamental analysis, multidimensional comparative analysis, TMAI, prospect theory, investment risk.

JEL classification: G00

Introduction

In contemporary publications on Econometrics and Financial Engineering there are many methods, which are used by investors in making decisions. Among them, we should distinguish methods of econometric prognosis as well as methods of technical and fundamental analyses. However, one should ask the question what role in decision making play theoretical models, and what role play psychological aspects. Combining both methods would seem to be a justifiable solution, in which the stiff mathematical and econometric rules are supported by a behavioral approach, which is more characteristic for the investor`s way of dealing.

In this work, selected methods taken from fundamental analysis as well as selected notions of behavioral finances have been used. The research consists of two parts, where the first presents formulas and references to literature on motions applied to data analysis, while the other is of empirical character.

1. Elements of multidimensional comparative analysis – TMAI construction

Multidimensional comparative analysis provides methods that make it possible to analyze at least two variables describing the examined phenomenon, which has several applications and plays a very important role on the capital market. Moreover, it allows to compare different objects that are described by many features. On the basis of data matrix on objects, many taxonomic measures can be built. A taxonomic measure may be used to examine the attractiveness of investments, fundamental power of a given company, which means the financial and economic situation of the company. Such an analysis may cover the period of past three to five years. A taxonomic measure, which allows to perform a fundamental

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company estimation is called a taxonomic measure of investment attractiveness /TMAI/. With the use of only one number, the condition of a stock company can be presented. When TMAI is built, the data matrix presents diagnostic features which characterize financial condition of companies. It is important to select among many available indices the most crucial ones, which allows to work out an accurate estimation of economic and financial condition of a company. A detailed division of indices is presented, among others, in the work of Jaworski [1]. However, in practice a standard set of financial indices is used for companies listed on Polish Stock of Securities in Warsaw, and can be found In Website of GPW.

Building a taxonomic measure consists of three stages [3, 4]. Having data matrix, we normalize (standardize) the values, following the formula

$$z_{ij} = \frac{x_{ij} - \overline{x}_j}{s_j} \tag{1}$$

where:

$\overline{x}_j$ – mean of feature *j*,

s_j – standard deviation for *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

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

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

$$z_i = 1 - \frac{d_i}{d_0} \tag{3}$$

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 $d_0 = \overline{d} + 2s_d$, where:

$\overline{d}$ – mean d_i,

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 $w_j = \frac{V_j}{\sum_{i=1}^{m} V_i}$, and V_j is the variability coefficient of *j* diagnostic variable for primary data (before normalization) $V_j = \frac{s_j}{\overline{x}_j}$.

On the basis of above presented formulas in the empiric part of work, TMAI measure has been built for data taken from Stock Exchange in Warsaw.

2. Selected notions of prospect theory

Methods taken from behavioral finances can be used, among others, for examining phenomena concerning decision making in investing on capital market. Generally speaking, prospect theory describes behavior of people facing risk.

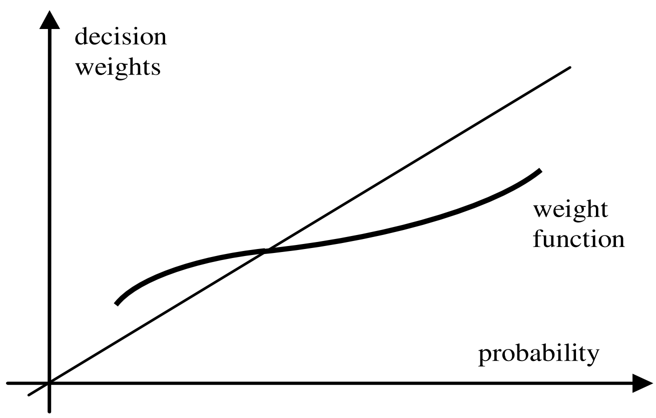
In 1979 Kahneman and Tversky suggested a model describing economic behaviors, this approach was called prospect theory. That theory proves some general regularities that are essential in investment decision making such as:

- Defining the problem may have influence on decision taking.
- Profits and losses of the same absolute value do not reflect the same absolute utility; a loss is more harmful than profit utility of the same value.
- Two consecutive losses are more harmful than a single loss of the same value.
- Investors are more likely to take the risk in order to avoid a loss, but rather avoid risk at a possible profit.
- Cumulative utility of two consecutive profits is higher than single profit utility at the same value.
- Deprived of risk profits are overestimated when compared to games whose expected value is identical, though result is not certain.

Utility function in the prospect theory is called the value function. An aversion to risk in face of expected profits, and on the other hand, a willingness to take the risk when facing a loss is assumed. Profits and losses are considered with regard to a certain reference point, we consider then the utility that results from change of profit and loss in relation to a certain module. It means that together with the change of reference point, the value of taken decision will change as well.

The prospect theory concerns also the way the investors estimate the probability of given events taking place at the moment making a decision. The authors of prospect theory brought in the decision weight function (weighting function) instead of probability. For little probabilities the function takes higher values than corresponding probabilities. However, for higher probabilities the function takes lower values than corresponding probabilities. Therefore, decision makers are inclined to increase little probabilities and decrease the higher ones.

Figure 1: Weighting function



Source: Own research on the basis of [2].

Value function may be described as dependence

$$Ew = \sum_i w(p_i)v(i) \tag{5}$$

where:

Ew – expected value function,
$w(p_i)$ – decision weights,
$v(i)$ – value function.

3. Including selected elements of fundamental analysis and terms of prospect theory into the process of decision making

3.1 Fundamental approach

Empirical analysis is based on data taken from Stock Exchange in Warsaw. Values of closing rates for Stock Exchange companies included in WIG 20 indices in June 2011 were used. Data on 19 companies, covering the period from 31st May 2010 to 30th May 2011 was obtained. For further analyses were included companies of positive historical rate of return *R*. Table 1 presents *R* and their return rate standard deviation *s*. Next, following averaged economic and financial indices of companies from 2007 to 2010 were calculated:

- 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)

NAME	*R*	*s*1000*	*Net profit margin*	*ROA*	*ROE*	*Earning per share (zł)*
BOGDANKA	0.001895	0.330765	0.114919	0.127510043	0.286411	*5.88945*
BRE	0.001231	0.243619	0.143464	0.062181209	0.115077	*68.671*
CEZ	0.000422	0.193351	0.213828	0.055847667	0.210089	*35.01*
GETIN	0.001357	0.195473	0.154519	0.046871957	0.08496	*1.0655*
HANDLOWY	0.001064	0.198724	0.154519	0.080054378	0.116857	*30.27125*
KERNEL	0.001217	0.471784	0.247733	0.098600726	0.245342	*14.12326*
KGHM	0.00279	0.438159	0.410187	0.021739611	0.142598	*5.135*
LOTOS	0.00163	0.255632	0.14646	0.007947603	0.13948	*18.1045*
PEKAO	4.55E-05	0.23363	0.201384	0.016524429	0.016524	*0.6845*
PGE	0.000683	0.130934	0.243638	0.213621431	0.303138	*17.17225*
PGNIG	0.001033	0.148576	0.032196	0.035047715	0.06808	*3.753*
PKNORLEN	0.001401	0.295156	0.28603	0.020351281	0.156309	*10.1265*
PKOBP	0.00034	0.23089	0.070273	0.04314059	0.061844	*0.23175*
PZU	0.000498	0.159572	0.013491	0.018003454	0.039687	*2.0965*
TPSA	0.000703	0.305653	0.242203	0.020906376	0.182682	*2.61075*
TVN	*2.08742E-05*	*0.226659*	*0.141075*	*0.069553953*	*0.170336*	*0.77575*

Table 1: Results of empirical analyses for given companies
Source: Own work on basis of data from www.gpw.pl, www.bankier.pl

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)). Weights for given variables were as follows:

- Net profit margin index – weight 0.166759
- ROA return of assets index – weight 0.266077049
- ROE return of equity index – weight 0.170169
- Earning per share index – weight 0.396995041

NAME	*Net profit margin*	*ROA*	*ROE*	*Earning per share (zł)*	*TMAI*	*Ranking TMAI*
BOGDANKA	-0.612398	1.299775	1.658145	-0.417455	0.41225	*5*
BRE	-0.326183	0.06721	-0.368254	3.034204	0.245028	*8*
CEZ	0.379346	-0.052285	0.755463	1.183464	0.414192	*4*
GETIN	-0.215333	-0.221631	-0.724456	-0.68267	0.125504	*15*
HANDLOWY	-0.215333	0.404425	-0.3472	0.923029	0.242212	*9*
KERNEL	0.719303	0.75434	1.172407	0.035231	0.334424	*6*
KGHM	2.348185	-0.695804	-0.042759	-0.458933	0.516094	*1*
LOTOS	-0.296138	-0.956019	-0.079636	0.254115	0.130076	*14*
PEKAO	0.254569	-0.7942	-1.533856	-0.703617	0.264676	*7*
PGE	0.67824	2.924445	1.855982	0.202861	0.480322	*2*
PGNIG	-1.441835	-0.444719	-0.924101	-0.534914	0.133464	*13*
PKNORLEN	1.103292	-0.721998	0.119404	-0.184506	0.078288	*16*
PKOBP	-1.060045	-0.292031	-0.997853	-0.728509	0.216067	*11*
PZU	-1.629391	-0.766295	-1.259911	-0.625987	0.458351	*3*
TPSA	0.663855	-0.711525	0.431321	-0.597714	0.184978	*12*
TVN	*-0.350137*	*0.206312*	*0.285306*	*-0.6986*	*0.234349*	*10*

Table 2: Normalized values of diagnostic variables and TMAI values
Source: Own research

Next, fundamental portfolio was built and with the use of Solver, the following optimization problem was solved

$$f = \sum_{i=1}^{16} TMAI_i x_i \to \max$$

$$\sum_{i=1}^{16} R_i x_i \geq \overline{R}$$

$$\sum_{i=1}^{16} s_i x_i \leq \overline{s}$$

$$\sum_{i=1}^{16} x_i = 1$$

$$x_i \geq 0 \quad i = 1, \ldots, 16$$

where:

$TMAI_i$ – taxonomic measure of investment attractiveness for *i*-company,
x_i – contribution of *i*-share in portfolio,
$\overline{R}$ – average return rate for companies,
$\overline{s}$ – mean standard deviation.

Additionally, in order to diversify the portfolio, a condition $x_i \leq 0.3$ was added, and the solution is the following

$x_3(CEZ) = 0.1$,

$x_7(KGHM) = 0.3$,

$x_{10}(PGE) = 0.3$,

$x_{14}(PZU) = 0.3$.

Calculation results are presented in Table 3.

Share	Share participation in portfolio	Price of share on 31st May 2010	Number of bought shares	Purchase cost of share	Price of share on 30st May 2011	Sales value on 30st May 2011
CEZ	0.1	140.3	71.27583749	10000	152.3	10855.31
KGHM	0.3	98.5	304.5685279	30000	188.2	57319.797
PGE	0.3	21.09	1422.475107	30000	24.64	35049.787
PZU	0.3	350	85.71428571	30000	388.9	33334.286
Portfolio value	1			100 000		136 559.18

Table 3: Fundamental portfolio
Source: Own research

Therefore, when one invests PLN 100000 on 31st May 2010 following the above presented model, on 30th May 2011 the return rate is 36.56 %.

3.2 Prospect theory approach

Future share price values are treated as random variables. Due to the construction of utility function values used below, based on standings, the higher the value of utility function, the more desired it is for the investor. It is possible, taking into account inclinations to take or not to take the risk, to adjust constant parameters of utility function to the preferences of investor.

Considering the formula by which we can establish value function in prospect theory, as the theoretical function vector of decision weights, there was taken a vector calculated as frequency appearance (probability) in case if the investor purchased only shares of WIG 20

$$w_T(p_i) = \frac{number\, of\ transactions\ for\ i\, share}{total\, number\, of\ transactions\ for\, WIG20\, shares} .$$

As an approximation of real decisions made by the investor a vector was calculated using estimated formula (value was added when $w_T(p_i) \leq \overline{w_T(p_i)}$, and subtracted when $w_T(p_i) \geq \overline{w_T(p_i)}$), according to Figure 1. An example of weight function may look like the following

$$w_R(p_i) = w_T(p_i) \pm 10 * s_i^{\,3} .$$

NAME	*Probability vector for decision weights* $w_T(p_i)$	*Vector of decision weights* $w_R(p_i)$
BOGDANKA	0.010368611	*0.010368973*
BRE	0.027511661	*0.027511806*
CEZ	0.015808138	*0.01580821*
GETIN	0.03170135	*0.031701425*
HANDLOWY	0.009720963	*0.009721041*
KERNEL	0.010168853	*0.010169903*
KGHM	0.160630891	*0.16063005*
LOTOS	0.036010518	*0.036010685*

PEKAO	0.068499429	*0.068499301*
PGE	0.065478048	*0.065478026*
PGNIG	0.066869468	*0.066869435*
PKNORLEN	0.077773545	*0.077773288*
PKOBP	0.135268185	*0.135268062*
PZU	0.096986314	*0.096986273*
TPSA	0.075415242	*0.075414956*
TVN	*0.030874589*	*0.030874705*

Table 4: Weight vectors for companies
Source: Own research

Ew values were calculated by formula (5). The following results were obtained

$$Ew = \sum_i w_T(p_i) TMAI_i = 0.274342282,$$

$$Ew = \sum_i w_R(p_i) TMAI_i = 0.274342324.$$

Therefore, allowing the shape of decision weight function produced higher value function.

Treating the values of average rate of return ($\overline{R} =$ 0.001020648) and mean standard deviation ($\overline{s} =$ 0.000254) as reference point, an investor willing to take the risk during decision making, will make the decisions with expected standard deviation higher than 0.000254 and expected return rate lower than 0.001020648, counting on events to happen: higher expected value with little probability. The decision maker who has aversion to take the risk will select only such shares that have variance lower than historical value and higher expected return rate.

Needless to say, that the way of calculating value of weight vector depends on the investor, and it has influence on *Ew* value. The decision is also dependent upon reference point. By choosing the corresponding values it is possible to describe behavior of investors, their preferences and manage investment risk in an active way.

Summary

The investor, making decisions wants to get the highest possible profit at the lowest possible risk. In order to ensure making an optimal choice, a rational investor may take advantage of different methods for analyses and help to make the best possible decisions. The risk connected with making decisions results not only from choosing and using the right analytical tools to describe the situation but also from own emotions and mental aspects.

The conclusion to be drawn is that combining selected quantity methods and using psychological theories is justified, but the future will confirm to what extent taking into consideration seemingly different fields of science may be useful in the process of making decisions, and managing investment risk.

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Web sites

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