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INVESTMENT DECISIONS MODELLING ALONG SUSTAINABLE DEVELOPMENT CONCEPT ON FINANCIAL MARKETS

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Abstract. The goal of the paper is development of the conception of sustainable return investment decisions strategy in capital and money markets and modeling of investment decisions along sustainable development concept in capital and money markets. The research was performed with an experiment in FOREX and in some matured and emerging capital markets. The adequate for investments decisions reliability assessment portfolio will be presented and analysed as main instrument for developing sustainable return investment decisions strategy. The cases of practical implementation of adequate portfolio will be widely described. Further, the pragmatical problems how to use the strategy as innovative and effective financial instrument for investors and stock treasury will be discussed. Practical calculation was made on the very last data of different markets.

Keywords: sustainable investment strategy, market behaviour, adequate portfolio, profitability, reliability and risk commensuration.

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1. Introduction

Making decisions in business and finances, we always face the problem of risk. Reliability and risk categories frequently are invoked together, while analyzing processes, system conditions and development sustainability. However, often these categories are conceived as opposite to each other: when risk increases, reliability possibility decreases, and conversely – when risk decreases, reliability possibilities increase. There is no doubt that such a statement is the generalization of real situations, though often such absoluteness of the reliability and risk definitions can interfere with a deeper research on these processes interaction (Rutkauskas 2006b; Rutkauskas 2008).

Risk category is used when the possibility of incurring financial or other loss is discussed. Whereas reliability category is used for stressing sustainability of the particular system, in

other words – its ability to retain identity or capability of performing its functions. In practical situations it is important to evaluate what requirement must be implemented in order to guarantee the system sustainability with the changes in internal or environmental risk.

Naturally, stock prices, currency rates as well as market generated investment effect are stochastical processes or sets of stochastical values. Thus the implementation of the used sustainable development decision strategy in capital and exchange markets requirements is measured according to certain probability criteria.

Usually analyzing investment decisions, the main attention is paid to two parameters – profitability, or in other way measured investment efficiency, and risk. Attention to those two characteristics is especially clear in modern portfolio decisions. However, investor along with investment profitability possibilities must have the characteristics of this possibility reliability or guarantee, which would determine the probability of each of the possibilities (Vaidogas *et al.* 2007). When discussing investment strategies, sustainability reliability assessment is the primary issue.

2. The concept of sustainable return investment decisions strategy

Strategy can be perceived from different points of view. In terms of organization, strategy is the entirety of decisions, describing the most important organizational future goals, also actions and means for reaching them (Garavelli *et al*. 2004). Strategy, in cybernetics opinion, is any rational rule determining certain actions in any decision-making situation. Formally, strategy is the function of the information obtained, which takes values in all possible set of alternatives at the given moment. This rule must include the whole decision-making period and all possible situations.

Determined rules and situations are named as simple strategies. Their using result is usually described as strategy implementation or non-implementation. Strategies composing simple strategies possibilities probability distributions, are named as mixed strategies; and about their realization we can say by these categories: by mean, with probability 1, by probability, etc.

Nowadays the strategy's category more often goes together with the adjective "sustainable". There is no difference – is it a global atmosphere pollution reduction problem, or is it a small firm energy supply problem. And this is explained not only in terms of intellectual development, but also in terms of behaviour economy. Naturally, with the beginning of the broad exploitation of the category "sustainable strategy", its contents vary a lot. However, almost unambiguous trend is noticed – sustainable strategy more often is described quantitatively, i.e. to find quantitive indicators allowing to identify strategy sustainability. There is no doubt that the core gratings for sustainability grounding is the reliability of the analysed strategy separate elements or their certain combinations.

Strategy in finances is understood as a plan of actions in order to obtain the highest utility. As major actions, attracting funds in finances are concerned with investments, investment strategies development becomes an increasingly important financial problem nowadays. Investment strategy is the investment decisions set, by implementation of which an investor attempts to get the best profitability and reliability combination. Here the possibility reliability

is a very important factor, towards evaluation of which the idea of adequate investment decisions reliability assessment portfolio was directed.

The sustainable investment decisions, or simply investment in currency and capital markets strategy, can be taken such a strategy, which allows to secure not less than market generated profitability, as well as invested capital value increase. Considering exchange and capital market riskiness degree and risk variety, the attempt to develop such a strategy can be seen as intention to swim through the Atlantic ocean with a simple boat. So the real solution of such a complex problem as sustainable investment strategy development is possible only with adequate means.

3. Trying to explain financial market behaviour

Various studies performed by the scientists have proved that application of various techniques can give promising results concerning stock markets forecasting (Zavadskas, Turskis 2008). As a result, a great deal of examples of different methods applications on stock markets has appeared in literature. Two main trends of stock analysis have developed over years: fundamental analysis and technical analysis.

Fundamental analysis is based on the study of factors external to the trading markets which affect the supply and demand of a particular market. Fundamental analysis is performed on the economy, industry and company levels and considers factors like weather, government policies, domestic and foreign political and economic events and changing trade prospects (Markowitz 1952).

Technical analysis is based on the theory that market prices at any moment reflect all the known indicators, which influence supply and demand on a particular market. It analyses market prices themselves. Technical analysis includes such methods as simple filter rules, moving average, relative strength analysis, and many other trading strategies. Also, more complex non-linear models for stock prices analysis, such as chaos theory, fuzzy sets, artificial neural networks are increasingly discussed among researchers (Biacino, Gerla 2002; Chatterjee *et al.* 2000; Grim 2006).

Trying to understand the market and explain its processes in order to forecast its behaviour adequately has lead to the formation of numerous theories and hypotheses. An *Efficient Market Hypothesis* (*EMH*) was formulated, stating that it is impossible to beat the market because prices already incorporate and reflect all relevant information. Supporters of this model believe it is pointless to search for undervalued stocks or try to predict trends in the market through any technique from fundamental to technical analysis (Fama 1965).

Another well-known theory is the so-called *Random Walk Theory* (*RWT*). This theory claims that market prices follow a random path without any influence by past price movements, making it impossible to predict with any accuracy which direction the market will move at any point. In other words, this theory states that the fluctuations of the stocks prices cannot be determined from historical price information (Chi, Lu 2006; Malkiel 1973). The proponents of this theory believe that neither fundamental nor technical analysis have any validity.

However, getting to perfectly know and adequately predict the market would lead to its inefficiency, and, in turn, inability to function properly – to valuate assets and distribute resources. Thus the main feature of the market should be incognizability. Rather, an assumption could be made that, in general, the market is more or less efficient, but there exist the so-called efficiency shoals (Rutkauskas, Kaleininkaitė 2005) on the market – certain sections of the market in a certain period of time – where it is generally possible with the help of adequate strategies to get higher than average investment returns.

4. The concept of market portfolio

The measurement of the market behaviour is best evaluated and repeated with the help of market portfolio construction. Thus there is a need to specify the concept of the market portfolio. A market portfolio is a portfolio consisting of a weighted sum of every asset in the market, with weights in the proportions that they exist in the market (with the necessary assumption that these assets are infinitely divisible). An investor who wishes to hold the market portfolio as part of his overall investment portfolio would theoretically hold shares in all the companies quoted on the stock market, in amounts proportionate to their total market values.

The concept of the market portfolio produces a definition of equilibrium market prices. If the market portfolio contains the shares of all the quoted companies, then the market prices of those shares (and hence the return they are expected to produce) must be such that they are acceptable investments for inclusion in the market portfolio. In other words, share prices are at equilibrium, when they produce an expected return that is just sufficient compensation for the risk that they involve (Lioui, Poncet 2001; Markowitz 1952).

It should also be noted that, given the risk reduction effect of diversification, then the market portfolio represents the ultimate diversified portfolio: it represents that portfolio of risky assets in which all the risk that is possible to eliminate, has been eliminated. However, a question can appear: how can any investor seriously attempt to hold a risky portfolio that consists of shares in all quoted companies? Several studies have shown that constructing a randomly selected portfolio of shares consisting of only between 15 and 20 different securities results in the elimination of around 90 % of the maximum amount of risk which it would be possible to eliminate through diversification. As a result, it is relatively easy to hold a portfolio of risky assets which closely resembles the market portfolio in terms of both risk and expected return (Lumby 1994).

5. The adequate portfolio – a better instrument for investment decisions evaluation

Adequate portfolio, retaining profitability and risk commensuration possibilities, reveals also profitability and reliability, as well as reliability and risk commensuration possibilities.

For a better understanding of the adequate scheme of investments portfolio risk analysis, let's consider both – the scheme of a classic or modern portfolio's study and the adequate one (Markowitz 1952; Sharpe 1963; Vaughan 1997). According to the modern portfolio

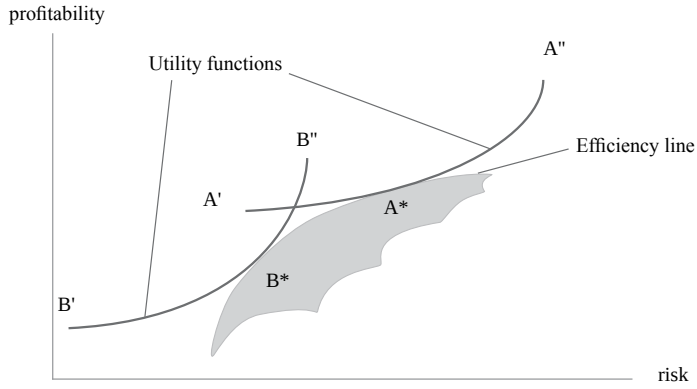


Fig. 1. Efficiency line and utility functions of modern portfolio

theory, the investor should be interested only in those portfolios, which are located on the efficiency line (Fig. 1).

The efficiency line is understood as a set of maximal expected values of profit (averages), calculated for the every standard deviation or another risk measure of portfolios value set. Putting the existing investments into a portfolio in all possible proportions creates the feasible set of portfolios' values (Fig. 1). Also, total portfolio profit averages and the standard deviations are evaluated.

However, in real situation profitabilities of portfolios, i.e. portfolio investments, are observed and realized not as averages of their profit, but as such possible values, which depend on investments market and acquisition price. Thus, it is important for the investor to see the whole range of portfolio profit possibilities, not only the portfolios, which are on the efficiency line of modern portfolio. So, the investor is interested in the whole efficiency zone, which is understood as the set of efficiency lines of all possible "standard deviation – quintiles" portfolio ranges (Fig. 2).

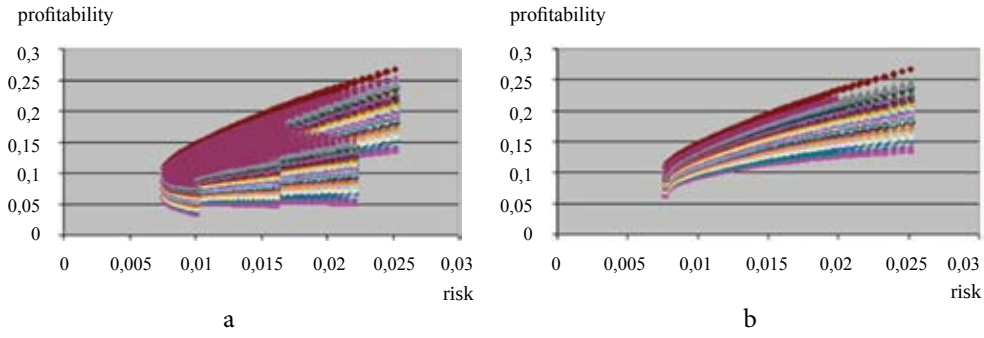


Fig. 2. Elements of the adequate portfolio:

a – Bunch of "quintiles (percentiles) – standard deviation" portfolios; **b –** The confidence zone of the adequate portfolio

So, analysis of the efficiency line, on which average value maxims of the portfolio are set for standard deviation of every possible corresponding portfolio, is replaced by the analysis of the efficiency zone.

Figs 1 and 2 compare modern, or "mean value – standard deviation" portfolio with the so-called adequate portfolio for investment decisions reliability assessment. "Mean – standard deviation" portfolio (Fig. 1) is a portfolio formed for independent values, having normal probability distributions. Next, a bunch of the possible values of all possible "quintiles – standard deviation" portfolios (Fig. 2, section *a*) is formed. More precisely speaking, there were not used all quintiles for this bunch, but only percentiles. In turn, the efficiency zone – all portfolios "quintile – standard deviation" set of values for each quintile efficiency lines – is presented in Fig. 2*b*.

There is no doubt that investor is interested not only in quantitative indicators of investment profitability possibilities, but also in a guarantee of each possibility, i.e. probability that investment efficiency (return). In case of modern, or Markowitz, stock portfolio, the guarantees of investment profit possibilities are usually not discussed, although in case, when portfolio returns possibilities probability distribution is a normal one, there is a direct possibility to evaluate these guarantees, if mean value and standard deviation are known (Rutkauskas 2000).

Fig. 3 shows a set of values of the adequate portfolio (left side) and utility functions (right side) interaction possibilities searching for the most useful portfolio values for the subject whose interests reflect the utility function. Applicate and ordinate axes reflect reliability and riskiness, and abscissa shows required profitability levels, which would guarantee a selected utility level.

Therefore Fig. 3 also could be treated as spherical view of Markowitz portfolio. True, it must be considered that in portfolio case discussed possibilities are maximums of some particular sets and this can have effect on the assessment procedures of guarantees.

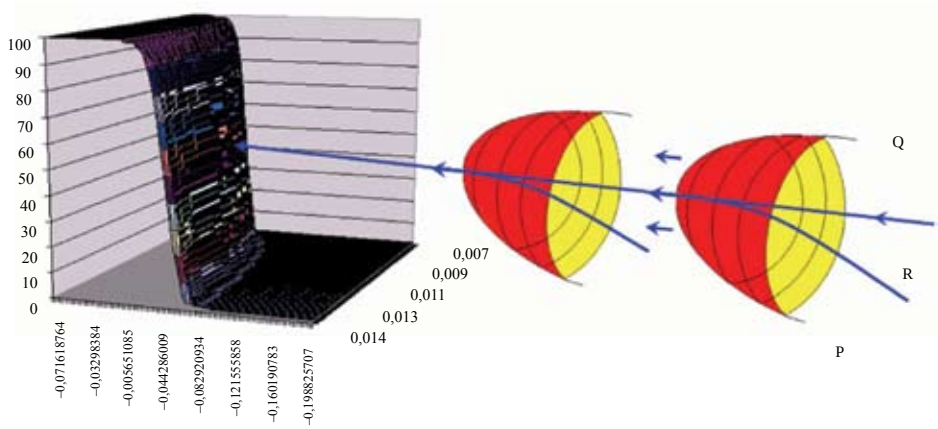


Fig. 3. Possibilities set and utility function in three-dimensional space

In this way, the further analysis of a portfolio should be moved from the rather obvious two-dimensional "profitability-risk" analysis to three-dimensional "profitability-reliability – riskiness" analysis. Thus analyzing the surface from one side, there is a set of izoguarantees, from another – a set of survival functions. As a result, this surface provides all the information for decisions possibility profitability, reliability and riskiness levels evaluation.

Thus it becomes clear that an investor is directly interested in two investment features. This is the profitability possibilities and guarantee, or reliability of each possibility, which is measured in probability p that possible profitability ξ will be not smaller than our selected profitability x.

$$\overline{F}(x) = P\{\xi \geq x\} = p\,. \tag{1}$$

Thus we can see that investor in principal should fully know the probability distribution of profitability possibilities

$$F(x) = P\{\xi < x\}\,. \tag{2}$$

Often if mean value of possibilities and possibilities' variance is given, the probability distribution of these possibilities is also known. However, it is not always the case. Usually knowing mean value and variance does not allow to describe fully the probability distribution and, in turn, the reliability and survival function (Rutkauskas 2006a):

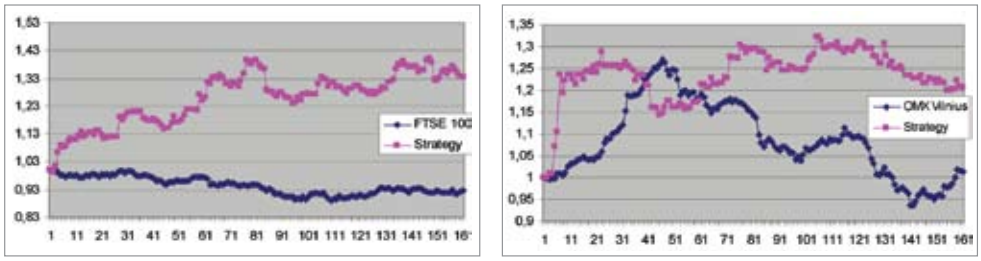
$$\overline{F}(x) = 1 - F(x)\,. \tag{3}$$

Also, and what is especially important, investor's risk usually goes beyond assets and portfolio riskiness, and this riskiness is only one of the factors influencing the extent of investor's risk. At that time reliability of outcome entirely rests on the profitability possibilities distribution function.

6. Description of the performed experiment

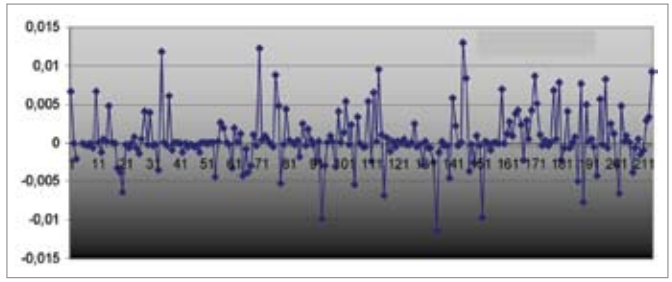
Adequate portfolio, its components and space utility function discussed in previous chapter are just separate, though very important elements of the decision management system on financial markets. In order to use decision management system on the financial markets for sustainable investment strategies search, it is required to use all its subsystems step by step (Rutkauskas, Kaleininkaitė 2005):

- To form strategy objectives and tasks and pre-check their theoretical logical correctness and conformity to possible constraints;
- To perform a more accurate historical data analysis, as well as currency rates, stock prices and their interrelation change forecasts;
- To choose and develop mathematical models of the formed objectives and stated constraints, select or develop decision-making methods for these models;
- To organize a wide monitoring in order to correct objectives and tasks adequately for changing circumstances, improve mathematical models and information supply, develop decision methods possibilities and constantly broaden the range of markets under analysis.

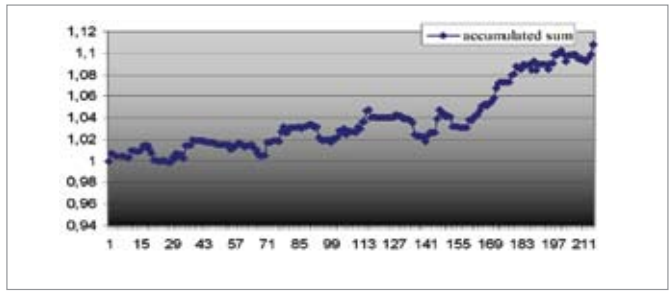


a b

Fig. 4. Comparison of indices and strategy using results on capital markets:
a – FTSE 100 (London) and the strategy. Daily step; **b –** OMX Vilnius and strategy. Daily step



a



b

Fig. 5. Results of one of the strategies application:
a – graphical view of changes in invested capital; **b –** accumulated capital sum

Using all possibilities of the developed system, the sustainable strategy search experiment is performed (The Double-trump Model Experiment). It emphasizes possibilities to choose such strategies in a series of markets. Here (Fig. 4) we will present examples of London and Vilnius markets.

Thus we can make a conclusion that in London and Vilnius the use of sustainable investment decisions strategy gives higher than average results, because on Fig. 4 the strategy results exceed the average market indicators – FTSE 100 and OMX Vilnius indices.

The system of sustainable investment decisions strategy development can be also implemented on exchange market (Rutkauskas 2005). Such application gives results that are further presented.

The main goal of the sustainable investment strategy development on currency market is the formation of the effective portfolio of currencies giving high return (Rutkauskas 2005). The main statements and organizing principles of the strategy:

- forecasting the probability distribution of rate change for the t+1 step using the historical currency rates data for the $[t_0, t]$ period;
- choosing a new currency portfolio for the t+1 step on the basis of the current portfolio and the forecasts;
- as soon as the historical dada for the t+1 period appear, evaluating the effect of the decision made;
- combining the t+1 period data with the historical database, we perform forecasts and make a portfolio for the t+2 period;
- continuing the process (Rutkauskas 2005).

Fig. 5 presents the results of the sustainable investment decisions strategy implementation on currency market. Section *a* shows the increase of invested capital, and section *b* – accumulated capital sum, if we compose a portfolio suggested by the strategy.

7. Conclusions

- Sustainable investment return strategy on the exchange or capital market can be called a strategy allowing exceeding market generated effect in a rather long period.
- One of the most suitable means for sustainable investment return strategy development is adequate for investment decisions reliability assessment portfolio. It differs from the modern portfolio, because modern portfolio operates only with two categories – profitability and risk. On the other hand, adequate portfolio commensurates profitability, riskiness and reliability.
- Sustainable investment return strategy was implemented on exchange and capital markets. The system of decision management in currency and capital markets, was used for developing and implementing a sustainable investment return strategy. Strategy implementation results show that the strategy is capable of achieving higher than the average utility.
- Getting to perfectly know and adequately predict the market would lead to its inefficiency and would question the main feature of the market – incognizability. Alternatively, an assumption that there exist the so-called efficiency shoals on the market would retain its incognizability and allow to predict it in certain time periods.

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INVESTICINIŲ SPRENDIMŲ MODELIAVIMAS VARTOJANT TVARIOSIOS PLĖTROS SĄVOKĄ FINANSŲ RINKOSE

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Santrauka

Pagrindinis straipsnio tikslas – tvariosios grąžos investavimo sprendimų strategijos kapitalo ir pinigų rinkose sąvokos apibrėžimas ir plėtojimas. Kartu siekiama modeliuoti investavimo sprendimus, vartojant tvariosios plėtros sąvoką kapitalo ir pinigų rinkose. Investavimo sprendimai buvo modeliuojami atliekant eksperimentą FOREX rinkoje ir kai kuriose išsivysčiusiose ir besiformuojančiose rinkose. Išnagrinėtas rinkos portfelio sudarymas, rinkos elgsenos tyrimo prielaidos ir metodai. Pasiūlytas ir išanalizuotas adekvatus investavimo sprendimų patikimumui įvertinti portfelis kaip pagrindinė priemonė tvariosioms investavimo sprendimų strategijoms kurti. Pateikti ir plačiai aprašyti adekvačiojo portfelio eksperimentinio taikymo atvejai.

Reikšminiai žodžiai: tvarioji investavimo strategija, rinkos elgsena, adekvatus portfelis, pelningumo, patikimumo ir rizikos subendramatinimas.

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